The Icarus Project

By Jeffrey Ellis

Part II

I stepped into the main hangar and looked at the unfinished Icarus spacecraft. In a little over a year since we had come down to Texas, we had made enormous progress. The aluminum airframe structure was nearly complete, essentially the shell of the craft. Curved structural pieces outlined the shape of the craft, with a minimum of metal used; inside, structural cross pieces and mountings for engines, various systems, cryogenic tanks, and crew quarters were easily visible inside through the large, weight saving holes (including the open nose.) All the components and systems of the spaceship would be mounted to this frame; outside, a thin composite skin would be covered by the thermal protection system. The entire assembly stood on several stands, but the mounts for landing gear were visible from the bottom. On top, a technician was preparing to wield something in that part of the structure.

"How was your trip?" Susan asked, coming in from the other hangar. I had just gotten back earlier in the afternoon from Virginia. We were still doing much of the system development up there, and construction had begun on the second of four engines. Troy and Peter were still based out of there. overseeing that part of the operation; between the road and Virginia I had been traveling most of the last week.

"Not bad," I said. "I hit some traffic going up, but not much coming back. And they've got thing under control up there; the prototype tests we ran all came out almost perfect."

"What about your truck?" she asked. For a number of reasons, I had kept my truck registered in Virginia, as well as my VA residence. Icarus is still, technically, a VA based corporation, and it seemed simpler to keep it that way. But that meant I had had to make time to get my truck inspected while I was up there.

"All taken care of." I said. "I told you it would pass without any trouble."

"I wonder about you and your truck sometimes." she said. "Here we are building an advanced rocketplane, and you're still driving a truck that's older than you are."

“It made the trip, didn't it?” I said. “Besides, the only time it sees a mechanic is when it gets inspected; I can do all the work myself. I couldn't do that with a newer car.”

She shrugged; she'd long since given up seriously arguing about my truck. “Do you want to do something this weekend?”

“I don't know; there's a lot to catch up on, after my trip.” I said. “Besides everything else, I've got to get starting on the simulator program. I've been putting that off since we finalized the airframe design.” That was important; now that we had the modeling done, I could take the data and build a flight simulator around it, which would practically show the flight characteristics of Icarus, and allow us to begin flight training.

“Still,” she said, “You could always use a break. Besides; I haven't seen you in a week and a half, and I don't think we've had a date in two months. And we've only been down to San Antonio a handful of times.”

“I'd like to do something,” I said equivocally. “There's just so much to do. And I told you once, Icarus takes precedence over everything.”

“We could catch a movie,” she suggested.

“Yea, maybe we could,” I said, still thinking about what had to be done, but also that a movie would be nice. “I have been wanting to see that new horror movie, Leathermask, that came out a couple of weeks ago.”

“I had a couple others in mind,” she said, “But I suppose we could check that one out, if you know where it's playing.”

“I'll have to look.” I replied. Leathermask had sounded interesting from the first preview I had seen. “I didn't see it on the theater here when I came through, though.”

“I still don't understand your fascination with horror films.” she replied. “All gore and guts.”

“Suspense. Excitement. Thrills.” I explained, “But they don't make them like they used to. You've

seen some Hitchcock, haven't you?"

"Only that one we watched a while back." she replied. "really, I wasn't that impressed with that, either."

"He was a true master of the art." I said. "He really could get inside your mind, play on your fears and anxieties. And he could do so much without resorting to crude brutality or shock value."

She shrugged. "I guess we can go see Leathermask; just find out where it's playing. But I'll pick the next film."

"That sounds fair enough." I replied, and turned the topic back to Icarus. "How have things gone down here?"

"Well," she said, and summarized some of the work that had been completed as she led me back into the other hangar. We had kept one as the main hangar for Icarus, and setup partitions to divide much of the other into office space, test labs, and the like. About half of the hangar was still open floor, and we had fabrication equipment set up, and extensive storage racks. We also had a couple of offices set aside for us, besides the hangars, but they were off in the main terminal, and we rarely used them. "We did catch a couple of bad wields on the airframe, but that's been an easy fix. Corbett said they would have been fine up at the Boeing plant; he'd thought we should just leave them as they were. But I told him we needed them perfect." Corbett was one of our chief wielders, and we had hired him not long after we got down here. He had worked for more than a decade building 737s up in Washington state before moving back home to San Antonio. He had heard about us in the media coverage when we first came down here, and had come by, interested in the work.

"And he agreed? Good. We've got to aim for perfection." I said.

A few weeks, later, the main group met to discuss some of the final systems to be designed. There were now six of us: besides the original four, Troy had of course joined, and Hank, our shop foreman, was fully participating in the planning and design stages. He was a valuable voice for what was

actually going on in the shop – we all tried to stay actively involved, but there was only so much we could do - and his experience as an aircraft homebuilder was immensely valuable, even more so than we had realized.

"There are probably the last two of the biggies." I explained, "The orbital control thrusters, and the Auxiliary power units to provide hydraulic power during launch and landing." We had discussed them before, but had agreed to put them off in favor of other systems, for a number of reasons. "For both, our needs are very similar to the space shuttle. However, the Shuttle uses hydrazine, which I think is more dangerous than the hydrogen fuel, and I'd rather use something safer. And hydrazine is expensive, and we'll have to custom manufacture the components – it'll be harder to find vendors than it was for engine components."

"Weren't you talking about getting jetliner APUs a while back?" Uncle Robert suggested. "That would be a perfect use of off the shelf technology. Just a matter of reconfiguring to use internally-supplied oxygen."

I shook my head. "I looked into it, but it wouldn't work, for two main reasons. First, aircraft APUs are generally configured to provide electrical power and air pressure; reconfiguring them to run hydraulic pumps would be almost as big an effort as designing one from scratch. Second, there's a problem of scale – I haven't been able to find one of the appropriate size for our needs."

"Could we use electric pumps to pressurize the hydraulics?" Peter suggested. "I believe the 777 does something like that."

"That might work, but it would be a major power drain." I said, considering it's implications, weighing the current power figures. "If we needed to add extra fuel cells, just for that, it would probably offset any benefits."

"What about running them off the main fuel tanks?" Hank suggested. "We could adapt the engine turbopumps pretty easily, I think."

I nodded my head. “That might work. It would certainly be a place to start.” I scowled. “Except that they'll need to run during deorbit and reentry, as well – they won't be able to run off the main tanks. We'll have to vent the tanks once we're on orbit, to prevent vapor buildup, and there wouldn't be enough pressure to maintain flow, anyway. We could run them off the fuel cell hydrogen, instead – but that would require a significant expansion of those tanks.”

We considered several other ideas, but they all had problems. We couldn't just buy something off the shelf, and different fuels all posed various problems. We discussed Hydrazine again, but that posed as many problems; I had already found it to be the most expensive option. Hydrazine is a monopropellent; it doesn't require a separate oxidizer. “Any monopropellent poses a significant hazard,” I pointed out, “As well as handling difficulties in the system itself.”

Uncle Robert had a suggestion, “If you want to use off the shelf systems,” he said, “Maybe you're thinking to directly – we're not going to find much in the way of available turbopumps or turbines; they're too limited a market. But internal combustion engines are much more proven, and widely available. We probably could find a diesel generator that would fit our power and weight specs, at least.”

Peter chuckled. “A diesel spacecraft.”

“Why not?” I said, liking the idea. It fit with many of our other solutions, adapting existing components from widely varied sources to our needs. We tested everything extensively, and never used anything we didn't feel was flight ready; but a NASA engineer would probably shake their head, looking at some parts of Icarus, and I pointed this out. “Diesel fuel is heavy, but workable; it has a high enough energy density we might be able to get away with it. Adapting any engine to work on tanked oxygen would be a bigger challenge, but should be workable. I noted a couple of other problems, notably finding and engine that would work under zero gravity (we'd hate to start reentry, only to find our APUs wouldn't start just as we entered the atmosphere) but there were probably more designs of

diesel engines than any other form of powerplant, and we just might be able to find one that worked. I said i would look into the possibilities, and we would go from there.

That left the thruster problem. Troy immediately suggested, “Why not use the diesel fuel for thrusters as well, if you're already bringing an additional fuel supply on board?”

The simplicity attracted me – we didn't want five or six fuel supplies aboard. But diesel would be the absolute worst thruster fuel, and I explained why. “The weight and thickness of diesel – the very things which make it such an efficient internal combustion fuel – would make it difficult to get consistent flow of small quantities. We could probably come up with a configuration that would work, but then there is the varied consistency of diesel fuel batches – we'd never get consistent thrust out of it.” I thought about it another moment, “Control thrusters are particularly difficult – they need to be able to activate very quickly, abruptly, for short bursts. Getting that to work for any dipropellant system would be difficult. And we've already been over the hazards of a monopropellent.”

And again, we suggested – and weighed – various options. Compressed gas seemed the safest option, but there was no way we could carry enough for several days. Some kind of pressurized gas generation might be possible – a small hydrogen/oxygen burner could pressurize a tank which could then supply the actual thrusters. This would eliminate the need for very precise control of burner start and stop, but was very complicated.

Hydrogen peroxide would work as a monopropellant, and was less toxic than hydrazine, but still posed the same basic problem: the inherent instability which made it suitable as a monopropellent.

“What about electric steam generators?” Susan suggested. I had been going over peroxide, which decomposes into steam. “We could have a liquid water reserve, and a small electric boiler to generate pressure. We would get precise control for thrust, and I don't think anything else could be safer.”

“Elegant,” I said, “but inefficient. Water's heavy, and electric heating is about as inefficient as you can get. Also, we would need to keep the pressure vessel sufficiently insulated during reentry, lest it

overheat and explode. Still, it probably presents the safest alternative, while meeting our needs. The thrust requirement would be minimal."

We discussed it some more, comparing it with peroxide. It would be more complicated to design, by a stretch – I couldn't think of similar systems being developed – but it's advantages led us to believe it was worth investigating. "I can run the basic numbers for water weight and possible thrust," I said, "And figure out if it's in the realm of possibility."

As we were breaking up, I sought Troy out and asked, "How's everything going up there?"

"About the same as you were up last." he replied. "Development work is going apace; we've hit some snags, but are working through them. I did want to talk to you about money, though; it's getting thin again."

"I know." I said. "I've been making the rounds of our investors, but without too much luck. Some of them seem to be getting investment fatigue."

Troy shrugged. "They want to limit their exposure. Even if they're big on the project, there's only so much they want to invest."

"That's basically what I meant." I said, "And it is perfectly reasonable. We just need to raise more. I'm going to work on another round of investor seeking, but there are only so many places to look; I've covered most major venture capitalists by now."

"You'll have to get creative." he said, "You've done remarkably well so far. I'm sure you'll think of something. But as I was saying, you'll need to do something soon."

I nodded; I've spent many days thinking of novel fundraising methods. "We could start selling advanced reservations, for when we actually fly."

"That could be risky, this far out." Troy said. "After all, we're still designing major systems. In most industries, you've got to be a lot closer before you start selling tickets."

"Yea, but this isn't most industries," I replied. "After all, two people have already paid $20 million

each for a few days on the space station – and they brokered that several years in advance. Just the prestige of being first in line when we finally do fly will be worth it to some. Still, it's chancy, especially if we wind up selling too early." It was an idea I had considered from the very beginning, actually; it was just a question of whether the time was right. Still, we had an airframe, and most systems were progressing. If I could sell it right – but selling it was only part. Even with the right contract language, people would start to get impatient.

"Although," Troy pointed out, "and leaving the question of timing to you, it would have another advantage – we could book it as revenue. It has accounting advantages, and our investors would like to see that we are getting some revenue." I nodded at this.

"Well, I'll talk to everybody, see where we stand." I said. "After that, I'll make a trip up and talk to our lawyer; we'd have to draw the contract up very carefully."

Talking with everybody confirmed my sense of where we stood, and our lawyer, while pointing out the legal risks, said the timing might be right. "Be clear about what your selling, and draw the contract up right." He didn't feel he was qualified to draw up the contract, however, and referred me to another.

That lawyer was very helpful, pointing out the need to avoid establishing status as a common carrier and the specific legal regulation that would entail, "And probably be illegal, as you are not at this point authorized to conduct passenger flights to orbit."

"We're not authorized to conduct any flights, as yet." I pointed out, "Orbital or otherwise."

"Ah, but common carrier law only cares about actions as a common carrier," he replied. "What else you do is beside the point."

In the end, we drafted a contract for flights "At such time as they are available." The terms guaranteed nothing, and no refunds would be given even if we never reached orbit. They were clearly laid out as reservations of space when that space became available.

Then, I set out to sell them, at a million dollars a piece. It was an easier sell than investments – I

targeted people who showed inclination to spend this kind of money, and had interest in spaceflight. Early tries didn't net much, but I soon had sold several contracts.

At the same time, I was busy developing the simulator program. I eventually integrated it with some available open-source software, patching together a couple of sources along with my own code. It wasn't as fine a model as I had used for airframe design, using the standard flight simulator approach of basic, easily calculable assumptions, but it still showed a very high conformity to my baseline tests.

I flew the first test with everybody watching. I'd set up only a very limited instrument panel, a few digital readouts along the bottom of the screen; my main concern now was to see how it actually flew.

I made a last check of the program parameters and simulated settings, then said, “Here we go!” and pressed the key to activate the ignition sequence. The screen showed us accelerating rapidly down the runway. As the speed picked up I began to pull the stick back, hard, and we lifted off. “Gear” I announced as I hit 'G' to retract, and pulled the nose up.

“BZZZ” came the stall alert, and a light on the bottom of the screen. We held attitude and little seemed to be happening on the screen, except altitude wasn't climbing as fast as it had been, then the nose began to drop. Airspeed increased rapidly as they nose dropped below the horizon, and we were nearly five hundred knots as we hit the ground with an unceremonious “CRASH” written across the screen.

“Let's try that again.” I said, resetting the simulation, and the same thing happened (although I did gain a couple hundred more feet.) “I'll try pitching up a little less steeply this time to try and avoid the stall. Engine power should be enough to maintain climb.” I had to pull the stick as hard to get off the ground, but I let up a little more. For a second I had it, then the stall siren came on again – I lowered the nose slightly, but it began to sink again. I was able to hold it above the horizon, but speed was increasing very rapidly. I was just about to begin to pull up again when the screen froze, with the message “CRASH! DYNAMIC STRESS LIMIT EXEEDED!” In short, I had gone supersonic at too

low an altitude, and broke up. “At least I kept it – sort of – under control.”

“I hope it's not going to do that for real.” Peter pointed out.

“I just got to get the hang of it.” I said, resetting once again. This time, I was able to avoid stalling and pulled to almost 80 degrees, but when I began to roll towards launch heading, it wasn't enough – a little more rudder, suddenly it began to oscillate, then spin out of control. I tried to pull back and forth, but not quick enough as I arced over and spiked into the ground.

“Let me try,” Hank said. “It's gonna need a pilot's touch.”

I reset the simulator again, and showed him the keys. “These triangles show your flight path.” I said, pointing them out on the screen. You'll pitch up to 80 degrees above the horizon, then begin to roll due eat to launch trajectory.”

“What's my rotation speed?” he asked.

“215 knots.” I said, and he whistled at that.

“Gotcha.” Hank said as he launched. He did better than me – slightly – but in six flights was never able to stay airborne more than two and a half minutes. “It's extremely sensitive,” he said, “Doesn't feel much like anything else I've flown – some pretty odd characteristics. And with all that power, you'll lose it real quick.”

“I think,” said Uncle Robert, “That you're going to have to learn to fly. Many, many things.”

“I figured that,” I said. “But was putting it off. I was hoping-”

“Hoping what?” Peter asked, with an almost betrayed tone, “That you could just fly it?”

“That I could get enough of a handle on it to asses it's practical flight characteristics.” I said. “Extensive flight training was always part of my expectation, before anyone actually flies Icarus. Jet training at least, and probably into the military trainers as well. I was hoping to wait until the airframe was a little further along, but I suppose the sooner we start, the more hours we can get. Now, Icarus calls for a crew of three: Commander, Pilot, and Flight Engineer. The Commander and Pilot, at least,

should be fully trained and qualified. Given backups, at least four of us should be qualified, but six or eight would probably be better. I'd rather not go any more, this is going to be expensive. I'll go, to start. Hank, what about you – you've already got your private pilots license."

"Yea, but just trying that thing – feels way out of my league." he replied.

"Still, you did better than me." I replied. "And where else will you get trained to fly jets."

"That's true." he said. "Might as well try; count me in."

"Alright, who else?" I asked. Peter hesitated, then said he'd have to think about it. Uncle Robert said, "Maybe if I was twenty years younger. But I don't have the reflexes for that anymore." There were a couple of other people interested, but no firm takers. "Well, anyone who's interested, talk to me. And I'll be talking to some of you, as well."

I brought it us with Susan later, over dinner one day. "How about doing the flight training with me?" I asked.

"I don't know," she said. "I've never really thought of myself as the flying type. It's just never really been something I wanted to do."

"Still, doesn't it sound like fun?" I asked.

She shrugged. "Maybe, but I could think of other things I'd rather do. Besides, we're not just talking about a small plane here. You made a fine show with that simulator. And Hank, too, and he is a pilot."

"Well, it'll take a lot of practice." I said. "And one more thing we have to do. But it's something we could do together."

She looked at me and said, "We do enough together with Icarus. It's time to get together outside of Icarus that I'd like more of."

"You knew what you were getting when we started going out," I said. "And if I'm doing flight training, I'll only be that much busier."

“You better still have time for me.” she said sternly. “Do what you can.”

“Oh, I'll do that,” I said, “No matter what.” I reached over to take her hand. “But Icarus is still my baby, and you did see that flight today. I am gonna have to do alot of work. I'd much rather be doing it with you.”

She looked at me and laughed. “You are obsessed. And you can be persuasive when it comes to Icarus. Which is very funny, because you can be so shy other times.”

“Well then tell me what I have to do to persuade you and I'll do it.” I said. I really did like spending time with her, but knew flight training was going to take a lot.

“Well, you could start by buying dinner,” she suggested,

“But I was going to do that anyway.” I said.

“And go see 'Third Bride' with me.” she said. That was a romance move – a chick flick – she'd been wanting to see.

Now I chuckled. “Are you trying to bribe me?” I asked, “Because I said you could pick the movie next time. I just wasn't sure when it would be.”

“Ah, Dan,” she said, “You can be so confounding.” She shook her head, and let a wry smile. “I won't promise anything, but I'll give it a try. Does that sound good?”

“That sounds perfect.” I said. “I'll talk to the airport people right away; I know they offer lessons there. We'll have to do ground school first; I'll let you know when I get that set up.”

“Alright.” she agreed. “Now, when do we see my movie?”

No one else was interested, at least at the moment, so I scheduled Susan and I for ground school. We could have gotten most of the ground instruction from one of the instructors at the airport, but given our specific, and very complex goal of being able to fly the Icarus, we decided on a classroom course at a San Antonio college. Speaking with a couple of the flight instructors confirmed my supposition that it would give us a better grounding in theory. It was a sixteen week course, a total of forty-eight hours

classroom time. Hank deferred, although I suggested he might benefit from some of the more advanced theory – he already had ground school, and preferred to begin refreshing his flight skills. “The truth is,” he said, “I've kept proficiency flights up since Icarus started, but not much more.” He also pointed out that his pilot's certificate already served as prerequisite for the higher level ground school needed to advance his license. We also could have gotten our FAA medicals and begun flight training while also taking the class, but had to much to do continuing to build Icarus.

Class was one evening per week, on Thursday nights, so on the appointed night, Susan and I left the airport, got in my truck, and sped down towards San Antonio.

“It'll be exciting learning to fly,” I said.

“I guess.” Susan replied.

“At least it will make things easier to get home on occasion.” I said. “Just hop in the plane and takeoff.”

“It won't be that easy,” she said, “Or cheap, even compared to taking a direct flight.”

“No, but we'll need the flight hours, as well.” I said. “And it will be quicker than driving.”

“That's true.” she said, “But really, I'm just looking forward to spending the time with you. And forwarding Icarus, of course.”

We got there well before class started, so we could find the campus bookstore and pickup the materials for the course – a book of FAA regulations, a small textbook on learning to fly, and a course booklet – then we made our way to the classroom.

Sitting down, towards the front, Susan said, “I feel like I'm back in college.”

“I know what you mean.” I replied, looking around the classroom. The students still coming in were a mix of young college students and adults of a varied range; most had the same books we did with them. A few had backpacks or other indications of being full time students, and others were clearly here just for this class. “I don't think I've been in a classroom like this since I graduated.”

The professor walked in, right on time. A slightly older man man with a beard, he introduced himself to us as “Mr Howey” and said, “This is Aviation 101, which will cover the basic principals of flight, aircraft operation, FAA regulations, and the like; it meets the FAA requirement for ground instruction for a private pilot's certificate. Most of you are registered as part of this schools flight training program, some as part of the aviation engineering program, and a few for an independent course.” He then read the roll, stopping for a moment after my name, then continuing. “For those of you taking this as a part of flight training, the FAA does require complete attendance, so I will be taking roll.. There will also be a fifteen minute break at a convenient interval each night.” He then gave a brief overview of the content of the course, then began by going over the basics (like the parts of an airplane.)

When he called for break, he asked me to stay in the room a moment; so Susan and I did. “Are you the same Daniel that's building a spacecraft up in Domingo?” he asked.

“I am, in fact.” I said. “The Icarus Project. But we need to learn to fly it, as well as build the thing.”

“I would have thought you'd have that down by the time you started.” he said.

“No, not really.” I said. “We've been doing design work so far, and building components. Designing Icarus has pretty much taken up all our time and money.”

“And I take it you're with Icarus as well?” he asked Susan.

“Yes, I am.” she replied. “I do a lot of the chemistry, help manage things. And of course look after Daniel here.” He chuckled at that.

“I remember reading a couple of things about that a while back,” he said, “I thought I recognized your name. How far along are you?”

“We've got the skeleton of the airframe complete, and a lot of stuff in place on it.” I said, and gave him a quick summary. “We're using a lifting body design, somewhat different from the basic airplane.”

In a moment, he said, looking up at the clock, “Fascinating. It' always interesting finding out the different things students are doing. Well, we've got to get back to class.”

Afterwards, as we were leaving, Susan asked, “Do you want to stop for dinner on the way back?”

I looked at my watch and said, “I don't know. It's almost nine now; it'll be almost eleven by the time we get back to Domingo. If we stop on the way, we may not get back until midnight.”

“And then we'll still have to eat,” she said. “I'd rather find somewhere to stop here; no place will be open in Domingo.”

“We also have to get up in the morning." I said. "What did you think of the class?”

“I think I'd like to get something to eat,” she said. “Then we can talk about class.”

“We'll talk on the way.” I said, knowing it was inevitable – we would stop for dinner. Susan could be more stubborn than me, when it suited her. And in truth, I was hungry – I just didn't want to get back that late.

We did the same for the next sixteen weeks – class, dinner, then drive back. Uncle Robert commented one Friday how tired we looked, and another time Peter asked what we had really done when we left early the day before, but things went well enough. In truth, things were running pretty smoothly, and Icarus was quickly taking shape. The last few systems were resolved, although they still have to be built. Class itself was interesting – a lot of the material I knew already, but not all of it, and certainly less of the practical stuff.

Finally, the Friday before our last class, we both went to get our medical certificates, and schedule our flight training, although we wouldn't begin until the beginning of the year (we were going back to Virginia for Christmas, and thought it would be disruptive to start before that, since it was already December.) We would finish the instructor hours within a month, and then take our checkrides as soon as we were ready.

I started my lessons first, within a couple days of getting back down. We had contracted with the

most experienced instructor at the airport, Mr Gary Beatman. A little before the scheduled time, I hopped in my truck and pulled it onto the taxiway for a shortcut to the General Aviation terminal. Hank, Susan, Uncle Robert and I all had received clearance to drive in the airport area. We had been told that, at large airports, cleared personnel still need a good reason to drive out on the tarmac, but with traffic here so light, “Just keep an eye out, and keep away from moving aircraft.”

Gary had just pulled the rental plane up when I got there, and commented as I got out, “I don't usually get customers coming across the airport.”

I shrugged, and said “I'm sure you don't get customers looking for what we're looking for, either.”

“No, I suppose I don't.” he agreed. “But you understand I'm going to be especially hard on you. You don't want to pick up any bad habits here.” I agreed, and he explained, “I've already done a preflight here, but we'll go over that first.” Once he'd walked me through that, and we were in the cockpit, he said, “I like to give my students as much control time as possible; I'll generally only touch the controls to show you something, or if I have to recover the airplane. Don't worry, though; I'll be ready to take it in an instant if necessary. I will take the radios, though, today. Now, let's start her up.” I followed his instructions, and in a moment, he checked with the tower, and had me taxiing away from the terminal. He had me taxi around the airport a couple of times, so I could get a feel for it, then told me to be ready to turn onto the runway for takeoff. After he got clearance from the tower, walked me through it. “Remember to check all your control surfaces first, then a little squirt of power to get rolling. Once on the runway, turn to line up with the centerline. You've got the runway, so once you're lined up, give it full power for takeoff.”

“Got you.” I said as I did so, making sure the control surfaces worked, then pushed us onto the runway. “Here we go!” I said as I gently pushed the throttle in to full, and we began to speed down the runway.

“Give it a little rudder to counteract the torque,” he instructed, and I kept us straight with the rudder

pedals. We bounced a little as we gained speed, then he said, “Alright rotate, gently.”

I pulled back on the control yoke and felt the nose lift up, then the main gear come off the runway. We were in the air. “Use the ailerons to keep straight with the runway.” he instructed, and the plane bobbed back and forth, and drifted slightly off the centerline. “A little more ... you're drifting.”

“I see that.” I replied, fighting with it a little to get us in line.

“Remember, you fly the plane. Don't let it fly you.” he said. “Alright, climb to 2500' then begin to level off.”

Getting it level took a bit of work, but I got it – although we rose another thousand feet before I did so. He had me turn, to get out of the flight path of the airport, then we worked on turning, climbing, descending, flying level, and transitioning between all of them. I thought for a moment about Icarus, how different it was going to be, gaining altitude quickly, rocket engine pushing – but this was all basic flying skills, and necessary to do that.

I got it, slowly, and not very smoothly. We were airborne for almost two hours, before he directed me back toward the airport. “Time for a break,” he said. “I usually work in hour lessons, you know. But that's alright. Here, I'll take it in.” He did so, bringing us in for a smooth, easy landing. “Walk around, stretch you legs, then we'll go up again.”

I used the bathroom, then spent a few minutes looking out over the airport. It wasn't very busy, even for general aviation, but I saw a couple of planes take off. When Gary got back, he had me do a preflight, then taxi to takeoff while he handled the radios. This time my takeoff was a little smoother, and I did a better job of keeping over the runway as we ascended. He had me practice more maneuvers, over an over. Turn this way, turn that way. Fly along a road. Fly S curves over the road, to one side, then the other. Fly a box over a field. Go up. Go down. Fly slower, increasing pitch to maintain altitude.

Finally, he had me try landing. “Don't worry,” he said, “I'll take over if I need to.”

I got us in line with the runway but was too high; I flared early, stalled, and hit the runway with a thudding bounce. We tried a couple more landings and they were smoother, but not by much, and by then, time was up.

“Good job, for a start.” he said.

I laughed; I felt like I had been all over the sky. And I still felt that first landing. “Yea, right.” I said. “I know, I've got a long way to go.”

He shrugged. “No, you really did alright.” he said. “Most people have trouble the first few times; even so-called 'natural pilots' don't get it right away. Besides, we did about four lessons worth of work today; doing it rapidly like this will help you, as well. Just don't let it overwhelm you.”

“I'll try not to.” I said. “Thanks. Same time tomorrow?”

He nodded; Susan came out in a moment. “Here I am,” she said as she came out. Looking at me, she asked, “How did it go?”

“Alright, I guess.” I replied. “I'll tell you about it later. Good luck up there.”

“Thanks.” she said, then went with Gary. I watched as he took her through the preflight inspection, then had her taxi around the airport like I had done. After a few minutes, they taxied onto the runway and took off. I watched her until she disappeared into the distance, then got in my truck, and headed back across the airport to our hangar.

Uncle Robert saw me come in and asked, “How'd it go?”

“Well, the plane's still in one piece.” I said, shaking my head and saying nothing.

“Not so good, huh?” he asked. “We'll you'll get it with practice.”

“Maybe. Lots and lots of practice.” I said.

“Don't worry about, Dan.” he said. “If you can put half as much effort into learning to fly Icarus as you did into building her, you won't have a problem.”

“I suppose not.” I said, and went into one of the smaller offices. Really, I didn't feel very good

about it; I had been all over the sky. I'd had trouble keeping it straight, trouble keeping it level, trouble making nice, even turns. And those landings! And this was just a Cessna 150, a tiny, two seater – I thought about the Icarus, standing over in the other hangar. Was I going to be able to fly it?

Well, I had other things to do, anyway. Flying or no, I had a lot to do before it would matter. Most of the major systems were designed, but there were always details to be worked out. Weight was getting closer and closer to the critical limit – the inclusion of diesel engines for hydraulic power had added considerable weight, and things were still up in the air for the thermal protection system. I pursued a couple of things, and worked on a couple of components, until Susan walked in.

"Oh, is it that late?" I asked, a little surprised. I guess it was easier than I expected to lose myself in my work. "How'd you do?"

"Alright," she shrugged. "But I thought we were going to do our flight training together."

"Yea, but you know the regs. Besides, it's probably best to do our basic training one-on-one. We'll pair up for the more advanced training. Besides, you saw that airplane – where would a third person sit?" I said. I had been disappointed that we wouldn't be able to ride with each other as we trained; it would have been nice to have be able to give each other feedback on how we were doing. "Why don't we get dinner, and talk about our flights. Somewhere in town, though; we've got to do the same thing again tomorrow."

"Sounds good." she said. "Actually, that was more fun than I expected; but it's good to be back on the ground."

We settled for one of the diners here in town, and I told her about my flights. "I was all over the place; I could barely get the airplane to do what I wanted. It was not good."

"Well, I guess I did better than that," she said. "But it's not easy." she told me a bit about her flights. "I guess it'll get easier with practice."

"I hope so." I said. "Anyway, how did things go down here this morning? I pretty much shut

myself in that office and worked all afternoon."

"Not bad." she replied. "Not bad. Anyway, maybe we can catch a movie this weekend? I know we've got a lot to do, but it'll be a nice relief after two days of flight training."

"Yea, maybe," I said. "But not like that one we saw over Christmas. I'm sure you can find something better."

"Yea, that really wasn't .. what I expected." she said, and we talked about it, and other things.

Things did, in fact, get better as we continued the lessons. Gary had me do takeoff after takeoff, landing after landing, and patiently had me practice each and every maneuver, and I did do them smoother. Gradually, I began to feel like I was flying the plane, not the other way around.

It was still a lot of work.

I forgot to scan gauges, lost track of vertical speed. Over and over we practiced. The first time we did crosswind landings I kept drifting over – I had to abort my first three attempts and was starting to get frustrated, when Gary said, "Just keep calm; everybody has trouble with these. When I first learned to fly, in a Piper Cub, I got blown all over the place. By the time I got it down I was sliding right across the runway centerline." He shook his head. "If it was anything but a cub I think I would have wrecked it. I'd have been in the grass at least."

"Yea, but" I said. I was on downwind, preparing for yet another approach. "But I'm planing of flying the Icarus. If I can't master this thing ..."

"Don't worry about it." he said. "Anyone can master these little birds, some just need more practice than others. As to the big birds, well, I've known people who picked things up quickly, but couldn't manage anything more than this, and others who came up very slowly, and went on to fly the big iron. Sometimes, it's effort more than natural talent – and sometimes even natural talent takes a while to come out. Just keep at it, and you'll get it." And I kept at it, and, at times, I felt like I was getting it. Other times, I wasn't so sure.

We did four hour lessons, twice a week; after the first few sessions, Gary endorsed both of our certificates, authorizing us to begin solo flights. “Get as much practice as you can,” he said, “And of course, I'll continue working with you. You're catching on pretty quickly, now. It won't be long until you're ready for your ppl checkride.”

The following Saturday, I rented the same 152 for my first solo. I was both nervous and excited as I carefully went through my preflight. Flying is something I've wanted to do since I was a little kid, and now, here I was, about the climb into an airplane and fly it, all by myself. But it's harder than I ever thought – I've just had so much trouble getting it.

Well, I said to myself, if I'm gonna do it, it's time to do it. I look up at the clear blue sky; the weather report had said this was a perfect day for a first solo.

As I climbed into the plane, I mentally went over my plan for the flight. Take off, head southish towards San Antonio. I would practice a few turns along the way, but mostly I just wanted to get comfortable soloing. After twenty minutes or so, I would turn around, and head back towards the airport.

With the plane started, I contacted the ground control. “Cessna NM703 ready to taxi, south departure.”

“NM703, taxi to runway 5 and hold short.” came the reply. I acknowledged it, and gave a spurt of power to start taxiing. Within a few moments I was waiting at the runway. “Cessna NM703 at runway 5.” I announced.

The reply came, “NM703, Switch to tower on 116.4”

“116.4, understood.” I said, and switched my radio. “Tower, this is Cessna NM703, requesting VFR departure to the south.”

“Cessna NM703, hold short. American Flight 6204 on final.” replied the tower.

“Understand hold short.” I replied, and looked into the sky off the end of the runway. In a moment I

saw the regional jet on its approach; I watched it as it roared overhead, full flaps, gear down, and touched down past me on the runway; the whine of the thrust reversers powering up and slowing the aircraft, then it turned off the runway while retracting its flaps.

"American Flight 6204, switch to ground." came the tower, and when the airliner's pilot acknowledged, the tower continued, "Cessna NM703, clear to depart to the south."

"Understood." I replied. I checked my control surfaces, a quick check of instruments, and I powered the aircraft onto the runway, and pushed the throttle to full. The aircraft began speeding down the runway, and as we reached speed, I gently pulled back on the yoke and the plane lifted off the runway. Holding just the right amount of rudder and aileron I focused on keeping the aircraft in perfect line with the runway as I maintained optimal angle of ascent.

When I had gained enough altitude I guided the aircraft into a thirty degree right bank, kept the turn with the rudder, then rolled out of it gently towards the southeast. I began leveling out as I passed 5000 feet, aiming for a cruise of 5500', as my airspeed came up I pulled back the throttle, watching the tachometer to set cruise, then set elevator trim to relieve pressure on the yoke. The altimeter read 5300' Not bad, I said to myself, giving it just a squeeze more power to gain a bit more altitude. I focused on holding my heading, feeling the aircraft as it responded to the wind and my control inputs. I watched the compass, and the passing scenery going by on the ground.

It really is quite a view from up here, I thought. The desert looked barren, and yet so open and broad. I could see the main road down towards San Antonio, a handful of other roads, big spreads of ranches, houses. And I could see so far.

Watching the clock, I was soon ready to turn back towards Domingo. I decided to turn left and checked behind me before putting the aircraft into a thirty degree left bank, keeping it coordinated with the rudder, and using up elevator to maintain altitude. My eyes went from the horizon to the attitude indicator, to the altitude indicator, then back to the horizon, edging the controls, ever so slightly, back

and forth, never quire on the mark. I leveled out back on course, but had gained a few hundred feet, and I frowned as I wiggled the plane back onto the proper heading – I had overshot by a few degrees.

Within a few moments I could see the airport and the town of Domingo beyond, and I began a gentle descent, reducing power, and gradually giving a bit more up elevator to reduce airspeed.

Looking at the airfield, it looked like the wind sock had picked up considerably. I turned on the ATIS, the automated weather/information line – indeed, there was a gusting fifteen mile per hour. Damn, I thought, I was still having trouble with my crosswind landings. Well, I thought, nothing for it but to do it. I wonder how Icarus will be in a crosswind.

Thinking of Icarus made me feel a little better – I had to work on these things, and it would get better with practice – and I called the tower. "Cessna NM703, requesting permission to land."

The tower replied, "Cessna NM703, make right downwind for runway 5, number 1 to land."

I repeated the instructions, then continued my descent. In a few moments I turned onto downwind, flying parallel to the runway. Then, at my judgment, I turned onto base, and began final descent. "Cessna NM703, cleared to land." announced the tower, acknowledged, then turned onto short final.

I actually brought the plane nicely into alignment with the runway – but then the wind was pushing me off. I compensated, then was drifting to far upwind, then back downwind. At the same time I was watching my descent, adjusting the throttle to keep me on the glidescope for the runway. Adjust one, adjust another, so much to watch; I was getting tense as I was getting closer to the runway and not getting any better alignment – was I going to have to abort and go around? - working all the controls, fighting the aircraft to keep it in line with the runway which was beginning to loom large in the windscreen – four hundred feet to touchdown, I was a little low and gave a touch more power, felt the torque pull to the side, adjusted, turned away from the runway slightly. "Come on," I said, pulling the aircraft in line. Two hundred feet. I had full flaps out, controls were felling sloppy with my low airspeed, fought to keep it as I approached the runway threshold, "Come on, I think I've got it," I said

to myself as I cut the throttle, began to flare while still fighting with the wind, and then one main wheel touched down, then the other, and I pulled the yoke back hard, keeping the nose off for an extra second, maximizing drag, and beginning to brake.

"Cessna NM703, Clear runway when able." the tower requested, and I released the brakes, my speed now below 20 knots, and I retracted the flaps. Seeing a taxiway, I touched the brakes as I turned onto it. "Cessna NM703, switch to ground on 112.90."

"Copy ground on 1-1-2-dot-9-0." I said, breathing a loud sigh of relief. I requested taxi clearance from ground control, and guided the plane back to the general aviation base.

Susan was leaning against my truck outside of the general aviation terminal, and I gave her a quick wave as I locked the parking brake, shutoff the engine, and secured the aircraft.

"How was it?" she asked as I got out.

I let out a relieved gasp. "I'm glad that's over."

"That bad?" she asked, with a hint of concern in her face.

I thought a moment. "Not really." I said. "No, not really. It was just the first time I've flown an airplane by myself. And, I had a little trouble with the wind as I was coming in; I thought I was going to have to come around again."

"I saw you rolling back and forth." she said.

"You saw that, did you?" I said. "I've got to work on it."

"You'll get plenty of chances." she replied.

"And so will you." I said. "Are you ready for your first solo?"

"No time like the present." she said. "But, like you, I'm nervous. I've already had my share of rough landings."

"Well, you already seem a bit better at this than I am." I said. "You'll do fine."

"Thank you," she said. "But don't forget, this was your idea. Do you want to get lunch after I

land?"

"I guess it was." I said. "Yeah, lunch sounds fine. I'll be waiting here."

We ducked in just to tell the clerk she would be flying the aircraft next, then I watched as she checked over the aircraft and took off.

We both began soloing regularly, while also continuing flight lessons. Our lessons now focused on more advanced tasks, such as more complex maneuvers and cross country flights. We followed this in our solo flights, making flights to Oklahoma and Louisiana; gradually I was becoming more comfortable with the aircraft. We also began night flying

Susan felt she was ready for her checkride before I was, and passed with flying colors.

"So now you're a licensed pilot." I said. "You beat me to it."

"You won't have any problems with the checkride, Dan." she said. "It's no more difficult than anything else in flight training."

"Yes, well," I said. I probably was ready, but I was nervous, and I wanted to be sure I got it right.

"But now that I've got my certificate," she suggested, "I think we should go up."

"That," I said, "Sounds like an excellent idea." So we rented the 152, Susan did her preflight, and we climbed in. We taxied to the runway and took off; she turned south, towards San Antonio.

"Want to take it?" she asked.

"Sure." I replied, and took the controls. It felt very odd to be flying from the right hand seat, and I said so. We flew towards San Antonio, then turned east, then northwards, commenting on the scenery, and the latests bits of Icarus as we went.

"You're not doing bad at all, Dan," Susan said. "You seem to have a fine handle on the aircraft. I think you'll do fine on the checkride."

"I don't know," I said. "I mean, I feel a lot better about it then I did when we first started flying. But I just don't feel quite ready yet."

“Well, don't wait too long,” she said. “You seem like you've got it, to me.”

I waited a couple more weeks, then did my checkride. I was pretty nervous as I did it, and when I landed, I was unsure how it came out. But the instructor, a grim-faced ex-navy aviator who said little except short, one word instructions, told me, “Very nice job, Daniel; I can see you've been practicing a lot. Keep up the good work, and congratulations.” and signed my checkride form. I was now a licensed pilot, too.

To celebrate, and to sharpen our skills, Susan and I planned a cross-country flight all the way up to Virginia. It would be a bit of a long flight in the 152, and we would have to stop for fuel, but we felt we were ready.

It was something, seeing the barren desert of east Texas give way to green country around the Mississippi, and open farmland in much of the south. Rough, wooded mountains began to build up as we came over the Appalachians, and we flew up along the ridges for a good long time, before turning eastward. It was evening by the time we finally made our approach into Leesburg Executive airport, the first of many landings we would make there. Susan had that leg, and brought us in for a smooth touchdown; Troy met us at the airport, and we checked out work in the Loudoun county building, and spent some time with our families.

But by the time we had planned to head back, a line of storms had moved over the Midwest. “Once we get instrument ratings, we won't have to worry about this as much.” I said.

“From the reports of those storms, I'm not sure I'd want to be flying in them, instruments or no.” Susan said.

I shrugged. “We'll mostly avoid weather with Icarus – reschedule launches, delay reentries. I suppose we'll need to have contingency landing areas arranged, in the event of bad weather”

By the time the weather had cleared up, we'd accumulated an addition three days aircraft rental. It was still overcast on the flights back, and we had to divert a bit to avoid heavy cloud cover over

Mississippi – but we both agreed it was a good way to get home.

Hank had been doing a lot of flying, as well, refreshing his skills, and he joined us when we began instrument training. We began training as a group, in a larger Piper Cherokee Archer – Gary sat in the right seat, whomever was currently training sat in the left, the the other two sat in the back. We had already gained proficiency in using navigation instruments, but now we practiced using them as the sole reference for flight. We practiced instrument landings – I pointed out that Icarus would rely heavily on her instruments – and also trained in procedures for IFR flight, where we were under close direction of air traffic control. Besides instrument flight, we learned to handle a more complex aircraft – the Archer had retractable landing gear and a constant speed propeller. And of course, we also practiced using instruments as we continued to fly on our own.

By this point I had taken to going for a short flight every morning. It was expensive, but it was a good way to accumulate hours, and flight experience. Troy pointed out to me how expensive this could be, when he had come down for a week, giving me a bit of a shock with how much we had already spent on flight training.

“I know you guys need to be very proficient at this,” he said, “But we can't just dump money at it, either.”

“I understand.” I said, looking at the figures. “Where are we on everything else?” he told me, and I whistled. It was falling within the range I had hoped, and we were doing it for far less than NASA had built the Space Shuttle, or Europe the Concorde; but we were still over our budget on most sections. “Still, I'd like everyone who takes Captain or Co-pilot seats on Icarus to have Airline Transport Pilot hours – at least fifteen hundred to two thousand. That means a lot of flying.”

“And a lot of aircraft rentals.” Troy said. “I hate to suggest it, because it won't be cheap – but what about buying an aircraft? It would be better than 5000 or more rental hours.”

“We'll have to do that, sooner or later.” I agreed. “I haven't suggested it, in part, because we can't

just train on one aircraft. We've done a basic trainer, now were in something a little more advanced. We'll need to train in a light twin, as well, and then a jet."

"Still," Troy said. "This is not a situation where rental economics make sense."

"I know." I said. "Figure out ranges we can afford, and I'll start looking into possible aircraft. But we'll need at least two, I think, as I said."

Meanwhile, the budget numbers weren't the only ones getting depressing. We were getting closer and closer to our maximum weight. I discussed the problem with Uncle Robert and Hank.

"We've only got about 2% weight left to work with." I said, "and I've played with the numbers as best I can. If we add much more weight, we're just not going to reach orbit. Any ideas?"

"I told you this wasn't going to be easy." Uncle Robert said.

"I know." I said. "I begin to understand the real essence of what John Kennedy meant when he said 'We do these things, not because they are easy, but because they are hard.' This is hard, and is very much worth doing. But we still have to get the weight down. Any suggestions on where we could cut?"

"If there's expendable systems, it might be the airlock." Hank said. "At least for the prototype. We haven't finalized it we know it's going to be heavy."

"We need the airlock." I said. "The ship would be useless without it."

"We could reduce the crew compartment a little more." Uncle Robert said. "If we change to just three crew, that would gain us a little." Icarus was meant to have five seats: three operating crew, two passengers, who could be tourists, mission specialists, or whatnot.

"Again, would render the prototype useless." I said. "Even with a successful test flight, I'm not sure we could raise enough additional investments to design a larger ship from scratch."

"It is just a prototype." Uncle Robert pointed out. "We'll be able to make improvements with the next design."

“We're taking this long to design this one,” I said. “It's dangerous to start putting things off until 'the next ship'. Icarus must be a viable transport spacecraft.”

“Reducing stores,” Hank suggested, “That would compromise functionality. Still, maybe it should be considered.”

“Everything should be considered,” I said, “Even if some things are rejected; a close look at necessary stores is a good idea. Where might we be able to reduce weight – what systems can be lightened – even a little bit would help.”

“I can think of several things we could pull,” Uncle Robert said, “But they won't amount to all that much, and some will affect safety.”

“Nothing that affects flight safety,” I said, “But we need to conduct a review of all systems, see what has dead weight that could be removed. Thinner shielding panels, reduced ductwork, anything.”

“We're on it.” Uncle Robert said.

Two numbers we had to get smaller. I watched them go back onto the hangar floor two numbers we had to get down. Well, Troy was right, about cost – if we were going to gain the flight hours we needed, we needed to buy our own aircraft. But what to buy? We needed significant flight experience in some kind of jet, at least, a Learjet, or Cessna Citation, or like – but we needed a lot more flight time before we were ready for that. So, I started looking.

I quickly identified several possible aircraft, of several descriptions. I also spoke with Gary, our flight instructor. “You're right to think about purchasing your own airplane,” he said, “Given the flight hours that you want, you're way past the range where that starts to make sense. But I also understand your point about type of aircraft – given what you've told me about the Icarus, you want jet experience, at least – and probably aerobatic or performance jet flight, at that.”

“That's what I figured,” I agreed. “The problem is money – we can't go around accumulating aircraft to get flight hours. I had kinda figured we would push into the jet range before looking and

buying a training aircraft."

"Well, jets are alot more expensive." he said. "And they're more expensive to operate. Getting more flight experience in a piston aircraft would be cheaper. It's a bit of an odd position you're in – and I would point out that most pilot trainees with similar goals – like large aircraft operations – usually go through flight schools which offer comprehensive training."

I nodded. "I understand, but I didn't want to do that, our flight goals are a little too ... specialized." I explained. "Also, there are no programs around here, and going through such a program would have required us to take a year or more away from Icarus."

"Didn't you tell me when you first approached me about training, that part of your intent was to avoid finding 'the hard way' to go about things?" he said. "I'd suggest you purchase some kind of high-performance piston aircraft – it'll be a lot cheaper to operate, and still be very valuable experience."

"That sounds sensible." I said. "I've already been looking at aircraft listings. If you're willing, I'd like your assistance in evaluating some of them. For a consulting fee, of course." Gary was a professional airman, his livelihood training students, and it wouldn't be fair to ask him to work for free. He readily agreed, pointing out that, whatever we got, we would probably need a pilot to fly it here, as well.

We looked at several aircraft, high performance singles and several twins. Gary pointed out a couple of warbirds, saying the performance and handling challenges could be useful, but I wanted something more practical, as well – hoped to use the aircraft for flights back and forth to Virginia, and other transport. That suggested a light twin, but the challenges of handling a high-performance single would also be good experience.

At the same time, Susan, Hank and I were continuing our instrument flight training, and practicing the techniques in our own flights. Now we were getting into precision flying, and this I thought would be the most useful aspect as far as flying Icarus, more than the actual procedures. Gary made sure we

got experience flying in real IFR conditions, as well, calling us to suggest unscheduled lessons a couple of times. We all took our checkrides on the same day, and passed them with flying colors.

We also went to look at several aircraft. I would go with Gary, sometimes Susan or Hank would come along as well. Uncle Robert and Peter came along on a couple of trips, and Troy met with us one time, when we looked at a Beech Bonanza at Shenandoah airport in Virginia. We drove to a few locations around Texas, and flew out to most of the more distant locations. On these flights, Gary let me or Susan do the flying, pointing out that we were the ones trying to get flight experience. Of course, he did most of the test flights of the aircraft we were there to see.

We found a promising Beechcraft Baron out in California. It was an older model Baron, but had low hours and had been hangared most of the last ten years. It also had dual controls, which we considered a requirement.

Susan said she wanted to come along, pointing out that we hadn't spent much time together lately.

"I'm sorry Susan," I said, "But I've been all over the place looking at airplanes, we've been doing our flight training, and Icarus is coming together, but has weight problems out the yin-yang. Things are busy, and they're only going to get busier."

"And we haven't been down to San Antonio for three months." she pointed out.

"As soon as we get our airplane, we'll do something. I promise." I said. "But we've just got a lot to do."

"I understand." Susan said. "That's why I'm coming with you."

"That," I surrendered. "Would be very nice. It's going to be a long flight to California."

We made the flight in several legs, with Susan and I alternating as Pilot in Command. We made most of the trip under IFR, mostly for practice. Visibility conditions were good for much of the flight, and we saw the desert of west Texas give way to the desert of New Mexico, then the high, rugged peaks of the Sierra Nevada mountains.

“It's something to see the country from up here.” I said. “It just looks so grand and expansive.”

“It is impressive.” Susan said. “And to be up here with the birds, flying like a bird. It feels very free”

“In some ways, I think it's an even better view than from a commercial airliner.” I said. “It's not just a flat patchwork, but real depth. But I can't wait to see it from space. Think about it, Susan, crossing all of this in a matter of minutes?”

“It will be different.” she said.

Our destination was just north of San Fransisco, and Susan suggested we make the last leg VFR, and take a scenic pass over the city (on the appropriate, legal flight path, of course.) I agreed, and she took the controls, bringing us in low over the city. We had to follow a narrow corridor to stay clear of the cities airports and busy traffic. But it was a clear afternoon, and we could see the golden gate bridge, the TransAmerica pyramid, and the other buildings of San Fransisco. “You don't see many double suspension bridges.” I said, pointing at the Oakland Bay bridge.” After clearing the city, Susan put the aircraft on a short climb, then brought us around to our destination airport and in for a nice, even landing.

The seller of the Baron was waiting for us when we landed. He asked how our flight went, and said we would look over the aircraft tonight, then could test fly it in the morning. He showed us to the hanger, and we got a good look at the aircraft.

It certainly looked sharp, if a little dusty. It was white, with red trim, and a faded leather interior. “It used to be my father's,” the seller said, “He bought it new back in '76, and flew it all over the place for a while. But he started having medical problems in about 1990, and lost his medical for good in '94. After that, he would only go up when he could get someone to go with him – three or four times a year. I don't think it picked up more than 250 hours since '90, really. But he kept up on the maintenance – it's never failed or lapsed inspection.”

“So that's why you're selling it?” I asked, looking over the panel after having climbed into the pilot's seat.

“He died several months back.” he replied. “The plane hasn't been up in about a year; the annual runs out in a couple of months and I'd like to sell it by then; I'd rather not deal with renewal.”

“Ah.” I said. I looked over the instrument panel; it was fairly well equipped; better than some of the aircraft we'd seen, though not top of the line – not even for the seventies. It had a decent set of instrumentation for IFR flight, though, and radios. “How to the engines look, Gary?” I asked; his head was currently hidden by the open cover of the left engine.

“They look good, as far as I can tell.” he said. “They look like they've been maintained, but not run much. They've been cleaned, though.” Cleaning of engines before sale can be an indication of hidden problems. “We'll have to see how she does in the air.”

The next day we came back to take her up. Mike, the owner, said “Since I'm not a pilot myself, I've usually had an instructor come up with prospective sellers. But since I've already seen your credentials, it won't be a problem. Just don't break my plane."

With Gary as Pilot in Command, I sat in the right seat, and Susan sat in back with Mike. He got clearance from the tower and took off, climbing to 5500'. “It feels pretty good,” he said. “Responsive. Do you want to take it, Dan?”

“Sure.” I said, taking my control yoke. I took the aircraft through a number of maneuvers, banks left and right, climbs and descents. Gary took back over after about fifteen minutes, and started to put the aircraft through it's paces. We climbed up to 18,000 – the highest we could go under VFR, checked out rate of climb and descent, max cruise speed at several altitudes, and other flight parameters.

“I think she's lost a bit from spec,” he said. “Definitely a little slower than other Barons I've flown. But that's to be expected, for it's age.”

We were up for almost an hour; I took the controls again for a bit, checking out some of the same

maneuvers, before Gary brought her around for a landing. “Do you want to try it, Susan?” he asked.

“Sure.” she said, “If that's alright with Mike here.” He nodded his assent, as long as we kept the second flight short. This we did – Gary took off, turned the controls over to Susan for about fifteen minutes, and asked her what she thought.

“It's much heavier than the singles,” she said, “And it doesn't climb as fast as I might expect.”

“Piston twins don't usually gain a great advantage in climb.” Gary said, “The extra power is offset by the weight of the second engine. But they can usually go faster than all but the most powerful singles. And they can carry alot more load.”

“It handles pretty well, though.” she said. “Certainly flys like it's in good shape.”

After landing, we thanked Mike, and told him we were very impressed. “We'll have to talk it over,” I said. “But it seems like one of the best we've seen. We'll definitely get back to you in a week or so.”

He handed us a thick sheaf of papers – copies of all the maintenance records, back to the initial factory inspection.

We talked about it on the way back. Gary said I was right, it was one of the best aircraft we'd seen – especially in the price range we were looking at. “Still, I did see a few minor problems,” he had pointed several out to me as he had inspected the aircraft, “And it's a well used aircraft – that is a concern for the amount of flying you expect to be doing.”

“Still, we expected that,” I said. “I thought it looked pretty good – and flew pretty good, too. It's got low hours for it's age, too. And I think we've got a motivated seller – we can get a pretty good deal because he's looking to unload it. What's your recommendation?”

“If you were buying it for typical personal use,” he said, “I'd say go for it. For a flight school, I'd say it still has too many hours on the airframe. You're going to have the same issues as a flight school would – but as you say, it's in your price range.”

“What about our specific purpose?” I said. “What about Icarus?”

He shrugged. “For what you're looking for – an advanced prop trainer – I think it will do you very well. Barons handle well, but are markedly heavier aircraft than the 152 you trained in. It's got a good instrument suite; not premier, but adequate; I've seen flight school aircraft with a lot less. You'll still want a heavier aircraft, though.” In other words, for what it was, and what we were looking for at the moment, it was a good choice - but we would need something more powerful, eventually.

The whole group discussed it after we got back; Troy looked over the specific operating cost numbers and recommended it, and Hank said he always liked the way Barons looked. We called Mike, and negotiated a sale. We also setup our insurance coverage, a small challenge given our unique purpose, but a good contact once Icarus was ready to fly. Once a mechanic had inspected it and the purchase was finalized, Gary and I went out – flying commercial into Oakland – to fly it back; the next thing was for us to begin lessons for our multi-engine ratings.

We had our mechanic work on a few things – issues that we had identified, but didn't think would preclude the purchase – then Susan and I began multi-engine instruction; Hank had decided he wanted to do separate lessons, for scheduling and other reasons, and that did tend to work out.

About halfway through the second lesson, we were working on precise, steep turns, Gary said, “You know what your main problem is, Dan? You've very overcautious with the airplane, very hesitant to push into maneuvers, or push the aircraft.”

“I like to be careful.” I said.

“Always a good idea,” he agreed, “things an go bad very quickly up here. But you've got to be a little aggressive as well; you need to be able to take charge of the aircraft, and push your own limits. That's the case for all pilots, of course, but especially for what you want to do. In fact, for a would-be astronaut, I'm surprised how overcautious you are.”

“I've never been much of a risk-taker.” I said. I had leveled the plane off after the last maneuver, coming out on the heading Gary had requested, and was flying straight. “And I'm trying to get this

right – I'm not taking any stupid chances. I wouldn't be doing it if I didn't think it was something worth pushing on."

"Still," he said, "You're going to need to learn to be a much more confident, aggressive pilot. The confidence will come with practice – but you're going to have to learn to push it."

He was right, I knew, and I fly the same way I drive – cautiously. There's nothing wrong with that, of course, but climbing into the pilot's seat of Icarus was not the cautious thing to do.

We continued the flight, and Gary had me complete a couple of touch-and-go landings before bringing it in; then Susan took over and I rode in the back seat.

That night, my sister, Abby called. I almost didn't recognize her, she sounded distraught. Since she's usually very high-spirited, and lets things just run off her, I was very surprised. It took a moment to get a picture of what had happened. Apparently, Robbie, her boyfriend, had broken up with her after a fight. I told her not to worry to much, one fight wasn't the end of most relationships; but she said that it hadn't just started with the fight, things had been getting tense for a little while, and "I think he's already left town. We're both wanderers – we're never going to wander into each other again."

"Well, I'm sure it's for the best," I said, but I wasn't sure it was true – all the family had been happy to see her in a relationship that lasted longer than a few weeks More so, now that I was in a relationship of my own, I was beginning to understand just how much it could mean, and I shivered at the thought of losing Susan.

But there was another thought, from another direction in my mind, thinking about what Gary had said earlier, and what it meant for Icarus. He was right, I knew, and indeed one of the reasons I think Icarus – and human spaceflight – is so important is precisely the need for that kind of risk-taking, push the boundaries – even if I'm not much of a risk-taker myself. But Abby, well, she was something different. In truth, she scared me sometimes – a lot of different ways – but maybe, she was something Icarus needed, if I could get her to come. And if I could get her to stay.

“Abby,” I said, “Do you remember how you always wanted to fly an F-16 when you were a kid?”

“Yea,” she said, still audibly struggling over her breakup.

“Well, I'm learning how to fly down here, for Icarus,” I explained. “And Icarus will fly a lot fester than an F-16.”

“You're spaceship?” she said, “You're kidding? You know how much I care about your spaceship.” That, of course, was hardly at all.

“Still,” I said. “That would be a heck of an adventure – and we'll teach you to fly. I know you'd love to do that.”

“You and your silly rocket ship,” she said. “Do you think about anything else?”

“Only when I have to.” I said. “And whatever you think of my spacecraft, we could use someone like you as one of our pilots.”

“Silly Icarus,” she said. “Still ... you'd train me to fly?”

“Right up through jets,” I said. “We haven't started jet training yet, but we're getting there. And the Icarus is a monster, just from the simulations.”

“That could be tempting,” she admitted. “Perhaps I might wander down towards Texas.”

“Just remember, we're at the Domingo Regional Airport.” I said. “And of course, I'll have to talk to everyone else, and see what they think – but they know we need more pilots on our roster.”

“Others?” she asked, a little skeptically. “You mean you don't insist they do what you want?”

“We all work to make Icarus a success.” I said. “And we're a team. That's the other thing – you will need to agree to stay. Flight training is expensive.”

“That,” she said, “is not something I do.”

“Well, perhaps for your pilot's license,” I said, “You could give it a try.”

“Well, no promises,” she said, although I could tell she liked the idea – and once she got an idea in her head, she tended to go with it. “But like I said, I may wander down that way.”

The rest of the group wasn't so excited about the possibility of Abby joining us, for a number of reasons. Not least was the idea of someone coming from outside, instantly jumping to a prime position. (It had been a while since Troy had done basically the same thing, and we had grown since then.) More than that, they had all heard a bit about my wandering sister. Troy, who had met her a few times, thought her to short-attentioned and flighty, asking how long I thought it would be until she left. But we did need another pilot, and none inside was interested. (Some of the techs did have some interest, but lacked the breadth of skills and astronautics knowledge; and as much as we all cared for Icarus now, few wanted to be responsible for flying her.) "Just remember, Dan," Troy said, "If she comes on, will be paying a good deal for her flight training. We can't have her turn around and leave when she loses interest."

"I know." I agreed.

It didn't surprise me when, a couple of days later, Abby called to say she was in Texas, and would be by "in a couple of hours. I gave her directions to our hangar at the airport, and pulled a lawn chair out next to my truck, and worked outside. Texas is pretty hot, but it was nice to get outside sometimes, anyway. And there was a breeze

After a while, I heard the roar of a motorcycle coming down the public road. Looking out I could see it slowing, and turning onto the airport access road. I heard it shift as it accelerated hard, then slowed and turned into the hangar. It came to a stop in front of me, and Abby took off her helmet. "Still driving that old wreck, eh, Dan!" she said, looking at my truck.

"Of course I am." I said, patting the hood gently as I got up, and reached out to hug her. "But Abby! It's so good to see you! "

She hugged me, and said, "It's good to see you, too, Dan."

"How long has it been?" I asked. "At least a year, or more than that – you were back in Virginia, what was it, thanksgiving of '03, right?"

“Yea, I haven't wandered that way for a while.” she admitted.

“That's a nice bike,” I said, admiring her motorcycle. I'd never have the guts to get on one, though it certainly looks like fun. It was a Harley Touring bike, big, clearly made for long-distance cruising. It looked like it had it's share of miles on it, but was in very good shape; Abby had a couple of suitcases on the back with bungee cords, and the saddlebags were overflowing. “Where's the rest of your stuff?” I asked.

“That's all I kept,” she said, shrugging. “Robbie and I had an old Winnebago wit a few things, but I'd already been working on selling that when I talked to you the other day; wherever I was heading, I knew I wanted to travel light, as I always do.”

“Light is usually a good way to travel.” I agreed.

“So, let's see what you've got for me to fly.” she asked.

“Yea, come on in, I'll show you around.” I said. “Icarus is still a long way from completion, but it'll take a lot of flight training before any of us are reader to fly her.” I showed her in, first to the hangar we'd subdivided for other functions. “We've got fabrication over there, and storage, several drafting rooms, computers, a couple of labs and whatnot in here.” I said, motioning in the general direction of each. We've got two hangars – this one we've broken up with – mostly – temporary partitions. We're building Icarus in the other one.” I showed here through the wide doorway. “There she is!”

She stared at it a long while. It was still mostly aluminum airframe; composite surface had been added in a few places, but the great big openings in the structural unit were still evident.

“That,” she said, “may be the ugliest thing I've ever seen!”

“Aw, don't say that,” I said. “Like I said, there's still a long way to go. It's a metal structural frame; you can sue a few sections of composite surface in place. Once we finish the internal systems, we'll put the surface pieces in place, and the heat shield tiles and panels will go on top of that. She'll have three control fins coming out the top, in back, as well.”

“I got that,” she replied; “And I can picture it with the skin on – I'm assuming it'll have similar coloring to the space shuttle. It's still ugly.”

“Well,” I said, “It's basically a flying fuel tank, so, that does a good deal to define the shape. And lifting bodies look unusual, to say the least. But like any aircraft, it's not about looks, it's how she flies.”

“And how does she fly?” she asked.

“Well,” I replied, hesitantly. In fact, we'd barley touched the flight simulator I'd set up, preferring to advance further in our flight training. “I guess we'll find out when we finish it.”

She laughed. “I'd have thought you'd have that all setup on your computer!”

“I did,” I replied, “And in truth it was too much for any of us to handle. We need more flight training before we try again.”

“That figures.” she said. “Probably why you called me. Well then what else do you have for me? When would I start training?”

“First you'll have to meet the rest of the team.” I said. “It's up to all of us, don't forget, if we want to bring you on. And not everyone likes the idea of a reckless wanderer at the controls.”

“Reckless?” she protested. “It's only reckless if you crash.”

I introduced her to Susan, and Hank; Troy and Peter hadn't had time to come down from Virginia, but we had them on a conference call line. “So you're Susan, huh? Dan's told me about you. About time he started going with someone.”

We all had questions for her, and some – Peter particularly - were pretty harsh. I'd told them a bit about Abby, and a bit more in the last couple of days, and they wanted to be sure she wasn't going to take off in a few months, or wreck Icarus. They asked her all the usual interview questions, not least of which, “Why do you want to be here?” and more, trying to plumb her depths.

In truth, I was impressed with the ease and confidence she answered with, her remarkable quick

ability to answer any question, finding the answer they were looking for. She told of her longtime desire to fly fighter jets, and her desire to go further and faster. "I've never had a particular interest in spaceflight," she admitted, "And I had the same doubts as I'm sure all of you once did about my brother's obsession. But what is further than space, and faster than Icarus?"

She certainly put on a real good show; I told her we would have to talk about it, but that I certainly would like her on board. "We'll make a decision today," I said. "So why don't you check out town and come back around five?"

"I came through town on my way in," she said with a shrug, "Wasn't much there. I'll take a trip down to San Antonio instead."

I warned her to watch for the rush hour traffic on the way back, and told her to have a good time.

Susan asked, "Is she really likely to go all the way down to San Antonio, for just a couple of hours?"

"Probably." I said. "She's never thought anything of hopping on her bike, when it moved her."

"And you practically told her she had the job," Hank said. "I thought you were going to ask what we thought, first."

"It's up to all of us, of course." I said. "But I wanted to be sure she would be back; I don't want her getting something else in her head at this juncture." I knew she would roll with the punch if we turned her down.

"Is that likely?" Hank asked. "Because we can't afford to have her leave as soon as she gets her certificate."

"She's a wanderer, and tends to go wherever the wind blows," I said. "And it is a risk – but I think we need her. She's the kind of pilot – the kind of adventurer, that we need, and she will bring something to Icarus that I cannot."

"You may be right," Uncle Robert said, "But don't forget just how flighty she really is – how many

times has she made it back home in the last dozen years? And how many times have we lost track of her for months at a time because she moved and never told us? What was it, three years ago, none of us had heard from her for six months, and she moved four time in that span."

"Don't I know it," I said, "It's always a surprise when I do hear from her. I don't think I've actually tried to call her once since we started Icarus. Even so, I do think she brings something we need, and I think it's worth the risk."

And so we discussed it. I e-mailed an audio file of the interview up to Virginia, so Troy and Peter could listen to it again. Peter and Hank had basically the same concerns, about her leaving at the first chance; Troy focused on the economic implications of her leaving partway through flight training. "We bought the Baron to save on flight training costs." he said. "We don't want to blow that by training your sister, just to have her leave."

Uncle Robert also pointed out that she had a tendency to be reckless. I defended that, to a point, pointing out that she had yet to have a serious injury (that we knew of) and that recklessness and boldness could be the same thing, distinguished only be the results.

"Haven't you been one of the most critical of some of the things she's done?" he asked.

"No, that would be dad," I said, "Though I've had things to say, too. But in this context – that is, after all, one of the things Icarus is about. I'm not saying it's reckless to climb into Icarus and climb above the wild blue yonder, but it's not the safe thing to do. You know me, I'm always one for taking the safe path – but sometimes we need a bit of recklessness. Icarus is about stepping further than we think we can, about jumping way out into the deep end. For all her faults, even recklessness, is there anyone you know who is better at doing that, then learning how to swim. She will bring something we need, whatever the risk."

We continued to debate, but people were leery. Finally, though, it was Susan who came to Abby's defense. "Dan is right that we need her kind of personality on our pilot's list." she said. "We all know

Dan's passion for Icarus, but we all also know how Dan is (no offense, my love); you haven't seen him flying, but he's the same way at the controls. Now, I'd get in a plane with him any day; he's a very capable, cautious pilot. But Dan is right – we need something besides caution here. I don't doubt that Dan – or any of us – will learn to fly Icarus. But it's going to take boldness, and probably a bit of recklessness, to tame her. It's a risk, but I think it's one we need to take."

And so, by the time she returned later in the afternoon, we had agreed to offer her a position as a Test Pilot (trainee) – but with several conditions, meant to ensure she stayed, and to limit our risk. She understood our need for a commitment, or said she did. I didn't doubt she understood it, I just wanted to be sure something else wouldn't turn her interests later.

"First," I explained. "You'll complete a comprehensive ground school course first." This had been Troy's idea – if she left before the course was done, we wouldn't be out for her flight training. "Second, you will make a deposit with us, and your compensation will be deferred by three months. If you leave before orbital flight testing, you will lose it. Third, you will abide by our rules, especially with regard to handling of aircraft, and fully observing FAA regulations.

She protested – she was impatient to start flying, and said she couldn't afford to wait for her first paychecks. "Do you want to fly?" I asked her, and she said yes; I promised her we would help her with living expenses and the like, and so she agreed. Perhaps, I thought, and feared, as quickly and impulsively as she did everything else.

We signed her up for the summer session of the same course Susan and I had taken. It was the same course length, but compressed over six weeks. That, at least, suited Abby, and she seemed to be counting the days until she finished the course and got up in a plane.

Meanwhile, Susan, Hank and I were continuing our multi-engine training. The Baron was definitely a lot of aircraft to manage, but as I became more comfortable, I began to prefer it to the smaller aircraft. It just felt more solid. By the time Abby finished her ground school, all three of us had completed

multi-engine checkrides and received our ratings.

When the time came for her to take her first lesson, I offered to give her a ride over.

“Not in your truck.” she scoffed. She'd only ridden in my truck a dozen or so times, always under duress.

“I can take you right across the airport, on the taxiways.” I said. “On your motorcycle, you'll have to go the long way around.”

She grunted, and assented. As she climbed in, I told her that only a couple of us were allowed to drive out on the runways. “Usually we just need go come out in front of the hangar, but sometimes we do have to go down to general aviation, or the airport offices in the main terminal.” As I pulled out onto the taxiway and sped up, shifting into second, then third, I pointed out several of the taxiways and key features of the airport. “You'll know this airport real well.” I said.

I introduced her to Gary, then wished her luck as I watched her taxi around the airport a couple of times, then take off and disappear into the distance before returning to our hangar.

Later, I asked Gary how she did on he first lesson.

“Your sister is one of the best natural flayers I have ever seen.” he said. This surprised me, because Gary generally expressed disdain for the concept of a “natural pilot.” He continued, “But she is also one of the most reckless pilots I have ever seen. She wanted to try loops the first time we went up. That's not unusual by itself – I get a fair number of new students who want to jump right into aerobatics and the like – but I felt like she would pull right into one if she thought I wasn't paying attention for a moment.”

“Yep. That's my sister.” I said. “What do you think you can do with her?”

“I've no question I can get her along, and faster than most. She'll be a challenge, but she defiantly has aptitude to pick it up very quickly, which will help with her impatience.” he said. “I think she'll be able to handle any aircraft she sets her mind to – including the Icarus – but she's going to have to learn

some patience."

"Well, do what you can." I said. "And you may need to work on teaching her patience as much as flying skills."

And over the next several months her flight training advanced. Gary told me she was one of the few pilots he thought ready for a checkride before the 40 hour minimum; and she passed with fine flair. She quickly caught up to Susan and I, though she showed some impatience with instrument training. Flying with her could be an ... unnerving experience – she had a tendency to pull the Baron steeply off the runway, daring stalls, and quickly pulled into and out of turns, flying the plane like a sports car – but she was a true master of the aircraft.

The Baron quickly came into use for transport between Texas and Virginia, as well. Any of the four of us would handle flights, though I usually paired with Susan or Abby, and Hank most often flew the route alone. The Baron didn't quite have the range to make it in one haul, and we usually stopped in Tennessee for fuel on the way. It was immensely useful – though fuel was expensive, we needed the flight hours, and booking last minute commercial flights was almost as prohibitive. We only drove when we had a load of equipment or parts to transport; then I invariably made the trip in my truck.

The last of the systems on the Icarus were designed and completed; we abandoned the steam system we had discussed for thrusters – it was quite plausible, but implementation was another problem we didn't want to deal with – and went instead with a thruster system using hydrogen peroxide. We constructed and installed many of the larger assemblies, including the cryogenic fuel and oxygen tanks, and began work on the crew quarters. For the instrument panels and controls, we had to scrounge and adapt parts from a number of different sources; surplus/scrap aircraft equipment. For a flight computer, we used an old 8-bit system I happened to be quite familiar with, installing five redundant units; a television mounted in the center of the panel functioned as the single multi function display. Most critical functionality we didn't run through the computers; flight controls in particular we set up with a

traditional hydraulic system, using control yokes from an unknown lightplane, and throttle levers bought off e-bay. We also constructed a second, mockup crew compartment, with instruments as close to the Icarus as we could find, and hooked it to a much more powerful computer system, to use as a simulator. By this time, we had flown the simulated Icarus with some success, but still crashed often. With the simulated flight deck; we could begin to practice procedures, as well.

By late 2006, we were almost ready for atmospheric test flights for Icarus. Weight was still a problem – she was about 2 percent overweight, and we had several ideas on the table; but save for the uninstalled engines, was nearly complete.

Most of us from Virginia returned there for Thanksgiving, and I got the core group – now the six of us – together the day before, to discuss flight testing and other things.

"Once we finish ground checkout on Icarus, we'll be ready to begin flight testing." I said. "The last major thing that has to be installed is engines; we have three of them in storage in Texas, and the final unit is almost complete up here; but we should build at least one additional unit as a spare. I know we've discussed this before, but I'd like to go over it in full; we're entering the final stages before we attempt orbital flight. Flight testing will comprise a series of parabolic flights – we take off, pull into a steep climb, then cutoff the main engines, coast over the parabola, and make an unguided landing. The first such flight will be the most dangerous; I'm confident in the numbers, but if the Icarus does show any significant deviations from my projections, we'll find out very quickly. We'll start with a fairly low, subsonic trajectory, then push to higher altitudes. I figure we'll aim for a maximum altitude for these tests of around 200,000 feet, which will allow us to push into the high supersonic range, and validate the craft's aerodynamic characteristics."

"Are we getting a little ahead of ourselves with test flights of Icarus?" Peter asked, "Considering none of you pilots has begun jet training yet."

"Yea," Abby said. "We've been flying the Baron since I got here – you promised we'd be flying

jets." She had been becoming increasingly impatient about this – sometimes I thought the only thing keeping her with us was the fact that she probably wouldn't be able to keep flying at all, and even so she sometimes had a tendency to disappear for several days.

"All in good time," I said, "But yes, we are more than due to begin training in jet aircraft. The main holdup there has been the lack of a suitable aircraft for training. We've looked at several aircraft, but haven't found anything suitable in our price range. Troy can give you better details on that, but we do need to get that soon – even if we have to go higher than we had intended."

"We may have to," Troy admitted, "But everything comes with a cost, and we're running short on cash again. Even selling advance flights, we're going to need to do something – the cost of liquid hydrogen and oxygen for the test program is only one of the larger expenses. The thermal protection system killed our budget; we're going to need to find a sure revenue stream soon, or we're going to be in trouble."

"What about suborbital flights, like that craft, uh, SpaceShipOne, from a couple of years back?" Abby suggested. "Certainly Icarus would be capable of that."

"Suborbital flight is a dead end," I explained. I had given that a lot of thought – I'd been aware of the X-prize almost from the beginning, and had closely watched some of the more efficient efforts – but had ultimately rejected them. "Especially to the barest edge of space, as the X-prize envisioned. It dodges the two largest problems of spaceflight – fuel load to reach orbital velocity, and reentry from orbital velocity. That really doesn't move closer to real orbit. We've – mostly – solved both of those problems; there's nothing to be gained from treading that ground."

"It could be a revenue stream, though," Abby suggested. "If we flew several flights with paying passengers, it could bring in some needed cash."

I considered it for a moment. "No." I said. "Even if we were able to make it work, we'd be apt to get sidetracked, and get off the orbital track entirely." Troy pointed out that we needed to do

something, and I continued, “Also, Icarus wouldn't be economical for suborbital flights – we'd burn more in fuel than gain in revenue.”

“Well, that brings us back to the question of money.” Troy said. “We're running short.”

“I'll make another pass at our investors, and another round of advanced flight sales.” I said. “One more round of financing should get us close to our orbital test, then we'll be on the home stretch. As to a jet aircraft, I think we should move now, as soon as we can find something suitable, so we can start getting hours, and proficiency.”

That agreed upon, we all went our separate ways for the holiday, then I spent Saturday with Susan, and we all flew back to Texas in the Baron on Sunday. The next day, I started the next fundraising round by calling James Tucker, our largest backer. I got his receptionist, who by now I was vaguely familiar with.

“Could you tell Mr James Tucker that Daniel is calling for him.” I said when the receptionist answered the phone.

She paused before answering. “I'm afraid Mr Tucker is dead.”

Stunned – and thinking about what this might mean for Icarus – I said nothing for a moment. Finally, I asked, “What happened?”

“He had a heart attack three days ago.” the receptionist told me.

I thought another moment. “I'm sorry to hear that; please, give his family my condolences. Who will be handling his business affairs and investments?”

“His son, Kyle.” she replied. “But he will be busy with family affairs all of this week. It it's more urgent than that, I can forward a message, or connect you to the lawyer handling the estate.”

“No, that's alright.” I said. This clearly wasn't the time to ask for more money, and it would take the same kind of relationship with this Kyle as I had had with his father. Mostly likely I would have to resell Icarus to him; I had never met him. In any event, I couldn't expect any significant funding from

that direction for this round.

I did have some luck from some of the other major investors – I invited several down for a tour of the facility, which would give us a chance to show off the nearly completed Icarus. I also sold a couple of additional advanced flight reservations, with vague promises that we expected our first orbital test flights "within the next two years, and passenger flights sometime after that."

With the money from those sales, we zeroed in on a 1980 Learjet 35A. We had seen it before, but thought it was a little too expensive, and it still had fairly high hours – but it seemed like the best we were going to find. It was a two-crew aircraft, which was, perhaps, less than ideal for our purposes, and yet perhaps not, as the Icarus would require a crew of three.

We were in the process of finalizing that deal when I got a call from Kyle Tucker. I gave him my condolences for the loss of his father, which he accepted politely. Then he said, "To get to the heart of the matter, I've been reviewing my father's investments. It seems he has invested a very substantial quantity in your Icarus Project, which has yet to show any returns, and I would like to know why. I am attempting to rationalize and streamline many of his investments, and I will be pulling out of several.

Here it was – and he already sounded like the worst kind of MBA. I took a breath and said, cautiously, "The Icarus Project is a long-term aerospace project. As such, return on investment doesn't come until completion of the project. I believe our original investment proposal – as well as several addendum's and updates – should be in Mr Tucker's files."

"Yes, I have skimmed them." he replied. "Something about an experimental orbital spacecraft; it sounded like some kind of pipe dream to me."

"I would be more than happy to come up and give you a complete overview of the project, as well as a status report." I said. "We are nearing the final stage of development."

"Icarus appears to be outside the realm of our normal investment portfolio," he said. "I am reviewing the documents, and am not sure I see anything suggesting it worthwhile to continue the

investment."

"That may be," I said, getting desperate. Framing it in MBA-friendly terms, I continued, "I'm sure your investment priorities will be somewhat different from Mr Tucker's. However, it would be remiss to change direction on a project of this sale or scope without full details. As I said, I am more than willing to come up there with all details, and answer any questions you may have."

He didn't say anything for a moment, then said, "If you're willing to come up here quickly, I will listen to what you have to say. But I've a lot of investments to consider, so don't expect much."

Two days later I flew the Baron back up to Cincinnati. He hadn't offered to provide a car, which wasn't a good sign, so I took a taxi to his offices. I was there early, but he kept me waiting more than twenty minutes past the appointment time, which made me nervous. He was visibly impatient, which only made me more nervous, but I felt better as I slid into my usual pitch, emphasizing the fact that we would in effect be creating an entirely new industry. I thought I did a very good job, when I was done.

He was clearly unimpressed, however, and said "That's all you've got? I thought it was a pipe dream, obviously I was underestimating your audacity. I wonder how you managed to sell my father on this ridiculous fantasy. Ahh," he said, thumbing through something on his desk. "But that was before Columbia broke up. If I'd only known then what he was involved in, I would have spoke to him. Clearly, he didn't understand the real risk he was getting involved in. For, that is what I really fear from this. I think the likelihood of you ever making dollar one of this back is slim to none; but that's beside the point – when you fail catastrophically, anyone and everyone involved is going get a share of blame. I hate to think of the liability implications of this." His eyes had left me, but now he returned his focus. "Not only am I freezing all investment in this, I am immediately recalling all existing investments."

"But, sir, that's not necessary." I protested desperately. "Icarus-"

"Is a waste of time and money." he cut me off. "I'll have my legal counsel contact you shortly regarding divestment procedures; I'm sorry to have wasted your time. Out."

I left heartbroken and dismayed, and could barely think during the taxi ride back to the airport. Besides the fact that we were simply too far along to stop now, divesting his investments would be impossible from a purely practical sense.

Once we reached the airport I tried to think a little more clearly. This was a business matter; I had to talk to Troy. I could call him, or call him once I returned to Texas, but this was to disastrous to discuss over the phone. I called him and told him I was going to divert to Leesburg now, and would be there in a few hours. I then preflighted the Baron, filed an IFR flight plan, and took off.

The chaos of takeoff preparations had calmed me slightly, but I felt, depressed and dejected on the way. I did my best to focus on the flight, but I couldn't help but think about Icarus. Surely it wasn't going to end this way? I think it was only my need to concentrate on the aircraft that kept me from openly crying.

It was night by the time I arrived over Leesburg. I became further impatient when I was kept in a holding pattern for several minutes, and when finally cleared to land, I flew a fast approach, and hit the ground with a thunk.

He was shocked when I told him what happened.

"Surely he can't be serious?" he said. "He wants to simply pull the plug?"

"That's about the sum of it." I said. "We're not going to let him, of course. We'll do something."

"There may not be a lot we can do." he replied. "If he wants to pull out his entire stake. It's not a majority, but we'd have to liquidate everything to come up with it; then we'd have to compensate all the other investors. Even in the best of circumstances, we'd have to start from scratch."

"I was thinking about the investment terms on the way here," I said, "And he can't just cash out – not for most of it, anyway. The same with the other investors."

"No, but there's plenty he can do if he wants his money out." he said. "Further, If I understand what he said about blame and failure, I fear he may do worse than that."

“What do you mean?” I asked.

“If he's that concerned about liability,” he explained, “He'll be concerned about what might happen even after divestment. Any further action could expose his company because of their prior involvement. He may try and shut us down completely.”

“That's ridiculous.” I said. “His liability is already limited to the value of his investment. And if he does sell or divest, those liabilities go to whomever buys them. Even if he cashes out, it simply comes back to us.”

Troy shook his head. “Not necessarily if it comes down to gross negligence. If a catastrophe were to happen – say we crashed into one of the towns along the gulf coast – lawyers would go after anyone they could get there hands on. Especially those with deep pockets. I.e, Kyle Tucker.”

“Damn.” I said. “We're still not going to let it happen. I'm just not sure what we can do.”

“Oh, we'll do something.” he said. “And you're not thinking clearly; I don't think I've seen you this panicked since the day you failed that history test junior year. You've gotten us this far; you'll get us the rest of the way.” I remembered that test – if I hadn't been so panicked, I would have passed it by a wide margin – I knew most of the stuff on it, when it came down to it – I just lost the ability to think clearly. “For now, we continue as we've been going – and close the deal on that Learjet. I think the most important thing will be to convey to our other investors that we have no intention of shutting down operations. I know how much you love it, but you're going to have to work harder than ever selling Icarus. But for now, get some rest, and get yourself together. He hasn't got us yet.”

I spent the night at the Loudoun building, after calling my parents and talking with them for a while; I was surprised how truly supportive they were.

The next day, Troy basically took charge, and for once I was glad of it. He made sure everything was in order here, for the next few days, then him, Peter, and I went back to the Leesburg airport; the group had to get together.

“Are you sure you're up to the flight?” Troy asked me. “We can always go down commercial, if we need, and send someone up later for the plane.”

“No, that's alright.” I said. “I'll feel better once we're airborne. Besides, I need the practice operating under stress, too.” The last I closed with a nervous laugh.

“Alright.” he said. He had already called the airport to make sure the Baron was fueled and prepped; I made an extra-thorough preflight, and we were ready to go. Calmly I talked to ground control, then the tower, and we were off on an IFR, two leg trip. It was a good day for flying, only a few thin clouds at low altitude; but I focused on instrument flying, and hardly looked out the window. Our fuel stop was brief; barley enough time for everyone to run to the bathroom and take on fuel, and we were back in the air.

We were mostly quiet for the flight; Troy and Peter had both sat in the back; Troy was going over various papers, investment contracts and the like, reviewing materials and making plans, I was focusing on flying the plane and trying not the think about much else. Peter made a few comments about the weather that met with little response; I think he spent most of the flight looking out the window.

Hank, Susan, Uncle Robert and Abby were waiting outside when we arrived; they had been listening to the tower frequency for our arrival, and we quickly went inside to discuss the situation.

“What did you say?” Abby demanded. “You've sold this before, what did you do now?”

“I think he was determined to cut us loose.” I replied. “He didn't have a spark of interest I could hook onto. And I don't think he has the imagination to understand where we can lead.”

In the conference room, Troy summarized the situation, then invited me to describe what had happened. I did, and said I thought he had it out for us.

Troy said he had already contacted both our lawyer and our banker, and apprised them of the situation. The bank was not happy to hear of the problem, but would assist us any way they could; they stood to lose much of the loan if we flat liquidated. The lawyer said our options were limited if he was

truly intent on liquidating his investment, although we would be able to delay action for a while. “Our best bet may be with other investors, They'll lose a great deal of money if we liquidate – much of the principal has gone into salaries and consumables; and I hate to think of what we'd get for an almost complete, untested spacecraft. More to the point, as long as they support our action, some of them should be willing to offer additional support. A smart investor never sends good money after bad; but will work to keep a good project going.”

“Are you sure giving up on convincing Kyle is right?” Susan asked. “If he's anything like his father, surely he can be convinced. Didn't he say something about not making dollar one? What about reminding him we have sold advance reservations, for several million dollars?”

“I made a point of mentioning those; I think he dismissed them out of hand.” I said. “I put particular effort into showing how we could make money. But he thinks it's just a great big pipe dream.”

“Still,” Peter said, “There must be something we can do. The investments are made – can he just pull out of them?”

We went over everything, and then everything again. Short term, we could do some things to keep the operation going. Longer term, it would depend on what exactly he did. He couldn't simply force us to refund the investments, and if he simply tried to sell out, it would collapse the value of the stake to virtually nothing. If he could persuade a few other investors to agree, though, he could close us down. “I figure his stake is about forty percent.” Troy said. “James Tucker's intent was to limit his investment to no more than one-third of our total fundraising; but some of our money is non-direct investments. The flight reservations don't gain a stake, for one, and some of the other money is in effect preferred stock or equivalent, and explicitly waives decision-making privileges. He doesn't have enough to shut us down himself, but he's close. Let's not forget, too, that James's efforts got us some additional investors – many of them may be quick to listen to Kyle. We've got to work on the other investors.”

That, then was the best we could do. We needed to continue all operations, to show investors that we intended to finish what we had started. And a point I made - “If we could get Icarus ready for a flight test, that will show we can do it.” So, emphasis was on getting Icarus finished, and flight and simulator training to lead to our first flight test; we needed to begin the process of contacting the FAA to get our experimental aircraft certification, as well.

Accelerating our efforts would have another purpose: that we could complete our efforts before he could shut us down.

Hank and Uncle Robert were to oversee the final stages of Icarus's completion, and making her flight-ready; Susan and Peter, who remained in Texas now, were to push other parts of the operation, Abby finally leapfrogged ahead of us in the piloting order, beginning lessons on the Learjet, and began making the rounds of our other investors. I flew the Baron extensively.

I adjusted my sales pitch, reviewing the reasons they had decided to invest, and emphasizing we were close to beginning flight testing. Some of the hardest were the investors who had gone in because of James Tucker's recommendation; the news that his estate was withdrawing it's support made some of them very skeptical. But other investors were worse.

One investor, Mr Schneck, was indicative of the attitudes of most. I met him in his offices in New York, on a trip where I was meeting several.

“You've been sending glowing progress reports, Icarus would be ready for flight testing within a matter of months,” Mr Schneck said. “And now you come and tell me that one of your biggest investors is pulling out his stake. It makes me wonder if you've been speaking overoptimistically all along. It make some wonder what this investor knows that you're not letting on.”

“Our original investor, unfortunately, passed away,” I explained, “And his son has different investment priorities.”

“Even so,” he replied. “Smart investors don't pull out of things, unless they have reason to believe

they're going wrong."

Here I had to be careful – I thought Kyle's problems were, at the core, a lack of vision, and a consequence of the MBA's focus on small details and simple, calculable rubrics – but I had to be careful when criticizing management theory when talking to dedicated managers. Vision, at least, was something they were told the importance of, but they usually pushed it aside when they couldn't place a dollar value on it. Though I disagreed with the whole mentality, I had to explain why Kyle's actions were wrong in an MBAs terms. "His priorities are different from his fathers," I said. "And he doesn't feel that this project is something he wants to be involved in." I had thought about suggesting that he had found his father's estate in worse shape than he head expected, but rejected that,a s it would suggest that James had had poor judgment, and shouldn't have invested in us in the first place. "And I think he has much less interest in the more speculative types of investments. I've never said we were likely to bring a return on investment in the near term – you accepted that when you made your initial investment. Mr Tucker accepted the same terms. Apparently, his son doesn't. But that doesn't mean that anything, fundamentally, has changed."

"That he has doubts still gives me doubts." he said. "You call this a speculative investment – some would consider that an unfortunate term: you're admitting that it might come to nothing but considerable loss. Or worse, that it is simply a 'guess' that might be successful. As you say, I understood the long-term nature of this investment when first got involved – but just because it is high-risk doesn't give me leave to be any less careful about it. This turn of events just gives me too much concern."

He wasn't convinced; I decided it was time to make a more direct attack on Kyle's position. "Beyond the simple practicalities of the investment," I said, "The younger Mr Tucker, frankly, doesn't seem to have the vision to see where this might lead. It is a risky investment: we may not successfully complete flights, and if we do, we still may not be able to build the market. But success will also open

a new, vast market, with us in the leading position." I went back into the core of my sales pitch, the hoped for benefits and profits from commercial orbital spaceflight.

"Perhaps," he agreed. "But I have also received some correspondence from this Mr Kyle Tucker. He raises a number of concerns, as well as significant liability issues, and you've said little to assure me those."

So he had heard from Kyle Tucker. So far, I had found that Kyle had made contact with some investors, but not all of them; he certainly seem to be trying. "As to his economic arguments, as I said, the fantastic nature of our venture doesn't diminish the returns that are there to find, if we can. As to the liability – I understand and share his concern. Legally speaking, the limited liability nature of your investments, and the investments of others, protects you; but in the event of a catastrophic accident, it is hard to foresee where the lawyers will look – especially if most of Icarus's assets are destroyed in an accident – they may look towards our larger investors. You may be able to defend such claims, but the legal fees could be consequential – not to mention the bad press." I had decided to be very open about this, partly because Kyle was hammering home the same points, and I had to address them directly, partly because it was the right thing to do – openness tends to be worthwhile. "In fact, I believe that – the risk of being associated with such an accident – is the real reason Kyle is so set to pull out."

"And what can you say to say it's wrong?" My Schneck said. "The legal rules of incorporation are supposed to insulate such risks – but the protection would likely not be enough. Negligence claims can be especially costly, and difficult to defend."

"I can't say anything about the risk, in the event of an accident, except that it is part of the risk of the investment." I said. This was a bit of a dangerous admission, I knew, because it made explicit a risk they may not have thought about before – or been willing to accept. But the risk was there, and the best way to diffuse it would be to show that we wouldn't be negligent. "As in any investment, despite protections of incorporation. Allowances always have to be made for the tenacity of lawyers. But the

risk of accident, and particularly of something which might affect nonparticipants on the ground, is forefront on our minds. All of us involved with Icarus know the real risks, and have accepted them – but the people on the ground is a different story. Further, as you point out with investments, accepting the risks, and being careless about them, are two different things. When Icarus flies, it will be with some of us inside – we're not going to try until we're confident it's ready. Claims of negligence can be set against our carefully documented preparations and precautions, and we won't allow carelessness – or impatience – to impair our judgment. I can't guarantee that things won't go bad, but not for negligence. Everything we do has that in mind – as you know, I flew one of Icarus's aircraft up here myself – not merely for convenience or expediency, but for the flight proficiency. Everything we do is intended to make Icarus a success."

"And even if I am willing to accept these additional risks," he said. "there is one other, even more pressing problem. Even if all you say about precautions, preparations, and prospects, is accurate, you still appear on the verge of loosing forty percent of you investment stake. That alone is likely to collapse your project, and I don't want to be the one left holding the bag." I nodded; there was indeed that. But that was the very reason was here, now, to convince him otherwise, and to do what was necessary to keep that from happening. "At best, you're asking me to commit more money to your project, to help offset this loss – in fact, to payoff a disgruntled investor who no longer wants a part – and to vastly increase my exposure. Your project may have vision, but I'm not sending good money after bad."

"Then the question you have to ask is whether the initial investment was right," I said, "And if you still think the project has merit. As long as it does, it's not about sending good money after bad, but keeping a good project on track."

"But if his pulling out collapses the project," he said, "it does become bad money I'm chasing, and lost investment. The project may be worthwhile; but I still have to believe it has a reasonable prospect

of success."

In the end, he was noncommittal. I felt like he still supported the project, saw it's merit, but didn't want to be the one left holding the bag. The same was true of so many other investors – at best, they wanted to see a little bit more before they would commit more money.

At the same time, I also was meeting with the FAA, seeking an experimental airworthiness certificate for Icarus. We worked with Pat Moxman again, but the FAA pointed out that they didn't have authority to issue permits for orbital flights – and they had no experience with lifting bodies.

"We're only seeking permission for atmospheric test flights," I said. "A boosted ascent phase, ballistic trajectory, and glider landing – the flight profile is somewhat unconventional, but but not completely unknown. As to the lifting body information, we've reams of aerodynamic material available for you to consider. And NASA has additional materials from their flight tests – we used most of their public data for our designs."

"And your flights will go supersonic," the FAA officials also pointed out, "which is prohibited over US land.

That was a difficult one, but there were always loopholes – and our supersonic flights would be very short. "They can be permitted for experimental flight tests, and I would note that ours will be very short – and directed very steeply upwards."

In the end, the FAA was receptive, if hesitant, and reviewed our material, and inspected the Icarus. They expressed concern with the improvised nature of some parts of the craft, but did issue permits for "no more than twelve flights."

The same day we received notification from the FAA that our experimental airworthiness certificate had been approved, our lawyer called us to say that Kyle Tucker had filed paperwork to vacate his investments, requesting that we promptly provide inventories of equipment and supplies for valuation purposes.

I spoke with Troy over the phone; he was still working out of Virginia. “He means to shut us down.” I said. “He's not even making an attempt to sell his stake to other interested investors.”

“I see that,” Troy said. “Since he can't simply cash out and request a refund of his father's investments, he's essentially trying to force us to shut down and liquidate. Then the proceeds of liquidation will be distributed to investors. It could be his quickest way out, if we shut right down – but he'd make more by finding other buyers for his stake.”

“Well, we're not going to let him shut us down.” I said.

“No.” Troy said. “Don't worry, I'm already on it. Just keep on with your stuff. Now that he's brought it into the courts, we can delay him quite a bit.”

“I know.” I said. “We've got to get that first test flight up.” That was the key to our strategy – get our first test flight in the books, raise our profile, and show people what we've done. Businesspeople swarm to success, and we needed to show them some. “I'm going up in the Lear today with Abby, getting more flight hours.”

I had been training in the Lear in the midst of fundraising flights, and had gotten the copilot type rating just a few days before; Abby was the only one of us yet rated as Pilot-in-Command. That had been one of the conditions for the Icarus's airworthiness certificate; both pilots had to have 100 hours in the Lear, as PIC.

I took the controls, smoothly speeding us down the runway and up into the air; the powerful jets gave much sharper acceleration than the baron, but the aircraft flew like it had a lot more weight to it.

“When are we going to get the Icarus up?” Abby asked.

“Just as soon as we can,” I said, “But we've got to get a lot more simulator time, all of us. We've got to finish all the systems testing. And we've got to get our hours in here, to meet the FAA requirements.”

“I've been banging out flights in the simulator; I'm ready to make the test flight now.” she said.

“The FAA can say what they like about flight hours, we're ready to go.”

“We don't want trouble with them – getting orbital clearance is still going to be difficult.” I said. “We don't want to give them reason to give us trouble. And we are going to do this right – we go by the book, where there's a book to go by.” By this time we were at cruise altitude, flying towards San Antonio. We would loop out over the gulf, then come back and practice touch-and-go landings

“We don't have time to be too careful,” she said. “You said yourself that this Kyle Tucker is just looking to shut us down - we have to get airborne before he gets the chance.”

“We're going as fast as we can,” I said. “But we can't take any more chances than we need to – this is chancy enough.”

“You never take chances.” she replied. “I came here to fly a rocketplane – and I haven't even flown a fighter jet. My motorcycle is more fun than that dinky thing you started me out in.” She had never like the little planes, and only in the Lear did she really seem happy with the plane she was flying.

“You're not thinking about bailing on us, are you?” I said. “You did agree to see this thing through.”

“I just gotta get on my motorcycle,” she said. “But I'll stay,a s long as we keep moving forward.” 'For now', I could almost hear her adding.

We made a slow job of the complete inventory Kyle had requested, and made sure to point out the limited resale value of many of the components, and our lawyer was working on countering his claims. As long as our other investors opposed liquidation we were able to go forward, so I made another round of trips to some who seemed to be wavering. Now I flew with Abby in the Lear, to get more experience, and she waited impatiently in meetings. She would head quickly around town, trying to find the most happening spot in whatever city we happened to be in - even at ten in the morning – and more than once I had to remind her that if I even suspected she'd had a drink, I would make sure we spent the night.

The rest of the time she spent either in the Lear, or in the simulator; and the rest of us were running

around, trying to get things ready. Money was tight, and I had to beg the bank for additional funds to purchase the fuel for the first test flight.

The final engine arrived from Virginia on it's tractor trailer, and we installed all four engines in Icarus. Internal tests were conducted, and we began the final stages for testing, while Troy and our lawyer ran interference with Kyle Tucker.

“It's simple, what we have from here.” I said, one day, as we sat for one of our final planning sessions. “As soon as Icarus's system checks check out, we'll prepare for a ground firing – all four engines on a dry run down the runway. After that, it's just a matter of getting a few little things done. We're all almost at the the mark on Learjet flights.”

“A remarkable feat in two months.” Peter commented, and it was true; the Learjet had been in almost continuous use so we could all gain proficiency; and the Baron as well, for additional skill training.

“The sooner the better.” Abby said, impatiently.

“Yes, we're working on it.” I said. “Robert,” and it still felt strange not to call him 'Uncle,' “Where do we stand on static testing?”

“Almost done.” he replied. “A couple of irregularities left to work out. We had a problem last week with the hydraulics – one of the lines leaked a bunch of fluid everywhere, but we've got it cleaned up, and replaced the part; we also adjusted the pressure and flow rates slightly.”

“Nothing that will cause a problem?” I checked. “We don't want leaked hydraulic fluid to catch fire in flight.”

“No, we got it all up,” he said. “And I ran a couple of other checks for line integrity. Peter's been running electrical checks.”

“Yes,” Peter said, “Everything is in order on my part. I've been checking lines, actuations, voltages, up and down; not so much as a lose wire in the spacecraft. And if there is a problem in flight, we'll

catch it in plenty of time."

"Good." I said. "I've put in with airport management for both the ground engine test, and the test flight – they'll have to temporarily shut down the aircraft to all traffic for both. Not a real problem, but one of the airlines is complaining about the rescheduled flight. After that, it's just a matter of checking out in the simulator, and getting the fuel and oxygen – we'll make the test flight in no more than a month, sooner if possible. Troy, can we hold things off for that long?"

"The time shouldn't be a problem," Troy replied, over the speakerphone. He was now the only one of the management group working out of the Virginia building, and daily consultations with the lawyer precluded a trip down here for the meeting. "We've got a couple of things scheduled, and another auditor to come in – we've intentionally picked one who won't be available for about six weeks; Kyle isn't going to act until then. But he knows something is going on; his lawyer has expressed concern about the quantity of consumables we've been purchasing. He may try and freeze our operations."

"Well," I said, thinking. "Have the lawyer ready for anything."

Anything came just a few days later, when we were notified that Kyle Tucker was filing for a preliminary injunction to force us to freeze all activities.

"On what grounds?" I asked when Troy read me the notice.

"He says we've been given notice that he intends to terminate our operations, for the purpose of recouping his investment." Troy says. "He says he has enough of a stake to put it before other investors, and that we're actively impeding that effort, and he wants everything frozen until the ownership of Icarus has a chance to file."

I made a low, irritated growl. "When's the hearing?"

"The day after tomorrow," Troy said. "In the morning."

"Make the preparations." I said. "I'll fly up tomorrow, so we have a chance to get everything ready. I'll take the Baron – Abby, Susan and Hank need to continue training in the Lear."

It was a rough flight – I wasn't able to get away until the middle of the afternoon, so it was already getting dark when I stopped for fuel, and there were several storms all across the south; visibility was poor to zero, and turbulence was bad. Ground level visibility was close to threshold as I arrived over Leesburg, but the airport was still open, and I requested clearance for IFR landing. I was cleared immediacy, as there was little traffic, and descended at the controllers discretion.

As bad as visibility was at altitude, it quickly closed to zero as I descended; and then I began to fly into a light rain. I tried the wipers, then ignored them; I couldn't see anyway. Crosswinds and turbulence were shaking the aircraft all over, and I tried to stay calm as I followed the air traffic controllers directions, and leveled out at 3000', then turned around my final fix, towards the airport.

"NB1674, Cleared to land on Runway 17, IFR approach, number 1 for landing." said the tower, and I acknowledged, reading back the instructions. I had the airport diagram and approach plate clipped in plate to the dash; I had to see the runway by 200' above ground level or go around, so I took a quick glance at the go-around procedure. As I slowed down to approach speed the baron was getting even trickier to control, as the wind tried to push it this way and that, and I was feeling just a bit of slop in the controls.

I watched the DME and glidescope indicators; as they indicated I was closing in on the runway I began preparing for final, extending flaps to approach, switched on landing lights, and further lowering my airspeed. "NB1674 beginning final approach." I announced over the radio as I began my descent. I tried to breath deeply, to calm myself, and gave a bit of rudder to compensate for the crosswind, and I descended towards the still unseen runway. I watched the instruments, keeping my rate of descent right, and on the glidescope, keeping my corrections small and my heading right. As I came below 1500' I put the windshield wipers on, then dropped the gear a moment later, and felt the airframe jolt as they locked into place, adjust the throttles to keep glidepath, careful, slight adjustments to the controls, then full flaps for landing, a little more back pressure on the yoke to bleed off airspeed, then eyes to the

windscreen as I came through 800', watching for the runway lights, and my hand right hand to the throttles, ready to go around, 700', need to see that runway soon, look for it, check the glidescope, a little to the right, 600', almost go-around, I really don't want to have to setup again, wipe the sweat off my brow almost without thinking – is that it – almost a flicker of light there - no, There.

I had it, the runway lights, a couple more slight adjustments, a little less throttle, and I was right in line for the threshold; as I crossed it I pulled the throttles to cut and began to flare, pulled the baron almost level over the runway, felt the onset of the stall, a little more back pressure, and right on the runway. Full back pressure, the nosegear eased onto the runway, and I exhaled as I lightly braked the aircraft down the wet runway.

"NB1674, exit runway when able." requested the tower, and I acknowledged, hardly releasing the light touch on the brakes as I turned onto the taxiway and retracted flaps. In a few minutes I had the aircraft parked and secured, and pulled my raincoat on as I ducked over to the airport building to meet Troy.

"I hope the flight wasn't too bad." he said.

"Oh, it was just merry." I said, sarcastically. "At least we got our instrument ratings. Couldn't he have filed for the injunction in a Cincy court – I think the whether was clear over there."

"You still would have had to stop here to pick us up." Troy pointed out. "Besides, we're a registered Virginia corporation; that's why he filed here."

The next day, we were in court. Kyle's lawyer pointed out that as an investor, he was an owner of the project, and wished it shut down; he was in the process of consulting with his fellow owners to do so. "More to the point," his lawyer said, "We have clearly indicated our intentions to project management, and rather than securing facilities and assets for shutdown, they seemed to be speeding up their work." and he asked the court to order us to immediately cease all operations, "Especially including ceasing deliver of all types of consumable supplies."

Our own lawyer acknowledged that we were in fact, continuing to work, “As per the original and evolving plans,” and pointed out that Kyle Tucker still had a minority stake; without guidance from other investors, we had no choice but to continue development. “And they have been supportive.” he added. “In addition, continued development will maximize value in the event ownership does decide to sell the project. The static and ground testing for which consumables, including fuel, are currently awaited, will only enhance the value of the airframe.” The latter argument was my idea. It was meant not for Kyle, who seemed more concerned about liability than anything else, but for the court, to demonstrate that our continued work advanced Kyle Tucker's stated concerns.

Kyle's lawyer argued, of course, that such testing posed a significant risk, including loss of vehicle, as well as considerable liability, which his client was unwilling to accept. The judge, however, ruled that continued development, and operation of the project as accorded by the original investment agreements, was proper and appropriate, and there was no reason to hold development at this point – even if sold, we had an obligation to deliver the maximum value to our investors.

We breathed a sigh of relief. Now it was just a matter of getting things done. I met with our bankers while I was in Virginia, and had a hastily-arranged meeting with the FAA, where I showed that we had completed the required flight training in the Learjet, and were all training in the simulator, and I put in the formal paperwork for our first test flight. I also made the arrangements to receive the hydrogen fuel – far less than a full load – for our test flight. Visibility was still poor when I returned to Texas, but at least the it was daytime, and the storms had passed.

As soon as we got a few more thing set, and out liquid hydrogen and oxygen arrived, we prepared for the ground test. An airport ground vehicle towed us to the end of one runway, and Abby, Peter, and myself climbed into the Icarus. We'd all sat in the flight deck, at this point, and run system tests, but now we were ready for a live test. When the tower informed us that the airport was now closed for one hour, we were towed onto the runway, and began receiving fuel and oxygen from a pair of cryogenic

trucks, which took several minutes, and we brought systems online.

“How do the pressures look?” I requested. With a light fuel load, some of the cryogenic fuel would evaporate in the tank, and the pumps might have trouble drawing in liquid. “If we wait to long, there won't be enough liquid for the pumps.”

Peter had all that information at his flight engineers panel, and he reported. “All good. We're ready to go.”

I conducted radio checks with the control station we'd setup in the hangar, and with the tower. “Brake check confirmed?” I asked; Abby had checked them while we were under tow, and she said they were perfect.

“Alright,” I said, looking out of the cockpit. We had six thin windows, two forward, two at an angle, and two to the side; we couldn't see any of the aircraft out the front, we were nearly on top of the nose. “Ready 10 second countdown for 20 second burn. Throttles set.” At the last, I pushed all four throttles to full power position. On checks from the tower and control I said, “Ready ten second countdown, now.” and pushed the initiator button, and began counting; Peter monitored the ignition sequence for the engines, as I read the countdown, turbopumps started, the combustion chamber was filled with fuel and oxidizer, Peter announced, “Ignition!”

We were pinned to our seats as the engines came to full power and we accelerated down the runway; I used the rudder pedals to keep us in line with the slightest of taps, and I watched the runway markers, yelling “Cutoff!” when I thought we were near the limit of our stopping ability. Abby lightly applied brakes as soon as I announced – the engines would take a couple of seconds to shut down, and we didn't want to burn out the brakes with positive thrust – then Abby applied emergency brake as soon as Peter announced, “Off!” and we coasted to a stop.

“Open tank vents.” I instructed, and Peter did so. We couldn't reclaim the unused cryogenic fuel, so we just let it vent into the atmosphere; the hydrogen would be safe enough after dispersing for a few

minutes.

"Whew!" I said after a moment.

"Now that," Abby said, "Was something."

A little bit later, we were towed off the runway, and I notified the control tower, "We're all set down here. It's safe to reopen the airport." They acknowledged, then transmitted that message.

A few minutes later, we exited the spacecraft. The Icarus's main hatch was on top of the spacecraft, and we used a modified set of boarding stairs to get down – we also had a thermal blanket and a rope ladder on board, in case of an emergency evacuation. Standing back, I looked at the Icarus. Abby had been right; she was an ugly spacecraft – but in a utilitarian, practical way – she was beautiful in the job she would do. She had the basic shape of a lifting body, basically, half a cone, cut lengthwise from the tip to the base. The bottom was a slightly flattened cone shape, very fat in the rear, rising to a rounded point at the nose, with a very long nose gear strut. The top was almost flat, but curved down right at the front, with the top section of the crew quarters poking out, coming to a slight point right along the centerline. An ugly craft, of course, but impressively powerful. I turned to catch a ride back to the terminal.

We quickly analyzed the data from the run, confirming that the engines did function exactly as expected, and that their thrust was within bounds. All other systems of the Icarus functioned perfectly as well, and the next morning we discussed the next step.

"We should be ready for our first flight test in a couple of days," I said. "The data checks out, I want Robert and Peter to physically check systems – just make sure there aren't any discrepancies or damage. We'll use the same flight crew for the test; I'll be Captain, Abby will Copilot, and Peter will be flight engineer." I had decided some time back to use airline rather than NASA crew nomenclature, to emphasize our intended ties to commercial aviation. "However, since Abigail is the best pilot – and most experience in the simulator, she'll have the controls for the test flight. The flight profile will be a

burn to 25,000, throttling back if necessary to remain subsonic, coast to apogee, then come in for landing. Once again, the tower will close down the airport."

"The real question," I continued, "Is whether we should publicize this event" Troy and I had been debating this one – a public success would vastly improve our position, but expose any, even minor, defects.

"The publicity can only help us," Troy said. "You've kept a lower profile than even the X-prize projects, a few years back. You say you want to get people excited about space; they can't do that if they don't know about us."

"And everybody loves a winner," Abby pointed out, although I knew she really just wanted her face on a magazine. "We want people to see us. And if we fail – if we crash, what does our reputation matter then?"

"We can't afford to crash." I said, "And we can't afford to give the press negative headlines, which they might find even if the flight is basically a success. More important, we can't give Kyle ammo to shut us down."

"Doing a test flight may do that," Troy pointed out. "Having it public will hurt his efforts, not help them."

"And alerting the press before hand would give Kyle a chance to do that." I said. "He may go back before the judge, and argue that actual test flights are beyond 'normal development' at this stage. We need to take him by surprise."

"So we don't tell the press what we're going to do," Abby said. "Icarus isn't a secret project; we'll merely put out a day or two before that we're going to have a major test, open to the press, and tell them to come along and cover it. We'll only tell them it will be an atmospheric flight test once they're here."

"That," I told her, "Is brilliant." So that was agreed, and we worked out the details. But there were

a few other points.

"Besides flight testing," I said, "The biggest concern I still have are that Icarus is still slightly overweight. I'd rather have that resolved before flight testing, but we don't have that luxury. However, if we launched Icarus as is, right now, we would not quite reach orbit."

Uncle Robert shook his head. "We've taken out about all we can," he said. "There really isn't any more weight we can take out, structurally or systemwise, without a major redesign."

"We're not going to have time to do that, whatever happens." I said.

"Can't we lighten our payload somehow," Abby asked, "Cut back on the consumable reserves, for example. If our first orbital flight is only going to be a couple of days,w e don't need to take a week or more of supplies."

"We don't know what could happen," I said, "Weather, or problems on launch. I'm not sure we could lessen consumable weight enough, anyway."

"Then what about some kind of booster," Abby said, "Something like the JATO units the air force uses. I know you're trying to go for an SSTO here, but a 1 ½ stage setup – like the Mercury-Atlas rocket – wouldn't be out of bounds, especially if it get us to orbit." I raised my eye at that reference – Abby had never shown much interest is spaceflight or space technology – but she said, "What? As long as I'm here, I'm going to find out what I need to know to fly this thing."

I nodded; it had also always been true that, whens he went for something, she went into it wholly. "Something like that may be necessary," I admitted. "But the design of Icarus has no accommodation for external attachment of boosters or other components. Conventional jato units wouldn't work; the structure around the outside of the frame wouldn't support the force. Something attached next to the engines might work, but I'm not sure." I mentally reviewed the aluminum airframe as I said this, considering whether the rear bulkhead would be adequate to bear additional thrust. Maybe if we kept boosters close enough to the engines – but then the heat might cause them to explode. "Further, any

booster would have to separate after burnout, or it will just wind up contributing more dead weight."

"What about some kind of afterburner on the engines?" Abby asked. "If we had additional fuel in some kind of drop tank. That would resolve structural issues, at least."

I thought about that – it would solve one set of problems, and raise another. "I don't think anyone's ever tested an afterburner system for hydrogen engines. Robert, might it be workable, and if so, how difficult would it be to modify the existing units?"

Uncle Robert thought for a moment. "We couldn't pipe it into the combustion chamber – they're already optimized for the engine's fuel parameters. There is some margin for error, but the increased temperature of additional combustion would be too much. Assuming we used conventional fuel – ie, jet-a, avgas, or similar, we could pipe it directly into the nozzle without too much effort – but it would still pose several other problems. Not least of which is oxygen – unless we leaned the main mixture, the afterburners wouldn't ignite until well clear of the engine, which wouldn't do us much good. But leaning the mixture affects the relative quantities of hydrogen and oxygen we need to carry – and the tanks are fixed. It would also create a number of other concerns – notably changing the parameters we used to design the nozzle shape." That was a big issue – optimal rocket nozzle shape is dependent on air pressure; a real nozzle is a compromise in performance between low and high altitudes."

"Could we add some kind of intake to the drop tanks?" I wondered. "Allow the fuel to bring some extra oxidizer?"

"Might work," Uncle Robert agreed. "But it would be more complicated, and raises addition problems. And any added components – even on the rear – are going to have aerodynamic and weight balance implications." This was certainly true, although the simulator showed the Icarus having a slight reluctance to rotate at the end of the takeoff roll, and moving the center of gravity backwards might help alleviate that. "And – given the added takeoff weight – it's not going to give us a great big boost. Atlas -" here he looked at Abby, "was designed from the start with that configuration. It may be

workable as a stopgap, but it may not; we should be sure there aren't other, simpler, solutions."

"Then take another look at the weight." I said. "Well, there you have it. That doesn't affect the first flight test, at least; we'll do that just as soon as Icarus checks out, and we can get the necessary clearances."

The airport was not excited about having to close down operations for us again, so soon after the ground test – but were willing to do whatever was necessary to help us, so long as they weren't taking too much of the risk themselves. The FAA was a little more of a problem; our experimental airworthiness certificate require that they approve of each flight, and redirect nearby traffic. They were willing to do that, and had indicated so when they granted the certificate – but the FAA doesn't normally move quickly. I made a trip up to Washington to badger them about it, and got results; our flight was approved, and we set the launch date. Within a week of the first static test, Icarus would fly for the first time. We notified the press two days before, that weather permitting, we would be making a major test and demonstration of the Icarus spacecraft.

Whether on the designated morning was clear and calm, and we began preparations. Launch time was set for 11:30; we had advised the press to be there by 11; they started arriving well before that time. Troy briefed the press while the rest of us were busy with preparations. Icarus was towed out to the head of the runways, and the airport was closed down; Peter, Abby and I climbed down into the Icarus and commenced preparation. Fuel and liquid oxygen were loaded and systems were brought online; Abby and I both completed radio checks with our mission control and the tower. A few minutes later, we were notified that the airport and airspace were now closed, and we were clear to proceed onto the runway. We couldn't see the tow vehicle pull us forward, but in a moment we were properly spotted, and it came into view as it sped away down the runway; the fuel and oxygen tankers were also visible, running down the taxiways.

After confirming with Peter that the fuel levels were right, I announced, "Switching environmental

systems on; external air ports shut." and I manipulated the controls on the environmental panel, on my left side. Though we would only be at altitude for a few minutes, we would still be high enough that we would pass out within seconds at outside pressure, and we didn't have a separate cabin pressurization systems. Besides, it would be the first real test of the environmental system, as well. Watching the cabin pressure systems, I conducted the system test. "Increasing cabin pressure," then wait a moment, no sign of loss of pressure, "Check. Decreasing to low." Again, no sign of deviation. "Check, returning to normal. Pressurization system is go. Ready for APU start."

"APUs to prestart." Peter announced as he toggled the switches. The diesel engines glow plugs were charged and heated, the fuel pumps were started, and the hydraulic turbine valves were opened. Each APU was controlled by three sets of switches – the first, main switch was "RUN – START – PRESTART" and controlled the starter sequence of the units. The second was a throttle switch, also three position, reading "IDLE – NORM – FULL." The final controlled the shutdown, and read "OFF – AUTO – INHIBIT." off would immediately shut down the engines, auto would allow them to shutdown if certain mechanical sensors tripped. Inhibit prevented safety shutdown in most circumstances.

After a moment, Peter continued the procedure. "APUs ready to start. Ready 1." There was a faint vibration as, far in the back of the craft, the motor started. "Ready 2." another vibration. "Ready 3. All APUs showing started and running normally. Throttle position testing – normal" and the vibration, increased, still slight, but noticeable, "and high." The vibration on high was quite noticeable, but felt distant. "Pressurizing hydraulic system now." The small turbines were spinning away furiously, increasing the hydraulic pressure to full. "Pressure normal, switching to low." In the low position, the throttles were regulated to maintain normal pressure, by a simple electric control loop.

"Ready control tests. Engine gimballing." I requested. The engine gimbals were linked with the flight controls, one of the main reasons Icarus was so difficult to control under power. Abby pulled and

pushed her yoke, then rotated around to roll the engines."

"Engine gimbal is check," announced Susan, over the radio. A video camera was placed behind us, at the corner of the runway, to allow control to monitor all tests and spacecraft prelaunch operations.

"Control surfaces test." I said, flipping a switch on the pedestal between me and Abby. The control system could be routed several ways, all manually switchable – gimbal only for testing, full control, gimbal off for glide approach and control surface tests, then another set of switches to switch each axis between control surface and thrusters. Again, Abby moved the control yoke, then this time the rudder pedals, and Susan confirmed that all surfaces had moved properly.

"Control tower, this is Icarus." I said on the appropriate channel. "Requesting permission for takeoff, as per flight plan."

"Airspace is clear to fifty thousand feet." The tower replied. "Winds aloft about fifteen knots out of the north. You are clear to takeoff."

Switching back to the control channel, I announced. "This is Icarus, ready to launch."

The several monitors reported, "go for flight test," and Susan said, "You are go for takeoff."

"Copy that, go for flight." I said. "Ready engine start; throttles to full." I pushed the four levers up as I said the latter.

"Flight engineer reports, go for takeoff." Peter said. Icarus was setup so that the flight engineer would handle many or the responsibilities NASA delegated to mission control, including final flight clearance. "Engine sequence ready; auxiliary pumps started."

I entered the appropriate program into the computer, and with two switches announced, "Ignition sequence on 1 minute countdown. Abby, are you ready for this?"

"I'm always ready." she said, calmly grasping the control yoke. "Let's get it on."

"All set." I said, watching the countdown on the computer screen. At thirty seconds, I flipped another switch. "Ignition sequence to automatic. Twenty seconds ... fifteen ... 10 – 9 – 8 – 7 – 6 – 5 –

4 – 3 – 2 – 1 – ignition!”

The Icarus jolted as the four engines came to life, and we were pinned into our seats with the massive acceleration. I watched the airspeed indicator speed up, and noted the passing distances on the runway. “No abort point ... now!” We no longer had room to stop in the event of emergency; we were committed to takeoff. I watched the airspeed indicator speed up rapidly. Icarus had conventional, clock style gauges, most of them from airliners, in the standard arrangement; a second airspeed dial showed mach numbers – and countless other gauges, almost all of them traditional. 125 knots ... 150 ... 175.” I took a glance out the windscreen at the rapidly passing runway; we had plenty of runway to takeoff light, but would be pushing it loaded for orbit. “Rotate!” I announced, and Abby pulled back hard on the control yoke, the horizon sank and we lifted off sharply. “Gear up!” I announced as I hit the switch. “Watch the stall, Abby.”

“I got it.” she said. The re was a light jolt as the main gear locked in place, a slight vibration of the nose gear came up on it's long strut, then it too locked in.

“Bring it to 88 degrees.” I said. An orbital takeoff would require a slightly lower angle, as the thrust would be slightly below takeoff weight, but with a lighter load we could go straight up.

“I know.” Abby said.

We were pushed back hard into our seats as the altimeter spun and the vertical speed was pinned to the high stop. “Everything looking clean – 10,000 feet, 2 and a half gees.” I took a quick look at the side window and the Texas countryside dropping away under and behind us. A bit of vibration picked up and I glanced at the airspeed – we were already approaching the transonic range. “Throttling back,” I announced, “Ninety percent ... eighty. Fifteen thousand feet “ We didn't want to go supersonic on this flight, and even if we did, we had to do it at low throttle to minimize aerodynamic stresses. “Continuing throttle reduction . seventy percent.” I checked the airspeed again – we were closing on 20,000', and airspeed was almost to desired max. “Sixty percent ... fifty percent, minimum power.

Twenty thousand feet." The gee-force was reducing, but we were still accelerating noticeably. "Twenty one thousand ... twenty two thousand – ready for engine cutoff ... twenty three thousand ... twenty four thousand ... cutoff ... mark!" Thrust immediately reduced as Peter initiated the shutdown sequence, stopping first the flow of oxygen. Hydrogen continued to flow into the engine for several seconds, acting as coolant.

"Engine shutdown nominal." Peter reported.

I quickly switched the control mode to surfaces only. "We're coasting. Abby, drop the pitch a little; we don't want to wind up on our back."

"I gotcha," she said, sounding a slight annoyed, and concentrating on controlling this missile. "Are we weightless?" she asked, after a moment – indeed, already felt myself floating against my shoulder straps.

"For a few seconds," I confirmed, with a combination of exhilaration and nausea – I felt decidedly off balance, and had to look out the side window to reorient myself to ground. Abby had already reduced our angle slightly; the ground continued to recede below us. "I told you it would happen – we're on a ballistic trajectory for the moment."

"I know," she replied. "its just – we're not in space yet."

"We're in freefall," I said, "It's the same thing. Peter, how do we look back there.?"

"Everything nominal." he reported. "Engine shutdown and powerdown complete; APU's not showing any problem in freefall." That had been one of our biggest concerns with using conventional, diesel engines – they're not designed to work in zero gravity, and we'd had to make a couple of modifications to ensure proper fuel flow.

"We're approaching apogee." I said, watching the rapidly decreasing airspeed; Abby was already letting the nose sink towards the horizon. It was a sense of quiet calm after the roar of the rocket engines.

“Tower, this is Icarus. Have you got us?” I requested into the radio.

“We have you, Icarus.” came the reply. “37,000 feet and descending, Come to 3 – 1 - 0 degrees when able.”

“Copy that, 3 - 1 – 0.” I confirmed. That was one of the things we had worked out with regard to the controllers responsibility; they had us on radar and would vector us around to the runway. “How's she feel?” I asked Abby.”

“Like I'm flying a rock.” she said. “I've got enough on the controls; I'm just not feeling much lift at all.”

“The air will get thicker,” I said. “And we'll be going faster coming on an orbital descent. Let the airspeed pick up before you try the turn. How's it compare to the simulator?”

“Fine-” she said, “Can't we wait until we're on the ground? I actually rather have my hands full over here.”

“Of course.” I said, and watched the instruments. I was essentially acting as copilot, monitoring instruments, flight status, auxiliary duties, allowing Abby to concentrate of flying the Icarus. As we went lower - and faster – Abby pulled us into a gentle turn, coming right out on heading. We were still heading down steeply, Texas spread out in front of us.

“Icarus, turn to 2 – 5 – 0 in one minute.” requested the tower, and I confirmed, then watched the clock.

“Thirty seconds ... twenty ... ready to turn ... enter now.” I said. Abby pulled us into the turn, a little steeper than before. She was pulling the nose up, but our vertical speed still increased, and I told Abby to watch it.

“I'm doing the best I can,” she said, then pulled us out perfectly on heading, once again.

“Tower, are you getting a read on our glidepath?” I requested. Looking out the side, I could see the airport off below us, and noting how quickly we were descending, and was getting a bit nervous that

we would make it around to the field.

"We're getting it, you're pretty steep." the tower reported. I had sat down with the controllers the day before and gone over a couple of things; particularly this. We wouldn't have another chance to try for it.

"We're parallel to the runway now." I told Abby. "Watch your airspeed."

She nodded; even for her, I could tell Icarus was a lot to control, and I watched the airport disappear out of view of the window. We were no longer in freefall and hadn't been for several minutes, and I felt heavy in my seat. "20,000 feet. We're going to need to come around soon." I took another glance out at the horizon, the deserts of southwest Texas ahead; yet the ground was already getting visibly nearer.

Finally, the tower instructed, "Make base leg." I confirmed, and Abby banked the Icarus back over, then pulled out.

"I see the runway." I said. Abby looked for a n instant, but I couldn't tell if she could see it from where she was sitting. "Watch your approach."

"I know." she replied. "I'm making final now." She turned us into a shallow bank, and for the first time our vertical speed didn't increase. "I have the runway." she said, indicating it was now on view, and in a moment had us straight an in line.

"Localizer on." I said as I hit the switch to activate the ILS and give precise directional cues; Abby would ignore the glidescope, as it was configured for commercial traffic and way to shallow for us. "Fifteen thousand feet. Are we a little low?"

"Possibly," Abby said, "I'm holding it."

I watched out the windows as the runway approached quickly. "Ten thousand feet." I said, and we were definitely low. Let's not come short.

"I'm stretching our glide," she said. But stretching a glide is tricky – try and pull up, you lose airspeed, and wind up coming in even shorter. In a powered aircraft throttles are used for rate of

descent, but not in a glider.

“Airbrake ready.” I said, flipping the arming switch, and reaching for the handle. It would actuate two panels along the top back of the spacecraft..

“Keep airbrakes secure,” Abby requested, “Until my mark.” If we were coming in low, we wouldn't want to slow until the last possible moment. The long nosegear extension time would add drag,d though.

“Five thousand feet,” I said, looking nervously at the runway – for the moment it seemed to be holding right, but we still seemed low. “Watch it, Abby, we're coming in short.” I continued to read out altitudes, now along with airspeeds; we were under three hundred knows. I could feel Abby rolling us back and forth slightly, compensating for crosswind. It was slight, but given Icarus's fat shape, significant. We still looked like we were coming in low, and I began breathing quickly and nervously, hand on the speedbrake, and gear ready. “Two thousand feet, 250 knots.” With the runway above a thousand feet, we were close now.

“Localizer good.” Abby said, “Just a little more ...” I saw her struggling with the pitch, fine adjustments now, and cringed at the approaching threshold. “Hold the gear ... speedbrake at my command.” I watched the runway, Abby began to pitch us up slightly – we were within five hundred feet. “I'm comin' in hot, but I think I've got it.” Out airspeed was dropping, and I was watching the altitude.

“Ready gear,” I said, more as a warning; I didn't want her to be surprised by the sudden increase in drag; we were quickly reaching that point. “Gear down.” I said, hitting the switch. I was her pull the yoke, adjust, adjust, and say something under her breath; she was concentrating fully on the approaching runway. And yet . Maybe ... Maybe ... the threshold was closer, closer, and we looked so close.

“Flaring,” Abby said, pulling back on the yoke, and our airspeed began to drop, the threshold shifted

lower and disappeared under the windscreen. “Airbrake ... now! Hard!” she requested, and I pulled back hard on the lever, felt the increase in drag, pitch, and watched the airspeed drop. And then – thunk, as the main gear hit the ground with a jolt, the runway, I hoped, and the nosegear settled. “Full brakes.” Abby announced, and we were slowing; I watched the airspeed needle spin left. And then, with a jolt, we came to a stop.

“See? I told you I had it.” Abby said. “Now that ... was fun.” I just nodded, trying to catch my breath. After a moment, she said, “By the way, you can release the airbrake lever.”

“Oh, yea.” I said. “Tower, this is the Icarus. We're down.”

“Perfect landing,” the controller said. “Right on the numbers. Any shorter and you'd have missed it.”

We had already vented the tanks at altitude, so after a few minutes, we were towed off the runway and the airport reopened; we emerged from Icarus a few minutes later.

Reporters had been watching from in front of the public terminal; they swarmed towards Icarus as soon as they were told it was safe.

Several reported crowed around us once we had exited, looking for an interview; I spoke to several. I answered just a few questions, explaining the goals of the Icarus project, and telling them this flight was just a precursor to orbit. “Humanity has been talking about the space age for forty years. We want to make that happen. Building and operating a viable commercial spacecraft is an important step to that.”

“Are you saying you can do better than NASA?” one reporter asked. “From what we've seen so far, your operation looks pretty limited.”

“Not at all,” I said. “NASA has done a great deal; and couldn't have built Icarus without the technologies NASA has developed. But we're trying to turn the strength of private enterprise on the problem. When Icarus does reach orbit, it will launch a whole new era.” But I was tired from the

flight, and kept my comment brief; besides, Abby was practically holding court at the base of the stairs, and after answering a few more questions myself, I left her to it. All told, the day was definitely a success.

Of course, the next day we received an angry call from Kyle Tucker's lawyer, saying we went far beyond the judges intent. We answered that we were doing exactly what we said, continuing development, but he wasn't placated. He warned that he was calling another hearing, and reiterated his clients intent to shut down the operation, as soon as he finished contacting the other investors..

But the launch – and the publicity – boosted the support of many of our other investors. Some expressed interest in making additional investments; others offered other support, and made clear they opposed closing the project down.

Then, publicity brought something else. Once again, Jessica Hunt appeared, protesting the project. We saw a report of her leading a rally in Cincinnati. "This project is a threat to the people of Texas and the world, and a waste of resources better spent here on Earth. The narrow-minded leaders of the Icarus project speak of bringing a new era in space; but we have so many problems here. People are starving, without jobs, without housing. We need to focus on the real problems people have, not these pipe dreams that benefit none but a few pilots."

"Her, again." I said, after watching the coverage for a few minutes. Several of us were sitting around the table, having lunch.

"She does seem to have it out for us." Troy commented. "I thought you said you out talked her the last time?"

"I did, but I figured she'd be back, sooner or later." I said. "And I got a better sense of her last time. She's a true socialist. Everything should be done for the good of the people. Not that I really disagree with that in the end. But things are never really that simple, and we need growth and dreams, which the top-down mentality never sees room for. Icarus may not put food on people's tables, this month,

but without economic and social growth, I hate to think what will happen."

The report was a summary of a protest that had occurred that morning; it cut to an interview with Jessica afterwards. "I've been meeting with Mr Kyle Tucker, whose father was a major investor in this project." she said. "And he agrees with me that this project should be shut down, and he already working to do just that. We will stop this obscenity, and redirect the efforts here, where there really needed.

I nearly dropped my food out of my mouth.

"Now there's an unholy alliance." Troy said. "I thought you said she was a socialist?"

"She is, and you're right." I said. "But he's a short sighted businessman of the worst type. No vision, no sense of anything beyond this weeks dollar signs. I wonder if she sought him out now, after our recent coverage, or whether they had already made contact?"

"Well, we still have to do something about them." Abby said. "People like that are always trying to take the fun out of everything."

"Well, if they're going to fight us with publicity, we can fight back."I said. "But if Kyle Tucker has allied itself with her, I think that eliminates any chance of getting him to stand down."

So we contacted several of the media outlets which had covered our recent test, and told them we would be delivering a public statement the next day. We setup the hangar for a press conference, in front of Icarus, and I spoke in front of the large gathering of reporters.

"Some people would have you believe that Project Icarus is a waste of money," I said. "That those of us involved in projects like this are just narrow-minded fools who care about nothing but boosting their egos, getting their names published in some obscure journal while doing nothing but diverting resources from 'more important' priorities. And yet, couldn't the same have been said of the Wright brothers? It was ten years after their first flight before airplanes began to be a practical mode of transportation. If they had thought only of that day, that month, or that year, surely they could have

found more productive ways to spend their time and money. Sure, they would never have become household names, but the common good is more important than anyone's ego."

"But where would that leave us? We can hop in an aircraft and be halfway around the world in time for dinner – thanks to two brothers who were 'afflicted with the belief that flight is possible to man.' Not everything we do has to have a immediate, practical purpose. In fact, many of the most visionary things that have ever been done were the things that seemed the least practical, the least necessary. Take the Wright brothers. Even recognizing, then, the potential value that flight might have – knowing the time it would take to develop, and the cost in money and lives, would lead many to say there were far more worthwhile things to do."

"Some have called Icarus a pipe dream." I finished. "And in some ways, perhaps they are right. We may well be tilting at windmills. But if it is a pipe dream, it's one worthing having, and worth pursuing. Where would we be if not for the dreamers, those who thought flight is possible; those who burn with the need to take two steps beyond the possible. Icarus isn't about whether spaceflight is possible – for we know it is. It's not about making it worthwhile, for human destiny is growth. It's about making it practical, for humanities greatest gift is our desire to reach out and be something more than we are – even if we risk falling along the way. To those who say it costs to much, I say: what are the costs of not trying – of settling for what we've got, only too late to find out it's shrinking away to nothing. And to those who say the risk is to great, well, perhaps it is too much, for them. But life is risk, and the greatest risk is in not acting because you're afraid of what might happen. I accept the risk, because I fear what will happen if we never try."

"If anyone has any questions, I'll take them now." I said, after the applause had died down, and there were several. Some having to do with practicalities, further testing, project timeframe, and others having to do with larger questions. I answered them all as best I could, making clear I thought the risk of spectacular failure far less than the risk of not trying. "Mr Kyle Tucker – is it really your desire to

stop progress – here and now – and find out how quickly it will start to slide backwards?" I asked, as I closed.

It went over well, I thought, and the coverage was very positive. It was interspersed with video from our flight test, and watching it, especially closeups of us coming out of Icarus, something bothered me. I couldn't put my finger on it for a moment.

"We look like amateurs in those t-shirts." I said, suddenly, and indeed it was true. Abby was wearing an ugly yellow T; I was wearing something different. It looked like we had hopped off the subway, and into the cockpit. "We need some kind of flight suit." I said. "Something practical – lots of pockets – but sharp. Modeled more along pilots uniforms, rather than NASA suits. We need to think about spacesuits, as well." The latter we had given a fair amount of thought to, as well, but hadn't finished.

"Spacesuits will add more wight." Peter pointed out.

Abby said, "What are you trying to do, make us look like a bunch of uniformed peons? I think we look fine."

"We need to look like professionals," I said. "Especially since this is shaping up to be a fight in the public arena."

Which indeed it was. Within a couple of days of our press conference, Jessica Hunt had called one of her own, this time appearing at Kyle Tucker's offices, with him in prominent attendance.

She began by repeating the grave safety concerns, a well as earlier claims about perchlorate pollution (was I going to have to rebut that, again? Hydrogen engines don't produce perchlorate) before launching into her main argument. "Icarus Project Leaders refer to the Wright Brothers, as if they are inheritors of some kind of 'mantle of innovation.' But practical use for flight could be conceived before they flew, even if it was ten or fifteen years before they were realized. I see nothing that can come from spaceflight, save for a few pioneering flights to nowhere. Indeed, humanity has

been flying in space for forty years, and what have we to show for it? What good has come out of space – communications, weather monitoring – has come from unmanned satellites."

"And here, while we're debating this, people are starving, here and now." she continued. "Dreamers are fine and good – we do need dreamers. I too have dreams, of world where nobody goes hungry, where people have work, shelter. That is where we must concentrate our efforts, the practical and the dreamers, to make life better for everybody. Not fulfilling pipe dreams."

And I answered with another press conference, within a couple of days. I spoke, keeping in mind that the prime audience was our other investors, to convince them that they were right to back us. That, indeed was where the real battleground was. "Perhaps the Wright Brothers foresaw the jumbo jet," I began, "But probably not. Airmail, expensive passenger flights, could have been foreseen – but even so, it took people years to find practical uses for airplanes. Let's not forget that many people said, 'If man were meant to fly, we would be born with wings.' Now, airplanes have come vastly further than any could have conceived, when the Wrights first flew. So even if we cannot conceive of where spaceflight may lead us, we must remember we are not limited - will not be limited – to our own preconceptions. I can envision, in part, where we might lead. Tourism, to begin – already, we have on record several dozen advance reservations for orbital spaceflights – individuals who have paid more than a million dollars for the chance to fly into space, when we are ready. There is certainly a market for that, a larger one than many realize. Science and technology – if the research done on the space station is limited, it is due to the still enormous cost of access – precisely the problem we are trying to improve. And if much of the best practical use of space science has come from unmanned satellites, none would be up there without human beings who have believed not only that man can fly in space, but that man should fly in space. But I think the real opportunity is far more than even this, and far larger."

It was well received, and of course, Jessica had another conference set up. But Kyle wasn't relying

on her to shut us down; we had another day in court, and another injunction request to fight.

In court, Kyle's lawyer argued that our continuing tests were risking what value there was to the company. “One minor incident,” he said, “And the Icarus prototype will be destroyed. As it is, it will have some salvage value. Any accident destroys that. My client is interested in recovering his investment, and is concerned that these continuing activities are endangering that.”

Our lawyer rose to respond, but I told him, “If I may.”

“Of course,” he replied. “But be careful.” We had agreed beforehand that I would address the court directly; but it wasn't going to be a little later in the hearing.

“Your honor,” I said, “Kyle Tucker speaks of destroying 'what value there is' in Icarus. But as you yourself acceded, these flights are about creating value, for what value Icarus has, is it's usability as a spacecraft. Yes, there is risk when Icarus launches into the sky; but there was also risk when Mr Tucker stepped onto his airplane for the flight here.” Mr Tucker's lawyer started to say something here, but the Judge told him to wait. “Second, if we were to liquidate Icarus, all assets, now, we would only recover a fraction of what has been spent.”

“Are you saying you've been wasting my father's money?” Kyle demanded, standing up; the judge quickly told him to be patient.

“Not at all,” I said. “But as you've pointed out elsewhere in these proceedings, a great deal of our expenditures has been consumables. We can't simply recollect and sell most of the fuel and oxygen we've burned. More important, the very process of construction destroys value as well as creates it. The value of Icarus, in parts, is far less than the cost of the raw materials used in building it, because of the work that has been done – like any large construction. If you took a built house and cut it into scrap, you would only recover a fraction of the cost of building it, because of the processes of working with materials, and the labor that went into it. It is such with Icarus; metal has been cut, composites formed, and many hours of labor. It's only when she is used as intended, as a spacecraft, that the value

we have added will mature."

Of course, his lawyer pointed out that was exactly why work needed to be stopped now, until all questions were asked, "Before more of my clients money goes up in smoke."

Our lawyer then pointed out that Mr Tucker, who still only owned a forty percent stake, was the only one yet calling for liquidation. His lawyer said he was still in contact with many of the other investors, but that it was a long and complicated process. He also pointed out that, even without majority stake, he could still recall a significant amount of the investment.

The judge called that a threat, and warned him not to act on that yet, then asked what had been done to asses the attitudes of the other investor; he said he would do nothing until he saw evidence that a majority of ownership wanted to liquidate. Our lawyer said that I had been speaking to number of our investors, most of whom had expressed continuing support, and some had expressed frustration about "badgering" by Kyle's team. His lawyer then said that they would have evidence of support for their side soon.

At this, I rose up to speak again. "If it's the views of other investors, you want, your honor, then we're willing to see what they think. We'll begin the process of circulation a shareholder question to asses the very question. But it's necessary that we continue the flight testing process at the same time; all investors must have a clear picture of our current status, and our prospects for success."

Troy poked me in the back, and asked, quietly, "Are you sure that's a good idea? That could show doubt and legitimize his position."

"Don't worry." I said, quietly.

His lawyer questioned it, asking first, who would write the question, then demanding that his client be permitted to review and approve the actual question. This I answered, saying, "My Tucker is still only a minor stakeholder in the Icarus project. Until he is any more than that – or can show that he has enough support to take control – he has no more standing than any other investor to review a ballot

question."

The judge agreed, but pointed out that, now that we had put a formal question on the table, the expected us to put it to all investors without delay. "And I have reviewed the complex investment structures you've used, which are typical of most start up organizations. I will be closely reviewing your processes and tabulations."

As we were leaving, Troy asked me what I was doing. "If more than a few investors vote on his side, we're done. I thought we were trying to delay."

"We were," I said, "And we still are. But our test has boosted our standing with other investors – this is the best time to take a poll. If we wait, we'll lose some support. And if we don't show investor support, the judge is going to start giving more weight to Kyle's concerns. But there's something else in our favor – most investors – most business men – don't like Jessica Hunt's type. As long as she's the face of the opposition, that's one more thing we can use – and that, too, is best used when fresh."

So I circulated around, firming up our support. Most were privately supportive, or very supportive; but often noncommittal in public – they still didn't want to be the ones left holding the bag, if we went downhill. Some of them were also still concerned by Kyle Tucker's points about liability and gross negligence; and I did my best to assure him that that we would avoid unnecessary risks. And I was careful to word the question to subtly favor us, but not so much as to leave the results open to compromising.

At the same time, everything else advanced. We conducted more flight tests, to steadily higher altitudes. Hank piloted one, the first that cleared a hundred thousand feet; he described the Icarus as a "monster" while under power, and not much better in the glide. Flight experience gave us much better approach, angles, as well, and we didn't have any more test flights come that close to the bottom of a usable final approach.

We also ordered flight suits. These were common enough, and there were many willing

manufacturers - many companies that make military and NASA replicas. Finding flight quality suits, as opposed to replicas, was more difficult, but there are enough companies that make high quality fabrics. More important was design; working with the selected contractor, I put together a design which, while maintained the one-piece, pocket-filled design of NASA flight suits, but was styled much like an airline pilots – white top, black bottom, and even epaulets. However, the black lower portion was trimmed in a curve, to give a modern appearance, and there was no collar.

And I continued to debate Jessica Hunt in a series of press conferences. She was astute and knowledgeable, and in fact I was coming to admire her diligence and passion – but was still determined to beat her. My main goal, though, was not to out-argue her, but to bring her socialist leanings out, and turn other investors natural antipathy towards her into active opposition to Kyle Tucker.

"The question is not," I said in one conference, "Whether society engages in technical and scientific research, but who directs it. It is government bureaucrats, guided by what they think are societies problems, and unaccountable for the eventual results; or is it individuals and corporations, trying to find a market, a niche, and doing the research to create and exploit it?"

She responded in a conference the next day, "Of course society engages in science and technology. Lives are saved by modern medicine; and jobs are created by industry. But in the end, it's people we're talking about – it must be the good of all we keep our focus on. A businessman may be seeking to fill a niche; but in the end he is only concerned with his own profit, nothing more; we must look out for the good of society."

Skillfully, she had dodged the core question. I continued to push, calling for another conference. This was was coincident with another test flight; Susan's first. I spoke, prior to the launch, saying, "Whether we succeed or not will, ultimately, be at the behest of society at large. Meeting the technical challenge is one thing; and that I believe we have mostly done; it remains only to prove it. But success or not, as a business matter, comes down to whether society values the service we offer, or rejects it."

Icarus flew after I spoke, rumbling down the runway, climbing steeply, banking towards the south. We had begun including a powered bank after the first couple of flights; besides putting us in a better position for landing, it would be an essential part of our orbital flight profile. Then Icarus climbed out of sight. The control tower reported an apogee in excess of 120,000 feet before Icarus began her plunge back towards the Earth; in a few moments Icarus came in sight as she bore onto final approach, and Susan brought her down for a smooth landing, and the crew greeted the press warmly as they exited the vehicle.

"How was it?" I asked Susan a little later, out of the eyes of the press.

"She's as nasty as everyone says," she replied. "But damn, that's a heck of a view. I begin to understand your obsession – and you haven't even been there yet."

"I know, that's why I'm trying so hard." I said. "And I haven't been up since the first flight – now you're getting high enough to see the stars, and the curvature of the Earth. What about the thruster function?" That had been one of the main objectives of this flight: Icarus was now getting high enough that the control surfaces began to lose effectives, and thrusters became necessary.

"Effective on all three axis," she said. "I'll give a complete summary later. But we should do something; I can't remember the last time we went out to dinner."

"It's been busy." I said, "And we've got to cram everything together right now. Once we get a few more test flights in, and we know what to do about Kyle, we'll be able to take a breather. I promise."

"Alright," she agreed. "But you're getting pretty on edge. You're gonna need a break soon, or you're going to explode."

"I'll do my best." I said.

The ballot questions had already started to come back, and the rest arrived in the next few days. There were a few votes to support Kyle, but all came from the smallest of investors, who had the least stake in the organization.

Energized by their support, this time it was us who scheduled the hearing, and the judge, presented with the results, said, “It's clear that majority ownership of Icarus supports continuation of the project. Therefore, I see no choice but to permanently deny you request for an injunction, and declare these proceedings over. Court in adjourned.”

“Don't think you've gotten away with this yet,” Kyle told me directly, as his lawyer handed me another paper. It was a formal request to refund all investments of certain classes – which entitled him to do exactly that. It amounted to more than ten million dollars. But Troy was, at this point, more concerned than I was. “I've got an idea,” I said. “Trust me.”

Once more, I made the rounds of our larger investors, to thank them for their support. And I invited them down to Texas, for an exclusive tour of our operation, and a chance to observe another test flight.

I handled the flight this time – my second, and my first at the controls. I made a point of this, having emphasized the very fact that I intended to fly Icarus, so I wasn't going to be careless about it. I was a little nervous at the controls, waiting on the runway; now having not only the difficult simulator, but all that I heard. On ignition, she barreled down the runway once more, and pulling up into the sky I found she was as much of a handful as everyone said. An instants loss of attention would be disastrous. And then, burnout, and we coasted to apogee, the intoxicating nausea of weightlessness. And the incredible view out the window, as we were already far higher than the Concorde had once cruised, and the Earth curved out of sight. Near apogee, thrusters on, one axis at a time, and I pushed the craft with light, gentle thrusts. It felt so different than an aircraft under atmospheric control, and different, even, than seeing the results on a simulator screen. And then descent, approach, and landing. I felt nervous as I exited the spacecraft, and yet relieved. A part of me had, up until that moment, wondered whether I would really be able to handle Icarus; in truth I knew my sister was a far better pilot than myself, and even she'd had more trouble with it than she let on. (The fact that she had spent three solid days in the simulator after our first flight was one clue. And I had been in the cockpit with

her on the first flight.) And I was glad to have performed well in front of our VIPs.

They were waiting back at the terminal, and as we returned, I asked them what they thought.

“Impressive.” one said, and others agreed.

“It's exhilarating, that's for sure.” I agreed. “While they're securing Icarus, and bringing it back to the hangar, I'll give you a tour around the rest of the facility; then you'll be able to have a closer look at what your investment has built.” The commented on the tight quarters of the simulator; I pointed out it was bigger than the Apollo astronauts had, “But not by much,” and noted how careful we had been with our budget.

And then I made the real point I had invited them to hear. I reminded them of the recent vote, and thanked them for their continued support. “But now, there is more. Kyle wanted to shut us down; he failed to do that openly. Now he wants the refunding of certain investment classes to which he is entitled; explicit compliance would terminate the project immediately – a project such as this simply doesn't have the ready cash. However, I value all of my investors, and would not try and stiff any of them – I intend to meet my obligations to him, just as I do to all of you; we only want backers as shareholders for Icarus. But I need your help. I ask your help, to allow us to finish what we've started. Buy out his shares, if he'll sell them, or provide us the funding to meet our obligations, and finish the final stages of this project.” They voiced support, and I knew I was right. Now that they had formally voiced their support of the project, I didn't think they would let it now be undermined. I got direct offers of additional funding, and additional investments to finish our work.

Kyle refused to sell any of his stake; and in the end he only called some of his investments. I wasn't sure if it was because he knew he was beat, or if he wanted to hold out to pinch us later – but it was clear we would be able to go ahead and attempt orbit. He said nothing to me, but sent a message through his lawyer that he still had his eyes on us, but that he would not – for the moment – offer us opposition. And – I found out through contacts in the media – he had cut Jessica off, blocking her from

any more press conferences or protests at his facility, and using his influence in Cincy to deny her media access he had previously provided.

The pace of flight tests slowed; we continued to look at the weight problem, and a few other issues. The flight tests were not without issues, of course (including a thruster on one flight that stuck on, reminiscent of Gemini 8; Abby had to counter it with constant thrust from the opposite thruster until she got low enough for atmospheric resistance to render the thruster ineffective. We rewired all the thrusters to provide an automatic cutoff; such a scenario in orbit would rapidly deplete thruster fuel.) and we resolved them as they came up. The duct-tape-and-bailing-wire nature of Icarus presented some of these problems; but we had no choice to go ahead. I wasn't worried about the criticism of the past months; but the cost of stopping was worse than the risk of going ahead. We double checked everything we did, and made sure things worked.

But as we worked through the other problems, the weight problem was starting to seem insurmountable. "So little overweight, and yet just too much." I commented, as we met, once more, to figure it out. "What about afterburners?"

"Workable," Uncle Robert said. He'd been working mostly on that since we'd first talked about it; and his previous work had given him a little experience with them, as well. "But they raise as many problems as they solve. External units will require pumps, or pressure, to get the fuel into the nozzles, and exhaust streams. Additional air does the same thing. And we've already been through the problems of running the rockets lean." Indeed we had, several times. Quite simply, the engines were designed for proper mix ratio; to lean and the combustion chambers would cool; while the base of the nozzle overheated from lack of hydrogen coolant; heat expansion could be catastrophic. And the turbopumps would lose half their efficiency. "I can see ways around all the problems. But even if we can make it work, it's still only going to give us a little more usable payload. Not to mention, whatever the FAA says about drop tanks."

“I know; I haven't even broached the topic with them.” I said. “So what else is there?”

“Looking at the flight tests, I've seen a couple of places where a little more weight might be removable. It will still require a partial breakdown of the Icarus, and I can't say it won't have any safety ramifications. But a couple of systems have worked well enough that I think we can cut just a little more. Not much, but it might be enough. Also, based on consumption numbers, I think we can get away with a little less diesel fuel. We won't save much, but a little will help.”

“That will require several months more work, at least.” I pointed out.

“So will afterburners,” he said. “And I think afterburners will pose more risk than a minor redesign.”

“Then we'll take it apart.” I said. “We need to do a close inspection of everything, anyway. We'll do two more test flights, as we planned, both two 190,000 feet; that will bring us to ten flights total. If we do any modifications, we'll want to do a couple more tests first. Then, we push for orbit.”

“One more question,” Abby asked. “Who's going to crew?”

“I will, as commander.” I said, almost without thinking – but there was really no question about this; in fact, I had largely settled on crew a while back. “Abby will be first officer. And Robert will be flight engineer; I'm most concerned about engine performance for this first flight. That will be our prime crew.”

“You do know you're the worst pilot of any of us, right?” Abby asked. “I know how much you've put into Icarus, but so has everyone else. Prime crew should be the best at all positions.”

“Meaning you should be captain.” I said.

“Of course,” she said. “And Hank is probably second best pilot.”

“Some would also say something about the fact that your prime crew is all related to you.” Peter commented sardonically.

At that I shrugged; but I thought about Abby's comment. She was right, of course; this wasn't just

my project anymore. But I hadn't built Icarus to watch on the ground as she made her maiden spaceflight; I had always intended to fly aboard her. But I had to be careful about what I said. I'd brought them all so far; I didn't want to lose them with a show of impetuousness. “I will be Captain,” I repeated, in a tone to make clear it wasn't open for negotiation. “You will be first officer, not least because you are the best pilot we have. And Robert will be Flight Engineer. And yes, I have put a lot into Icarus, as have we all; but it was my project from the beginning. I've made few unilateral decisions, but this is one. I'll name the first crew.”

"Deorbit burn in one minute." I said, arming the orbital maneuvering system (OMS). "APU status?"

"APUs running normally at idle," Uncle Robert reported. "All systems check out for reentry."

"Attitude check," I said, glanced at my instruments, then and Abby, who was currently responsible for monitoring spacecraft movement.

"Attitude is set for burn." she acknowledged. "Computer is holding reverse attitude." The computer could control the spacecraft using attitude thrusters, under careful supervision, but not in aerodynamic flight; concerns about radiation-hardening, as well as slow computer response times (not to mention the fact that I had written the entire flight control program, on top of everything else), had led us to use a conventional hydraulic system for flight control.

"Control, this is Icarus. Ready for deorbit." I said into the headset.

"Acknowledged." Susan said, through the radio.

"OMS to automatic," I said, flipping the OMS control switch, then fingering the SET button on the computer pedestal. "Ten second countdown ... Go." The screen in the center of the panel showed the countdown, then a loud roar as the engines fired as retrorockets, putting us on an intercept course for the atmosphere. When it was complete, I requested, "Control, burn is complete. Please confirm trajectory."

"Tracking now." Susan said, then paused a moment. "Initial indications lock good. Continuing to monitor."

"Thank you." I said. "Abby, pitch over to reentry attitude." She pushed the switch for a computer controlled maneuver, and we began pitching upwards (towards the planet, since we were traveling upside down and backwards) until we were forward, nose above the horizon.

An alarm began to sound, and we continued pitching upwards, too far. "Failure in forward

thrusters.” Uncle Robert reported, reading out which thruster circuit and axis it was.

“Switching to manual.” Abby announced, taking the control yoke; the computer system had limited routines for thruster-out situations. “Still nothing,” she said, after a moment, pulling the yoke back and forth.

“All forward thrusters are now failing.” Uncle Robert reported. “We have complete failure of forward thrusters. Peroxide pressure is falling as well; it may be a leak.”

“Check status of rear thrusters.” I requested. The aft thrusters could control the craft, but would take longer thrusts to do so. “Switching control mode to optimize rear thruster control.” I said “We're starting to roll; try not to get us into a spin.”

“I see that.” Abby stated sharply, 'popping' the thrusters with twitches of the control yoke. “I think I've got it.” The roll damped, and we came in to proper pitch. “There. Got it.”

“You're getting the hang of that,” I said to Abby, before requesting, “Status of rear thrusters?”

“No problems indicated.” he confirmed. “But I'm showing flat on the front thrusters. Peroxide pressure zero, no reading on control circuits.”

“Any indication of an explosion?” I asked; external damage could compromise the craft on reentry.

“Negative.” he reported. “It occurred to slowly. Likely valve or seal pressure.”

“Right.” I said, then contacted control, who confirmed our trajectory was good. I reminded Abby to keep pitch right as we continued around the Earth, then assisted her by monitoring several systems. Reduced thrusters clearly made control more difficult, especially during early reentry, and we rolled back and forth more than usual; but she kept it under control. As we descended deeper into the atmosphere we transitioned to control surfaces, and the rest of the descent was normal, down to a perfect landing.

“Very nice.” I said, as I began resetting switches.

“Yea, whatever.” Abby said, leaving me to get the switches on her side. “We need to get up there

for real, and out of this simulator."

"We're working on it." I said. "But we've got to have everything down cold first. But lets get lunch before we try another run."

"Yea, well, I didn't come down here to fly a damn computer." she replied, climbing the latter up to the hatch. As she climbed out, I heard her saying to one of the controllers, "A thruster failure – really. Couldn't you be a little more imaginative than that?"

I smiled as I climbed; I hoped we wouldn't have thruster or any other failures when it came time to fly for real. Behind me, Uncle Robert commented, "Couldn't you have put the exit in a little better spot?" as he climbed slowly up the ladder, and struggled just a bit to get to the hatch.

I offered him a hand to get out of the hatch, and as he thanked me, I said, "best spot we could find; anywhere but the top would compromise the heat shield."

"Oh, I know." he said. "It's just a pain. We could have put a side door in the simulator, at least." I shrugged as I helped him down.

I called everyone over as I came off the ladder, and said, "Let's have the second crew take the it this afternoon. Same scenario, deorbit to landing. I'll be flying up to DC later this evening to meet the the FAA, so the second crew will run the next several simulations; I'd like a look at their work first, so I'll be capcom. Robert, where do we stand on the weight?"

"We're almost there, I think." he said. "There are a couple of pieces I'm considering right now; but it may come down to backup systems."

"We don't want to do that." I said. "What about re-tuning the engines, like you mentioned a while back?"

"I'm working on that." he said. That was another thing we had discussed, whether we could squeeze just a little more thrust out of them. "But if we dial up much on the engines, we could affect reliability. We'll get it, don't worry."

"I know; just stay on it." I said. "Work on that while I'm gone; Abby will be Capcom for the simulator flights. Alright, lets get some lunch."

Abby came over me as we walked out, saying, "We know our jobs; you don't have to tell us everything to do." I shrugged. "You were doing pretty well, as far as not telling everybody everything. But you're starting to do it again."

"I'll work on that," I said, slightly annoyed – but she was right; I did tend to do that, and was always working on it. Anyway, there was much to do.

After the second crew – Hank, Susan and Peter – had completed a deorbit scenario, with a different emergency, I headed up to Virginia in the Baron; Troy picked me up at the airport. He wasn't on the spaceflight list because he lacked technical experience or flying skills, and had continued to run the now minimal group we had in Leesburg. The next day, we went in to meet with FAA officials. We had discussed or orbital flight planes with them, but only today was I going to formally request permission to conduct orbital flights from Domingo Texas.

Pat Moxman met us at the security gate, and showed us to a conference room, and introduced us to the several officials present, including from the Office of Commercial Space Transportation (FAA/AST). I handed copies of the short proposal I had prepared to him and to the other officials, explaining, "We would like to officially request permission to conduct manned orbital flights, Under the Commercial Space Flight Act, 2004 amendments."

They thumbed through my proposal for a few minutes, then one of the AST officials said, "We're only now implementing regulations for manned suborbital vehicles; we're hardly ready to think about orbital flights."

"You already permit private unmanned launch vehicles; as you can see, we have more than met the normal requirement for such launches," I said, calmly suppressing my exasperation: why did bureaucrats think that, just because there wasn't a permit process for something, it couldn't be done?

“And while the 2004 amendments, and your recently promulgated regulations regard suborbital flight specifically, but leave the framework open to extend to orbital flights. While FAA regulations do not specifically envision manned orbital flight, we have met all regulatory requirements which could be construed to apply, and the principal regard of safety for people on the ground.”

“Yes, but regulations only cover suborbital spaceflight.” the woman replied. “We have no parameters for ground safety requirements, for example. We do permit unmanned launch vehicles, but there is a matter of scale here; your spacecraft is significantly larger. In the event of an accident, it could do significantly more damage. And suborbital regulations are based on a comparatively small footprint; your flightpath on launch not only takes you over populated areas of East Texas, but over south Florida as well. Your return path will bring you over other population areas of the country. Many more people will be affected; many more will be at risk. In addition, there is the additional risk of uncontrolled reentry and ground collision.”

“More distant areas are at less risk, so overflights can be permitted,” I said, citing the specific provisions for unmanned space flight launches. Forestalling comment, I acknowledged the regulation “Which regards unmanned expendable launches, is equally true and applicable to a manned vehicle. With regard to both sets of regulations – unmanned launchers, and suborbital vehicles – we have prepared extensive risk analysis, failure fault trees, and safety protocols. In addition, the FAA has already approved the Icarus for experimental atmospheric flight, and considered the possibility of spaceflight from our current location.”

Pat suddenly looked uncomfortable with my last comments; since he had overseen our previous approvals, I was essentially putting him on the spot. I felt a little bad; he had been, and was continuing to be helpful; but he had also been as stubborn as everyone else at the FAA. “Those were advisory opinions,” he said, “And standard experimental flight certifications. While we considered the intended eventual use of the aircraft; that was not the basis of our approvals.”

“Even so,” the AST official asked, “What has been your assessment of the aircraft?”

Pat thought for a moment, then spoke very carefully. “Thus far, Icarus does met our standards for airworthiness. And their operation has demonstrated a commitment to safety; based on their unusual flight profile, we imposed some additional requirements, which they met. However, as I said, our approval was based on atmospheric flight testing, and you were told that at the time.”

“My only point in bringing prior approvals up,” I explained, “Was to demonstrate that we have already been meeting FAA requirements for airworthiness and safety, and that your inspectors are already familiar with our spacecraft. My point now is that, while regulations do not specifically accommodate manned spaceflight, they certainly provide a framework in which it can be considered and approved.”

“There is space to consider it.” the AST official finally admitted. “But approval is a different question, and will depend on satisfying the highest standards of safety.” A number of more specific questions were asked, regarding all aspects of our planned flights and safety precautions. Not to mention a detailed discussion of the risk analyses I had provided.

I expressed frustration with Troy afterwards, however. “Just because the regulations don't consider it doesn't mean it can't be done.” I told him.

“I thought you did rather well in there.” he replied.

“I did.” I admitted. “And I think they took it well; their later questions showed that they are open to the possibility. But it's hard to tell how they'll go in the end. And it's just frustrating, having to jump through their hoops.”

I flew back down to Texas the following day, and preparations continued. I reviewed the designs with Uncle Robert, and my fresh eye saw a couple more adjustments that could be made.

“What about these aux tanks?” I said, pointing out several small tanks supporting certain systems – in particular the hydrogen and oxygen for the fuel cells. “They're steel, aren't they?”

"Yes," Uncle Robert affirmed, looking them. "Some of them were set up early in the design process; those we the tanks we could find."

"If we could consolidate a couple of them," I said, "And replace them with aluminum tanks, that might be enough."

"It might." Uncle Robert said. "We're very close now."

It was enough, in the end – we would be able to make orbit. We finished reassembling Icarus, and conducted two more test flights. Abby, Uncle Robert and I made both of these, as prime crew. Both were to 190,000 feet and complete successes; all that remained was to wait for the FAA, and continue simulator training.

I made additional trips to Washington for additional meetings with the FAA, and several officials came to Texas to inspect and review Icarus; I was quick to provide data and schematics they required, and they at least seemed receptive.

We took the opportunity – and experience from the simulator – to clarify and formalize our ground control arrangements. We set up a 6 person ground control system. Capcom – Capsule Communicator – would be the primary communications point with Icarus. They would also lead the ground team; with the Flight Commander having final charge of the mission. INCO – Instrumentation and communications officer – would maintain all the communications channels, both voice and telemetry, to Icarus. Guidance would receive and process tracking information. Range Safety was responsible for safety procedures during launch and landing, including coordination with the airport control tower, and could abort the flight if the safety zone was breeched; they would serve as safety officer for the remainder of the flight. Health would monitor the our status on board the spacecraft – we contracted with two outside doctors for this, who would travel down from Houston – and Systems would monitor telemetry from the spacecraft. One FAA official questioned our limited ground support staff, pointing out that NASA had dozens of controllers watching various systems.

“We've set the Icarus us so that most systems are monitored on board by the Flight Engineer.” I explained. “We can catch and resolve problems much more quickly that way.” It also reduced the amount of data we needed to transmit to ground, and had simplified the communications equipment necessary.

We also conferred closely with the airports controllers, making sure that they understood what services we would require from them. Nominally it was the same as any other aircraft operating out of the airport – they would ensure airspace was clear for launch, and vector us around for our final approach, but the flight profile of Icarus complicated things.

We also had other arrangements to make. We contacted communications stations around the globe, many which served various commercial satellites, to allow communications and tracking of Icarus throughout it's flight, and we made arrangements for emergency landings at several sites. Kennedy Space Center was the obvious primary abort site, if a problem occurred when we were no longer able to return to Texas, but NASA was reluctant until I pointed out that “If we do have a problem, we'll aim to land wherever we need.” Discussions with several sites in Africa led to an agreement with Morocco that we could land there, if necessary. We also discussed procedures for ditching, either on land or in water. In fact, our options for aborts were better than that of the space shuttle, because the first part of our flight would still be west of Florida – by the time we were to far to return to Kennedy, we would easily be able to reach Africa. I considered this important, because of the hazards of ditching at sea: Icarus would make for a very bad boat.

And finally, after much prodding, the FAA issued us a “Special Permit for experimental orbital flight.” We set the date for our first launch to April 8, 2008.

We all arrived before dawn the morning of the 8th. Our fuel and oxygen had arrived two days before, and weather reports were promising; we began final preparations for an 11 o'clock launch. As the sun came up, it was proving to be a beautiful, clear day, and winds aloft were minimal. At 8, Icarus was

towed out of the hangar and down the taxiway. Hank, Uncle Robert, and several others went down with it, to oversee the fueling and final preparations; I remained at the hangar for other procedures.

Then, around ten, Clyde Parker, head of the airport called, to tell me that Jessica Hunt was leading a protest in front of the airport. “We don't want any problems here, you understand.”

I told him not to worry about it; flight success would overshadow any protest, and asked for details about it.

“She's got about two dozen people,” he said “Out front of the main doors. I recognize a few from around town, but I think she brought most of them in with her. But she's attracted the attention of some of the press who's here to cover the flight.”

“I understand,” I said, thinking for a moment. “I'll stop down there on my way to Icarus, once I finish up here. Could you have someone go by and 'remind' the press where there observation points will be? They won't be able to see the protest from there.” Clyde nodded in agreement and said he could do that, and I asked “Is everything else ready?”

“We just finished closing the airport down a few minutes ago,” he said, “And are clearing the airspace now. We've also sent security patrols out downrange of the runway, to make sure the exclusion zone is clear. We've got press stations setup at a couple of spots on the tarmac, just outside of the main terminal, and we've got an observation area open upstairs.”

“Very good.” I said. “I'll be down there shortly, and then to Icarus.”

I had things almost wrapped up already. An FAA observer was with me in the hangar, and I finished briefing him on our flight plan, collected a few other reports, and went over several last-minute things at the mission controls stations we had set up. It was a pretty simple structure – a long table with six computer workstations, a bunch of communications equipment, and two 30” televisions on the side, for general information display.

“Susan,” I said, giving her a hug “It's finally time.”

“You've done so much,” she said, kissing me. “Yet, I'll miss you, while you're up there.”

“We've all done so much.” I corrected. “And I'll be back down tomorrow night.”

“Tomorrow night.” she agreed. “Have a safe flight.”

We released, and I hopped into my truck and I sped down to the main terminal, then drove around it and into a parking alley; from there I ducked right out to the front, and the protest. There were still several reporters and cameramen there. Several of the protesters had signs, “Solve Earth's Problems First,” and “Icarus Endangers Texas.” Jessica Hunt was standing on a small stool, exhorting the crowd that we had to be stopped. I listened to her for a moment before stepping out into view.

“They currently have enough hydrogen right here at this airport to wipe out the town of Domingo,” she said, “Stored not in protected bunkers, but in a series of tanker trucks parked at the other end of the airport.” This was, strictly speaking, true, but the FAA had carefully reviewed our fuel plan, especially in light of the deadly explosion at the Mojave spaceport the year before, and eventually supported our decision not to stockpile fuel at all, but bring it in just before launch; the tankers had been on site all of two days.

She continued, “No effort has been made to clear people from the flight path of this craft, except a buffer a couple of miles directly down from the runway,” and she pointed out several other supposed safety defects. “They have also necessitated the closing of the airport for at least a two hour period, a significant inconvenience for the people of Domingo.”

“But more important is the question of why they are doing this at all.” she said. “There are so many problems down here – and yet they've wasted millions of dollars so three of them can go for a little joyride into space.”

Now I stepped into view, and the press immediately noticed, I spoke directly to them, first. “First of all, I want to thank you for coming to cover our little flight. I'll be taking off in just a few moments, but I wanted to say a few words before that. As far as safety, the FAA has reviewed and approved our

safety plan, including our fuel handling, and you will notice that you will be viewing our takeoff from a safe distance. But more important is the question of why – we're not just three going up for a little joyride, but trying to take mankind into space. Some say there are problems down here, and we should solve them before going elsewhere. I agree we need to work together to solve all of our problems – but that too, is what this is about. We can sit around and fight over things that really don't matter, or we can find big things to work together on. Bringing humanity together to reach for the stars is what I aim to do, and today I will be reaching for the stars." I took just a couple of questions before thanking them once again, and reminding them that two press viewing areas were set up on the other side of the building.

I got back in my truck and sped down the taxiway towards Icarus; they were almost done with fueling. Peter was supervising the process, and I got an update from him; Uncle Robert and Abby had arrived a few minutes before, and were already on board. "See to it that my truck is taken back to the hangar, will you?" I asked, and he said he would, waving one of the technicians to take it.

I took a brief walk-around preflight inspection of the Icarus. The rear was low to the ground, and the main gear were on short, stubby legs; but at the front gear I couldn't reach the bottom of the ship. Inspection complete, I climbed an aircraft boarding staircase, borrowed from the airport, up to the top of the Icarus, and climbed into the hatch. One technician was up too; I gave him a thumbs-up before I closed the hatch and descended the boarding ladder.

"There you are." Abby said. "Get lost, did you?"

"Just something I had to take care of." I said. I took a look around the flight deck. I was, of course, already well familiar with it, but it seemed worth a good look. It had a slightly trapezoidal shape, narrow end to the front, with the pilot and copilot seats. There was a main instrument panel in front, a mixed smörgåsbord of mostly traditional gauges all across it, and a TV monitor as display screen in the center, already showing the glowing green background the computer was known for. Below that,

between the two pilot's seats was a pedestal, with a standard keyboard as the computer interface, and switches and indicators for engines, and various other systems, and of course throttle and speedbrake levers. Side panels had a variety of other switches and controls The overhead panel had life support gauges and switches in the center, over the pedestal, and communications switches overhead of both seats. There was a vague resemblance to the flight deck of the space shuttle, but with just about every type of gauge and indicator in existence thrown in. Behind the pilot, and behind the windows, sat the flight engineer. He had a side panel, floor to ceiling, covered with switches and gauges, and panels in front. A pedestal panel came up from the floor almost to eye level, and an upper panel hung from the roof, with only a foot-high window between them. Both forward panels had mostly indicators, but also a share of switches and levers. There was also an overhead panel, directly above the flight engineer, also covered with switches. In effect, the flight engineer filled the roles of several NASA ground controllers, and had all their consoles rolled into one station. With analog gauges.

Centered in back of the flight deck was the airlock, it's hatch secured; spacesuits and a couple other pieces of equipment were stored in there; the exit ladder was off center, and went up one side of the airlock bulkhead. There was a small alcove on each side of the airlock; the one behind the flight engineer had a lavatory, and the other side had a small galley, with several storage compartments, a refrigerator, and a microwave (from KMart). There were lockdown points for two additional seats in front of the galley, but they had been removed for this flight.

"Right." I said, stepping forward and into my seat, and strapping myself in. I checked the flight clock and the panel; everything was active. "What's our status?"

"Everything is on track." Abby said. "Systems powered up; Robert is running through system checks now. Everything looks go."

"Perfect," I said, putting my headset on. "Let's do this thing. Radio checks." I flipped a switch on the overhead. "Control, this is Icarus. Read?"

“Confirm channel one, check,” Susan replied.

I switched to the second channel and repeated. “Channel 2 check, copy.”

“Channel two, read you clear.” Susan repeated.

I switched to the tower channel. “Domingo regional airport tower, this is Icarus, come in?”

“We read you, Icarus.” the tower replied.

“Abby?” I said, and she repeated the same process; then Uncle Robert did. It verified that all the comm channels were open, as well as all internal communication circuits. I switched back to a-channel, and glanced at the flight clock. “Communication checks complete. T minus 20 minutes to launch. Request final weather report.”

“Final whether report is clear all the way over Florida.” Susan reported, after a moment. “Winds aloft ten knots from the south.”

“Excellent.” I said. The tower channel activated; Hank in the Baron. He was parked on the runway ahead of us, and would act as a chase plane, and overhead observer for the flight, and requested clearance. When it was granted by the tower, I watched out the window as he took of, using much less of the runway than we were about to; he would then fly around to a position Northwest of the airport, well out of our actual flight path. “Hank, this is Icarus,” I said over the air traffic frequency. “Report at twelve thousand feet.”

“Copy that, Icarus. Have a safe flight.” he said, then received a flight vector from the tower.

“Control, we're ready to be set on the runway.” I said.

“Copy that.” Susan replied. She relayed the message to the tow vehicle in front of us, and in a moment we moved forward, turned, then were pushed back so our main gear were close to the edge of the runway threshold.

“Environmental system activation,' I said, as I flipped several switches in the middle of the overhead panel. There was a faint sound as vent fans turned on, and the gauges began to read. I watched them

for a moment, then announced, “Closing outside vents.” I watched the gauges for another moment, then said, “Beginning pressurization test ... increasing. Looks good, decreasing. Pressure and life support are go.”

“Fuel and oxidizer pressure normal.” Uncle Robert then reported. “Engine circuits check out; beginning startup sequence.” He then ran down several other systems, confirming that they were all operating normally.

“Loading final preflight program into computer.” I said, typing it one-handed and pressing enter. The screen changed, reporting several useful pieces of information.

“Now clearing launch area.” Susan announced, and I acknowledged.

I then switched the inertial navigation unit to program mode, and requested, “Tower, please confirm position.” They did, and I entered the figured into the unit, then locked them in. “Inertial Navigation set and locked. Entering final guidance program into computer,” and I keyed that program as well. “Robert, can you confirm fuel loadouts?” He read back the fuel and oxidizer weights. We had gone over that earlier in the morning, when we did all our preflight calculations; this was safety check review.

“Ready for APU prestart.” I requested.

“APUs to prestart mode.” Uncle Robert confirmed.

“T minus eight minutes.” I said as the clock marked it. “Control, timecheck.”

“One moment,” Susan replied, and left the channel on as she verified that everyone on the ground was ready. We hadn't included any built in holds in our timeframe, but were ready to pause as necessary. Since we weren't launching to intercept an orbiting target, we had some flexibility in our launch time. There was a pause as she was checking for word that all outside teams had removed to safe locations. “On track for time.”

“Very good.” I said, looking back. “Ready for APU start?”

“Ready.” Uncle Robert replied. “Beginning sequence. APU 1, on, idle. APU 2, on, idle. APU 3, on, idle. Speedchecks ... confirmed on all speeds. Hydraulic system is pressurizing.”

“Flight instruments, check.” Abby announced. “Pitot system static check, clear.”

“Hydraulic system pressurized.” Uncle Robert reported.

“Beginning control checks. Gimballing.” Abby reported. Susan confirmed over the radio that the engines gimballed properly. “Control checks,” and again, Susan confirmed their function.

“T minus four minutes.” I said. “Entering final launch program. Ready engines.”

“Engines active.” Uncle Robert reported. “Prestarting pumps.”

“Confirm engines gimballed to launch position.” I said.

“Gimballed and set.” Abby reported.

“Close O2 vents.” I said.

“O2 vent closed,” Uncle Robert reported. “Pressure building.”

“Close H2 vents.” I said.

“H2 vents closed.” Uncle Robert reported. “Pressure building in all tanks.”

“T minus 2 minutes.” I said. “Control, request final launch checks.”

“Launch checks.” Susan said. “INCO?”

“INCO, go for launch.” replied the controller.

“Guidance?” she requested.

“Guidance is go.”

“Range safety?” she requested.

“Exclusion area clear, air is clear. Go for launch.”

“Health?” she asked.

“Go.”

“Systems?” she said.

“Go.”

“Capcom is go.” she finished.

“Icarus is go for launch, Repeat, we are go.” I said. “T minus one minute. Tower, this is Icarus, requesting takeoff to the east.”

“You are clear for takeoff.” the tower said, and I acknowledged.

“Arm engine igniters.” I said.

“Armed.” Uncle Robert reported.

“Final launch program entered.” I said. “Engine ignition to automatic. T minus thirty seconds. Throttles to full. Pilot ready?”

“Let's do this.” Abby said as she took a firm grip on the control yoke.

“Twenty” I reported. “Fifteen ... 10 ... 9 ... 8 ... 7 ... 6 ... 5 ... 4 ... 3 .. 2 ... 1 ...ignition!” and we were pressed into our seats with a jolt as the engines started, went to full power. We sprinted down the runway, not as hard as in our tests, but quickly picking up speed. “Abort point ... passed.” The runway rumbled below us, the heavy spacecraft bouncing heavily. “One hundred knots ... one twenty ... one forty” We were now going faster than a 747 on takeoff. “One sixty.” I was the end of the runway ahead, racing towards us. “One eighty . rotation speed.” Abby pulled back on the yoke, gently but firmly and we lifted off the runway, first the nose, then the main gear. “Gear up.” I said, and felt the jolts as they came in. “Two forty knots” I said as I watched the horizon drop out of view. “Two eighty. Begin turn to course.” Abby slid us slightly into a bank, and I watched the heading indicator as we slid over, while maintaining an eighty degree climb. We came out right on course, due east.

“Damn,” I said, “We should have picked a time when the sun wasn't right overhead. Engine status?”

“All engines hot and normal.” Uncle Robert reported, but I could hear he was rapidly making adjustments. “We should be positive thrust.” he said, indicating that we had burned enough fuel that

we weighed less than our engine thrust.

I glanced at the indicators. “Airspeed three eighty, fifteen thousand feet.” Airspeed was climbing only slowly, but the altimeter was spinning fast. “Approaching max-Q.” I reached for the throttle as Icarus began to shake from the rapidly increasing dynamic pressure as we pushed through the thick lower atmosphere. “Throttling back to ninety percent.” I had found that, withing a certain range, an early throttle back would actually save fuel by reducing speed in the thick lower atmosphere. I continued to watch the airspeed indicator. “Throttling back . Eighty ... seventy ... sixty.” We continued to accelerate as we rapidly burned off fuel and oxidizer. I glanced at the attitude indicator; Abby was keeping a spectacularly stable course. “We are supersonic.” I kept an eye on the indicators; the rapidly thinner atmosphere was allowing our acceleration to increase as well. “Throttling up. Eighty percent ... full power.” We had now started to lower pitch, and were already flying higher than the Concorde. I glanced at numbers shown on the computer screen; guidance results, then out the side window at the coastline of Texas and Louisiana spreading out – we were still over Texas, but would soon be over the gulf. Abby dropped the pitch to just above 60 degrees, and we started to gain downrange speed.

“Pitot pressure dropping,” I said, watching the airspeed indicator begin to drop as outside pressure dropped too low to register. “Airspeed and altimeter gauges nonfunctional. Inertial speed Mach 4.5 and increasing.” This was expected; we would now get altitude and speed from the inertial guidance system. Speed could be read directly from the unit; altitude was computed by the flight computer; both were shown on the screen. “No return to launch.” We were now getting well out over the gulf and Abby had continued to lower pitch. The computer screen showed, among other things, the pitch and heading Abby needed to maintain.

“Ready to transition control.” Abby requested, and I switched the first axis to thrusters – but engine gimballing would still provide most control. “We've reached space, by the way.” I commented. I took another glance out the window; we were now almost over Florida, and continuing to lower pitch. The

g force was rapidly increasing as well.

"Three engine press to MECO." Uncle Robert reported – we could now reach orbit in the event of an engine failure. "Everything nominal." Glancing at the screen, I saw we were approaching 100 miles altitude; Abby had dropped the nose to about twenty degrees above the horizon; we now needed to gain enough speed to reach orbit. Out the window, Earth was getting distinctly further below, and distinctly rounder. I could see significantly up the eastern seaboard, up to the tip of the Delmarva peninsula.

"Two engine press to MECO." Uncle Robert report.

"All control axis to thrusters." I said as I switched the last over.

Suddenly there was a jolt, and I felt Icarus shift slightly left; an alarm went of – a look at the status panel showed "ENGINE" light lit. I quickly silenced the alarm as Uncle Robert reported, "We just lost number 3 engine!"

I went into emergency mode – as Captain, it was my responsibility to decide whether to abort or continue. We could make Kennedy if we needed to, but could still make orbit. I took a quick look at Abby; she was calm and had Icarus well under control. I glanced at the screen; the jolt had pushed us off course slightly, but we were back on, only shifted slightly northward, which would slightly increase our eventual orbital inclination. "Got it?" I asked her.

"I got it." she confirmed without looking. "Press." Of course she wanted to continue. And we were still in good shape.

"PRESS." I confirmed, keying instructions to the computer to recalculate our ascent to account for the reduced thrust; it showed "WORKING" for a moment, then gave Abby the adjustments. "control, this is Icarus." I said. "We have single engine failure and are pressing for orbit."

"Copy that," Susan replied. "We read and confirm; guidance and system concurs pres for orbit."

"Acknowledged." I said, scanning the instruments again, then out the front window. We were now

only slightly above the horizon, and rapidly accelerating, past 2 gees.

"Erratic readings on number 2," Uncle Robert reported suddenly, "Trying to adjust." I heard him frantically pushing levers, and switches, but then he said, "Loosing thrust on 2, overheat – shutting down. We have number 2 shutdown." Another alarm went off for this and I silence it.

Damn, I thought. Go, or abort? I glanced at the indicators – we should have enough speed now to reach Morocco – but we should still be able to reach orbit on two engines. But if another should fail ...

"Press!" I said. As long as we could make orbit, that was the right decision. I quickly had the computer recalculate, then informed control. Acceleration had dropped but was still near 2 gees, and we continued to gain speed; we were rapidly approaching orbital velocity. "What about one and three?"

"Nominal." Uncle Robert said. "But I'm watching them. I'll let you know if there are any more problems.

I looked at the computer screen – it called for pitch zero. That meant we were at apogee, where our speed gain would do the most good. "Fuel check?" I requested.

"130 seconds at current consumption." Uncle Robert reported. That should still be enough to reach orbit. I checked the other parameters – speed, computed altitude. We should be able to make it once around now, if we had to.

"Engines?" I requested again.

"Still nominal." he reported. Our acceleration was now nearing three gees as we were continued to burn off fuel.

"I'm not going to throttle back," I said – the original flight profile had called for a throttle reduction to keep acceleration under three gees – but the engine failure was prolonging our burn already, "Gees will go high. Three gees. Fuel?"

"Ninety seconds." Uncle Robert reported.

“Keep a count. Control, do you have us on tracking?” I requested.

“Hold on,” Susan said, then “You're still good for orbit; but not by much.

“Sixty seconds.” Uncle Robert reported. The acceleration was pushing us harder into our seats; I could see Abby was having trouble keeping from pulling back on the yoke. Gees were approaching four gees; I quickly recalled the thrust capabilities of the engines; two engines with dry tanks would produce just about that.

“Thirty seconds.” Uncle Robert reported. “Ready to throttle back for MECO.” I reached for the throttle levers. “Twenty ... throttle back.”

“Throttling.” I said, Pulling back on the levers and feeling the acceleration lighten. “Fifty percent.”

“We have MECO.” Uncle Robert said as the acceleration dropped entirely. “Full cutoff on one and four.”

I took a breath as I felt myself float into the harness; we were in freefall. I took another breath before requesting, “Control, have you got us on tracking?”

“We're tracking you,” she said, “We'll have your plot in a moment.” I punched up the computer, for it's inertial data; it showed we were nominal. Susan confirmed it after a moment. “We're projecting 180 by 110; apogee in 29 minutes.”

“Understood,” I replied, taking another deep breath. “That matches our inertial data. Prepare calculation for orbital insertion.” Closing the channel, I said, “Nobody leave their seats yet; we'll need an OMS burn in about thirty minutes.” They knew that, of course, But Abby looked particularly anxious to get up and float around. Before that, we had to make sure everything was secure and operating normally. “Ready APU shutdown.”

“Ready,” Uncle Robert confirmed. “Shutting down. All APUs are down and in safed mode.”

“Alright.” I said. “Begin system checks. Abby, roll us 180 degrees, then set attitude hold forward.” She put us in a slow roll. “Environmental,” I looked up at the gauges, watching them for a moment.

“Pressure steady, Temperature steady. Looks good. Power?”

“Fuel cell output is normal.” Uncle Robert reported. “All cells functioning. Batteries are charged.”

“Other pressures?” I requested.

“Hydroxide tanks normal.” Uncle Robert reported. “Diesel normal. H2 and O2 gas tanks normal. Air normal. All pressures normal.” We checked a couple more systems, then I turned to Abby. “Stationkeeping status?” Because of it's limited functionality – the computer was mostly limited to hold attitude – we referred to it as 'stationkeeping mode' rather than an actual autopilot.

“Set and holding.” she said. “All thrusters fine.”

“Good.” I said.

“Icarus, this is control.” Susan said over the mike. “You'll want a seventy second burn to circularize your orbit.”

“Copy that, seventy seconds.” I acknowledged. “Susan, we did it. We've reached orbit.”

“Congratulations.” she said. “Eight years have paid off. But you knew you could do it.”

“All of us did it.” I said. “But I'll get back to you after the burn.”

“Copy.” she replied.

“Ready to open radiator doors.” I said. “Opening.” Although Icarus didn't have a payload bay, we still had a need for radiators – so we had put them on a pair of panels which would open. They also covered the airlock hatch and a couple of other connector points.

Finishing checks took most of the rest of the time to the insertion burn; then, I set it in the computer. “Arm the OMS engines.” I said.

“Ready and pressurized.” Uncle Robert confirmed.

“Ignition to automatic on seventy second timer.” I said, entering the sequence in the computer, and setting th OMS control switch to COMP. The screen showed a countdown, then ignition. At burnout, I requested that control confirm our orbit. A moment later she confirmed, circular orbit at 182 miles.

I took another deep breath; Abby unstrapped herself and pushed herself up, gently pushing away from the overhead panels and back towards the roof windows.

“Any idea what happened with the engines?” I asked.

“Not yet.” Uncle Robert said. “The first didn't give any warning at all.”

I began calling some stuff up on the computer; one of it's functions was to record a number of system parameters, and I called up records for that engine, but they didn't show anything.

“Capcom, this is Icarus.” I requested.

“Susan here.” she replied.

“Have you had a chance to look at the data from the engine failure yet?” I asked.

“We're just beginning to,” she said, “But we don't have that much data; only a few parameters are sent down in telemetry.”

“Right.” I said. “Once we upload our recorded data, you might see something from that. Icarus out.” Then to Uncle Robert I said, “What worries me was that jolt when the number three went out. Any sign that caused additional damage?”

“No sign of system damage,” Uncle Robert said.

“Still, if it compromised the heat shield...” I said, trailing off.

“We could go out and have a look.” Abby suggested.

“We hadn't planned on a spacewalk this flight.” I said. “That will extend us by at least a day.”

“You're the one who wanted to bring spacesuits,” she said, “Just in case.”

“'Just in case' suits you when it's something you want to do anyway, doesn't it?” I said. “You'd want to go for a spacewalk this flight, whatever happens – am I right?”

“We're here, aren't we?” she said. “Besides, it's just a little stroll out back.”

“It's never just a little stroll.” I said. But she was probably right; it would be worth it to take a look. And anyway, we were here.

I removed my headset and switched the comms to speaker, then unstrapped and pushed myself up and back. It had been disconcerting sitting in my seat, when the engine first cut off – but now I felt completely unanchored, floating, falling. I felt like I was falling, and we were, we were in freefall, Balance, up, down – I felt completely unstable for a moment, and held on to something to catch my breath. Up, down, balance meant nothing, now, yet I felt completely out of balance.

"Here, come over here, Dan." Abby said, motioning me to the window. I pushed myself that way, then looked out – it was dark, but a bright scattering of lights, cities, highways, and vast dark oceans.

"This," I said, "Is going to take some getting used to."

She nodded. "But isn't it fun!"

"Yes, it is." I agreed. "Now aren't you glad you came along?"

She pushed down, into a somersault – but hit the floor instead. She bounced upward, into the sidewall, and then the back of her seat. She flailed as she did so, almost catching herself on the headrest. But she lost it, and floated, slowly, back up to the ceiling. "Careful." I said.

She laughed. "Why do I need to be careful? I'm floating!"

"Just be careful." I said. It began to get bright ahead, and I looked out the front window, where the sun was coming up over the horizon. "Look – sunrise from space."

Abby turned, but sent herself spinning again, and into the back wall. I turned more carefully, to look at Uncle Robert. "You've got to try this!" I said. "Come on out! You're practically in a cocoon behind that thing."

"You designed it." he said, but he looked a bit troubled.

"Nauseous?" I asked quietly. He nodded, and I said, "I'm feeling it a bit, too. But I'm already getting used to it. I feel more disoriented than anything else. No, disoriented isn't quite right – I feel like there is no orientation at all.

"I'm sure I'll feel better in a few minutes." he said. "Besides, I'm still looking over some of the

systems data."

"I've got all the records call up on the computer, up front." I said, pointing to the main panel.

"I'm sure I'll have a look at it." he said. "Truthfully, I'm still recovering from launch."

I nodded. "Well, you do have to try this." Now I pushed back and into a slow, careful somersault – then I "stood," inadvertently pushing myself upwards. I caught myself on the ceiling, then Abby bumped into my back. She was still doing flips.

"You could have made this a little bigger." she said.

"And you could be a little more careful." I said, pushing myself forward, then grabbing on the the back of my seat. "It already feels bigger than it did on the ground. I took another look over the instrument panel. Environmental systems were good, everything else was normal. I looked ahead at the scenery ahead. It was already fully bright, and were well over the vast Pacific. I watched islands go by and the coast of Mexico approach; Abby was continuing to try out her moves in zero gravity, and chatting with Uncle Robert.

Susan's voice called from the speaker. "Icarus, this is capcom."

I pulled forward, keyed the button. "Susan, we're here." I put the headset back on as I was doing so.

"You're coming in direct line with us; we can get you from our data antenna." she said.

"Right." I replied. "I'll start setting up for data transfer." I began keying the commands into the keyboard, but though I was holding on the the top edge of the main panel, I quickly floated upwards, and lost my grip. "That's not going to work." I said to myself and, pushing off the ceiling, I rotated back around and down to the center panel. This time I held on to the side of the chair as I keyed in the commands; in a moment, the screen showed "READY TO TRANSMIT" Now I pushed up, grabbed onto something on the ceiling, and set switches on the overhead, for the data channels. "We're ready to transmit." I said.

“Setting up now.” she replied. “We've got you.” A blue light came on on the overhead, indicating that the main data line had a connection with ground. I hit one more switch, next to it, then entered and executed a final command. “TRANSMITTING” the screen said. The connection was pretty slow; there wasn't that much data, but it still took several minutes. Several times, it switched to say “SIGNAL LOST ATTEMPTING RECCONECTION” and took almost twenty minutes before reading “UPLOAD COMPLETE”.

“Capcom, did that come through?” I asked.

“Looks like it.” she said. “Data verification is positive.”

“Excellent.” I said. “Robert, are you going to want to have a look at this? Before we return?”

“I might as well.” he said, so I marked it as transmitted, and saved it, then took the headset off.

“I have to use the bathroom,” I said, “And then we can see about lunch. I'm hungry.”

The lavatory had a curtain across it; it was the only “private” place on the spacecraft (except for the airlock) In a moment I emerged from there and, used my hands to “walk” my way over the the galley, using the ladder, the handle to the airlock hatch, and a handle at the other edge of the handle, before pulling myself around into the galley.

“It's so much easier just to push and glide.” Abby said, demonstrating as she pushed her self across the flight deck to Uncle Robert's console, turned around, and came back.

“I'll try it,” I said, “After lunch. What does everybody want, anyway?”

“There's a ham sandwich package, isn't there?” Abby asked. I nodded and pulled it out.

“Uncle Robert?” I asked.

“Another ham sandwich would be fine.” he said. I pulled another out, then a tuna melt for myself They were all packages from one of NASA's suppliers. I checked over the instructions – none of them required rehydration – then heated them in the microwave.

“Here you go,” I handed one to Abby. “Don't let any of it escape. And here you go, Uncle Robert. “

I took mine and hooked my foot into a loop on the galley floor. “Well, it took a long time, but here we are. Where few have gone before.” Abby and Uncle Robert both nodded. “I think, this requires some kind of toast.” Each of the food packs had a small drink bottle included, and I held mine up. “To Icarus, who sought to fly.”

“To Icarus!” they both agreed.

After a couple moments of eating – the “sandwiches” were more like small, bite-sized pieces – Uncle Robert asked, “Are you really thinking about doing a visual inspection of the engines?”

I sighed. “I'm still debating it.” I said. “We'll have to extend our flight by at least a day – which isn't necessarily a bad thing. We've got the supplies for it. On the other hand, I'm not sure what we could do if there is serious damage. It's not like we've got another ship that can launch a rescue mission. And NASA wouldn't be able to get to us in time.”

“We do have a couple of repair pieces, don't we?” Abby asked.

“Yea, about the same as NASA uses.” I said. “But there's the question of using it – and if something catastrophic happened to the number three engine, it probably won't be repairable.”

“Still, “ she said, “At least we'll know. And you've pointed out the importance of protecting those on the ground. If there is a problem, we could at least aim somewhere we could ditch, instead of a populated area.”

“You just want to go for the spacewalk.” I said.

“Of course.” she said.

I shrugged. “It's as good a chance as any. And I would like to know what happened back there. Alright; we'll plan on an excursion tomorrow. I'll go out first, and you'll come with me, Abby. We'll keep it short; just go back, do a visual inspection, and return.”

“You've always got to be the one to go out first, don't you?” Abby said; I chose not to respond. Of course I was going to be the first private spacewalker, as long as we were going to do it on this flight.

Finishing my food, I put it in the closed waste bin, and said, “I'll contact control and let them know what the plan is.” I washed my hands in the galley's handwash station – a half-dome with hand holes – then pushed myself in a graceful – and very badly aimed – glide back to my seat. I ended up closer to Abby's, but corrected, agreeing that this was easier – if I could aim, that was. I got on the headset and explained the plan to Susan. She sounded disappointed that I would be taking longer to get back, but agreed that a visual inspection was a good idea. They had already been reviewing the transmitted data, and hadn't found much.

“Well, the first priority is to be sure we can deorbit safely.” I said. “Once we're down, we can figure out what happened.”

“I guess that's it for the two-week turnaround you were hoping for.” Susan said. I had been hoping to match the X-Prize requirement, but safety was more important.

“We'll launch again as soon as we're able.” I said. “Icarus out.” After closing the communications, I said, “All right. If we're going to do this, we're going to do it right.” Briefly, I went over spacewalk procedures, especially safety. “We remain tethered to the ship, for one; and we stay in sight of each other.” I also reviewed the importance of not rushing preparation – we would spend several hours in the airlock, acclimating to the pure oxygen of the spacesuits; we didn't want to get the bends. “Today we'll focus on our other planned activities for this mission – continued checkout of the Icarus and her systems, and make sure she flies the way she's supposed to.” And so that's what we did – all the while marveling at the passing scenery, and the sunrises and sunsets coming every forty five minutes or so. We ran test programs on a number of systems; Uncle Robert cycled many of the pumps and valves throughout Icarus, and we maneuvered the craft to a variety of orientations. Abby and I both tried various maneuvers, and tested all the maneuvering modes. We rotated, pitched, yawed, and translated in all directions.

Using the computer, we conducted several simulated rendezvous, having the computer plot a

fictional satellite on the same orbit, and maneuvering closer to it. Small, quick bursts were best, and I practiced carefully and gently; Abby was much more apt to give big bursts and pauses.

Then we had dinner – I had spaghetti – and relaxed while looking at the scenery. Uncle Robert floated around the cabin a little now – although he had gotten out earlier to use the bathroom. Later, we dimmed the lights, and slept in out seats, with sleep masks on.

I had trouble getting to sleep; I was nervous about what we would find when we went outside the next day. I just had horrible visions of a big piece of the spacecraft having been blown off – and the knowledge of how little damage it took to be catastrophic.

I had known, and accepted the risk, because it was necessary. Still, it was one thing to think about the risk in theory; and entirely another to actually face the possibility that we might not make it back. Human beings are incapable of contemplating our own deaths, and it skews our judgment of risks. Still, I was here, I was now among the few who had traveled among the stars, and that, too, was worthwhile – and almost worse than the fear was the excitement that tomorrow, I would be spacewalking.

Eventually, I descended into a fitful sleep, with a few nightmares, all the worst scenarios of astronaut movies. I would have liked to get better sleep before my first spacewalk.

But the next day, we got up, ate, then Abby and I prepared to exit. I opened the airlock, and pulled out the thermal underwear that would be our inner layer; we each ducked into the lavatory to change. “This is the silliest looking thing I have ever worn.” Abby said, poking at the hoses.

“You'll be glad of it out there.” I said. “The hoses will keep the temperature regulated, and nice and warm in the vacuum of space.” I pulled on my snoopy hat, the same style NASA astronauts have worn for decades, and the headset. Uncle Robert was now sitting in the captain's seat. “Take care of the ship for us.” I said, before ducking into the airlock.

Abby followed me, pulling the hatch closed. “It's cramped in here.” she said, and she was right.

Even without the two spacesuits there wasn't much room for two people to maneuver.

"It'll be a little better once we're wearing the suits, not sharing space with them." I said, and we helped each other get into the two-piece suits. They had been somewhat difficult to make; only partial designs were available from NASA, and like so many of the things we'd done, few companies were qualified for the kind of work it took to make a real spacesuit. "There's certainly a lot of room for improvement in these," I commented as I helped Abby into hers. "Especially to eliminate the decompression time."

"So why didn't you?" she asked.

I shrugged. "Getting Icarus flying was the first priority. Once we can fly regularly, we can make other improvement incrementally; and we wanted to keep things as simple as we could in a complex enterprise. Also, things can be considered in theory – but until you try using a suit in space, you can't be quite sure what you get. I'd hate to get up and find out the spacesuit doesn't work." I pulled my headset into place, and plugged it to the connector just inside the neck of the suit. "Comms check. Uncle Robert, are you there?"

"Right here. How's it going in there?" he asked.

"We're just suiting up now; we'll begin decompression in a moment." I said. "How about ground control. Capcom?"

There was no response for a moment, then Uncle Robert came back on. "Hold on, let me try this one."

In another moment, I tried again. "Capcom? Susan?"

"Control here." Susan replied. "All set for your big spacewalk?"

"Getting there." I said. "Just doing comm checks now.."

"Acknowledged." she said. "You're loud and clear."

I motioned for Abby to do the same thing, and she verified connection with both. She started to put

her helmet on, but I motioned her no. “We'll bring the airlock to pressure, then suit once we've acclimated.” She nodded, and I pushed the two control switches to begin the cycle, then replaced the clear plastic cover which protected the panel. “Equipment check: tether's, check. Thrust guns, check.” The thrust guns, similar to to those used on Gemini, looked like a PVC T-joint pipe, with a large bottle at the bottom of the base, a dial at the top, and a strap to hold to the wrist. “They've only got enough pressure for about ten minutes continuous use; enough for a couple of hours excursion, as long as you're careful.” Abby nodded. “Now, just to review the procedure; I'll go out first. There are a number of EVA hooks going back along the Icarus's centerline. I'll take the long line,” and I held it up as I said so, “and connect each one of these hooks to the connectors. You can then follow along that line, keeping your tethers attached to it. We've each got two tethers; hook one before you unhook another – whatever you do, never be untethered from the ship. You'd never get back.”

“I can be a rendezvous target, like yesterday.” she said.

“Don't even joke about it.” I said. “I don't want to tell mom I left you in orbit. And Uncle Robert doesn't have much experience maneuvering.”

“Now, you brought me along because you wanted someone a little bolder – and you're telling me not to?” she said. “Now, what sense does that make?”

“Bold, not reckless.” I said. “Or stupid.” I took a glance at the panel, which had a clock, and a pressure gauge, showing the slowly declining. “Capcom,” I said, hitting the mike button.

“Go head.” Susan replied.

“Is health getting a good read on our biomonitors?” I asked. That was one of the things we had put on before coming into the airlocks, reading out heart rate, blood pressure, and a few other indications.

“They're reading fine.” she said. “and he says you both look good.”

“Copy that.” I said, closing the channel. Abby and I made small talk for a while, talking about the last time we'd both been home, her relationship with Robbie, my relationship with Susan, and many

other things; periodically I glanced at the gauges to see how much longer we had left. Finally, it read "5psi" and a small, green light came on, indicating the cycle was complete. "Alright, lets do this thing. Helmets on." We both put them on, checking each other to make sure we were locked in place, and switching on each other's life support systems. "Comms channels on." I said, flipping switches on the front of my suit; Abby did the same. "Intersuit. Ship. Control." I said as I switched them on. "Let's do this." I said, and when she assented, I opened the panel again, this time hitting the "DEPRESSURE" switch. Pumps began sucking the remaining atmosphere, now pure oxygen, out of the airlock and into temporary storage tanks – air is never vented outside, because it's too precious – and the light came on again when it was zero. I closed the panel and pushed up off the floor, catching myself on the airlock hatch.

"I'm opening the hatch now." I reported as I turned the lever, then pushed the hatch open, and was overcome with a second wave of nausea, an absolute inability to inhale, as I looked straight down at the whole of South America.

"Are you alright, Dan?" Abby asked. I couldn't speak, for a moment, but I gave her a thumbs up, and took a moment to collect myself as I hooked one tether on the inside wall of the airlock, firmly gripped the thruster gun, and pushed myself upward, coasting to the end of the ten-foot tether.

The radiator panels were open like a vast valley, running lengthwise down the ship, from just ahead of the airlock, to near the tail. But it was even worse looking forward, or backwards, where I saw not the two hundred miles to the surface of Earth, but the infinite distance that was space, the bottomless pit that was the universe – and for a moment, my heart fell to the bottom of that pit.

"Are you alright" Abby asked again.

I took another moment, then said, "Yes, yea. But tell you what – you can take the long line and go first."

I heard her laugh through the radio as she hooked her tether on and floated out – and in her face I

could see that she, too, was just a little overwhelmed by the vastness. Then, in a moment, she said, “Heck of a view, isn't it?”

“Yes, it is.' I agreed, now collecting myself a little more – and helped by seeing that it overwhelmed her as well. But whatever initial fear she may have felt – and she denied later she felt anything – she quickly set to work, moving backward, connecting the long tether, and methodically connecting and disconnecting her own shorter tethers to it.

I just floated there a couple more minutes, watching her work, before I pulled down on my own tether, and gave a quick thrust to move me towards the back of the ship. I bounced off the hull several feet from the line, and gave another thrust to keep from bouncing off, then pushed sideways and, after a couple moment's effort, had my hand on the long line. I still had two tethers on my belt, so I attached one to the main, then detached from the one hooked into the airlock and latched it's end the the main as well. I then worked my way down the lone, slowly, as I had described to Abby. Looking ahead, I could see she was already to the back, working her way along the central tail fin (Icarus had three, one in the center, and one, coming out at a slant, on each side.) As impressive as the Icarus had looked sitting in the hangar, looking down the tail, Earth above, infinite stars ahead, the view was simply majestic. For a moment, I wished I had a camera.

“Hold there, Abby. Wait until I get back before you go out of sight.” I said.

She made a slightly irritated noise at me, but waited once she had hooked the last clamp, at the back of the tail.

“Can you see anything from there?” I asked as I worked my way backwards.

I saw her lean forward, then respond, “Not really. All four nozzles are in place, but that's about all I can see from here.”

“Alright.” I said. “I'm almost to the tail, just another moment.” I was steadily getting more confident, and the infinitely vast view before me was inspiring more awe and less nausea. I slid around

the tail, then said, “Alright, I'm here.” Abby was, literally, sitting on the back of Icarus holding on to the rope (and I did check to make sure she was tethered.)

“Now this is a view.” she said.

“That it is.” I agreed, taking a moment to admire it, and working myself into the same sitting position as Abby had. It was a very stiff sitting position, more hanging off the tail, as the suit didn't really bend much at the waist – but it just seemed like the right way to take in the scenery. “Look how fast we're moving – we're already over the middle of the Atlantic. There's the Amazon delta.” I pointed.

“Yep.” she said

“Well, let's have a look.” I said. Why don't you float straight out to the end of the tether and have a look. Then you can work your way down; make sure you have a look at the bottom, too.”

“Sounds good.” she agreed, and with a diving motion, launched herself forwards, slowing herself with the thruster before the tether snapped taut. She gently pulled against the line to turn herself around, then stabilized her position and looked for a long moment at the back of the Icarus. “I don't see any obvious damage from here.” she said, finally. “I'm moving closer.” She fired her thruster straight upwards with a couple of quick bursts; as she floated downwards the tether caused her to arc towards the ship. She used a couple more quick bursts to control her speed. “I'm getting closer now. There might be a little bit of damage. Yes, some sporadic burn damage, but nothing too significant.” But she reached out for the nozzle and it moved easily with her pulling on it.

“That's not good.” I said.

“What is it?” Uncle Robert asked.

Abby said, “It feels like the nozzle is completely loose. I'm trying to pull closer now.” She began pulling herself up to the base of the nozzle.

“Be careful,” I said. “You don't want to get tangled back there.”

But she seemed to be ignoring me. “I'm not sure it is burn damage. Let me get just a bit closer.” I saw her reaching forward, just out of my view. “It's grease of some sort.” she said, after a moment. “It comes right onto my glove.

“Grease?” I asked.

“Hydraulic fluid?” Uncle Robert suggested. “See if you can get a sample. And have a look at the base of the nozzle.”

“The bell looks fine – it looks like it came from the line at the base.” she said.

“The one that runs up around the nozzle,” Uncle Robert asked, “Or the one that goes from along the back of the ship?”

“The flat one, on the bulkhead.” she said.

“Hydraulic fluid.” Uncle Robert confirmed. “But I didn't see a pressure drop. Strange.”

“We'll figure that out later.” I said. “But minimal visual damage?”

“None that I can see.” she replied.

“Have a check on the bottom, just to be safe.” I said.

She did so – her tether was just long enough for her to get a couple of feet below the edge. “No nothing. It looks fine down here. Do you want to take a look?”

I thought about it, but with a look into the void, I decided I wanted to stay right where I was. Splendid view, though. “No, I'll take your word for it.”

“Alright, I'm coming back up.” she said. Again she used her thruster to push her away from the tail.

I saw it coming as she made her way up, but I couldn't warn her in time. “Your tether – it's wrapped around the nozzle.” I said, but she had already snapped to an abrupt halt by the time I was done.

“Damn” she said, examining it. She pulled up, and twisted back, thrusting herself one way,t hen the other; but it took about fifteen minutes for her to get unlooped – she just couldn't quite get back around. As she came up, I took her hand and pulled her the last bit up to the top.

“Right.” I said. “So it looks fine down there for reentry?”

“It's fine.” she confirmed. “Just a bunch of grease all over the place.” She showed me the stain on one of her gloves.”

“Then let's get back inside.” I said. “You can pull up the main line, right?”

“I got it.” she said.

“Good.” I said. “We're on our way back in.” I said, and it was confirmed by both Uncle Robert and ground control. I moved back up the line the same way I had come out, looking behind me occasionally to check on Abby. I collected my first tether, then backed myself halfway into the airlock and watched her come back.

Even unhitching and wrapping the main line, she was coming up almost as fast as I had been. I took another look up, to see China now passing overhead, before backing the rest of the way into the airlock; Abby followed after a moment, but also hesitated before coming all the way in. When she did, she pushed her tethers down and locked the hatch closed, and said “Hatch secure.”

“Copy.” I said. “Beginning pressurization.” I activated the switch on the panel, and the gauge began to read, up to five psi. “Seems to be holding. Here goes.” I unlatched my helmet; it released with only the slightest of hisses. “There we go.” I confirmed, and Abby opened her helmet, and removed it, quickly. “Beginning repressurization cycle. We can run this one faster, since we don't have to worry about nitrogen. Best not to rush it, though.”

She nodded, but she looked impatient. I wasn't sure whether she wanted to get back to the flight deck, or go back out there – though I could make a guess.

“Heck of a view, wasn't it?” I asked.

“Looked like it was a bit much for you.” she said.

“Ah, well.” I said. “It got you to, for a moment.”

“It did not.” she said.

“I saw it in your face.” I said. “But it was impressive, too. I wouldn't have missed it for anything. I'm glad you talked me into doing it. And I feel better knowing what things look like back there. Hydraulic fluid kind of has me wondering, though – that shouldn't have caused that kind of jolt.”

“I don't know,” she said. “Come to think of it, I think there was something in the controls, just a moment – a change in the stiffness. Who knows what that could have done to the gimbals. And the jolt was, at least partly, just the sudden loss of thrust on that side.”

“Well, we'll figure out what happened once we're back on the ground,” I said, “And we have a chance to tear that engine apart. Be careful with that glove, though – we don't want any oaf that stuff getting spread around the flight deck. It's already becoming more liquid as it warms up in here. Tell you what – put it in a plastic bag.” I took my own gloves off, and pulled a ziplock back from the airlock storage locker. “There.” I said, closing it up. I glanced at the gauge again. “Now, when can we get out of here. I'm hungry.”

Soon enough, the cycle began to wind up, and we helped each other remove our spacesuits. As I was taking my suit pants off, I pushed up without thinking, flailed my arms looking for a grip before going “Ouch!” as my head thunked against the outer hatch. “You could have caught me!” I said, looking down at Abby.

“I thought I did have you.” she said, “But you came right out of your pants. At least you got them off.”

“Hmmm. There is that.” I said. The bottom of the airlock was crowded with Abby and two spacesuits, so I just gripped on to a handle on the front bulkhead. “Is the light on yet?”

“Not yet.” she said. “It's right at 14 psi.”

“Right. Just a few more minutes.” I said, and in a new minutes, the light had come on. Pressure was equalized. Abby pulled the hatch open and went through it feetfirst; I turned around, pushed gently off the top of Icarus. Catching myself of the floor, I tried to turn myself smoothly through the

hatch, but hit my back on the top edge instead, and floated back into the airlock. A moments scrambling, and I was able to pull myself through. “That's not so easy.” I commented as I pulled the hatch and locked it closed.

Abby was already in the lavatory, changing back into her flight suit, so I floated over and gripped the back of the First Officer's seat, pulling up for a look out the window. “Everything under control up here?” I asked.

Uncle Robert nodded. “I was just looking over the data from launch. Haven't found anything, though.”

“What about the hydraulic system.” I said. “If we lost pressure, that should have shown up.”

He shook his head, entering a couple of things on the keyboard, a chart came up, labeled APU SPEEDS. “There's a lot of variation as the APUs adjust to changes in pressure; as controls are run and stuff, and three APUs give plenty of extra capacity. If they did run up, it's lost in the normal variation.”

“Was there any indication it was an automatic failure?” I asked. I had been thinking about that in the airlock; there were a number of mechanical autoshutoffs, one of them being hydraulic pressure.

“It's possible,” Uncle Robert said. “I haven't found any elevated temperatures or abnormal readings right before failure. That could explain why the engine made such a severe jolt when it failed, as well. When the hydraulic pressure was lost, the nozzle would have started to gimbal randomly.”

“Kicking us to the side before it shut down.” I nodded. “Well, well have a look when we get down.” I took a look back to the lavatory. “What's she doing in there?” I wondered.

I guess she heard me; she said, “I'll be out in a moment.” When she did, I asked if she wouldn't mind taking care of dinner, and she said that was fine; I wanted the spaghetti.

We chatted a while, while eating, talking about what we were going to do once we got back on the ground, and how cool it was to be up here, that it would be cool if we could stay up forever..

Afterwards, I spoke with Susan over the radio, to coordinate plans for the next days landing.

“You're next window is as 3:03am, local time.”

“Can't take that,” I said. “We can't land in the dark.” That was a part of Icarus's “Provisional Experimental Orbital Flight Authorization,” one of several we had agreed to (many of which we had suggested, based on Icarus's limitations and experimental nature.)

“I know that, love.” she said. “After that, the next window is at 1:22 pm, local. That will put you touching down about 2:30.”

“We'll make for that one.” I affirmed. “Let the control tower know; remember, the airport has to be shut down and the airspace clear before we deorbit. That means we want things down by about 1.”

“I know that, love.” she said. “I spoke with them already today, for our projected landing; I'll let them know it's confirmed.”

“Right.” I said. “The I'll see you tomorrow night. Icarus out.”

I looked out the forward window. We were on nightside, but I could see the lights of Europe ahead. Bright clusters marked cities, highways, and outlined the coast; the Mediterranean was visible as a black void; the brightly lit boot of Italy stuck out it as it came over the horizon. Further south, the coast of Africa was marked by lights, but significantly fewer – only a few large cities stood out, and a bare scattering of lights below that, through the Sahara desert. I watched as Italy moved briskly forward and Greece came into view, then Turkey a few minutes later, and the lights became sparser away from the coast. Turkey drifted northward, and I thought we were over Egypt; already I could see the middle east; a few brightly lit cities, and the barest scattering of lights in between. I kept watching until the sun began to come over the horizon. It was first indicated by a dull reddish glow around the edge of the earth, steadily brightening, then the the sun began to emerge in brightness and glory (I took out sunglasses we had brought along. Thick, dark sunglasses.) The atmosphere glowed on both sides of the sun, and our star seemingly grew out of the Earth. It separated, rising majestically. The bright red of the atmosphere gave way to bright glow, then features came into view; even as the air closer to the

ship was still dark – the windows on the top of the ship, looking directly down, were still black. The sun rose quickly , several minutes and it disappeared from view out of the top of the window, and Asia was in full view. Remarkable. We had already seen several sunrises and sunsets – we got one each each orbit – and they were still impressive.

I glanced at the clock, then turned my head around to look at Uncle Robert and Abby, chatting in the back. Abby was in the galley, getting some kind of snack. "We've got a busy day tomorrow," I said. "So it's about time to turn in. I want to get things started early, clean everything up. I don't think we secured the spacesuits, either; we want to take care of that. Get things cleaned up a bit, make sure everything's secured for reentry."

Uncle Robert nodded and pushed himself back over towards the flight engineers station; Abby game me a bit of a dirty look as she ate an apple, but glided gracefully over her chair, making a neat somersault into the seat, constrained only by the tight space of the flight deck.

"You don't have to be bossy about it." she sad, loosely strapping herself in.

"I just want to be sure we're ready." I said.

We still chatted a little bit, before going off to sleep; Abby was still looking off into the vastness as I pulled the sleep mask over my eyes. Unlike the night before, I felt calm, knowing my ship was intact and safe, and I fell asleep quickly, and dreamed of floating around forever.

But the next morning we woke to worse news. High clouds had settled over western Texas, and day in Domingo had come overcast, and a cold front was moving through, bringing lower level clouds with it, and a line of light rainstorms.

"Weather is telling us the front should be through by around 11" Susan reported, "and the showers will be clear not long after that. But they're expecting IFR conditions after that, for most of the afternoon."

"We'll have to keep an eye on it." I said. "What's the expected ceiling?"

“They think about 2000 feet, after the front moves through,” she said, “And it may not break up until later in the evening.”

“For now, we'll assume we're coming in.” I said. “But we can't land in those conditions. Keep us apprised.”

“I will, but the airport is already pushing us for a decision.” she said. “I told them we were watching for the weather; but they're pushing for a decision, so they know if they'll have to divert flights.”

“Right.” I said, thinking over discussions we'd had with airport management prior to launch. With a 1:22 reentry window, we wanted the airport closed down by one; and they had said they needed an hours notice, at least, and more was better. “Tell them we'll have a decision by noon at the latest; and you can judge as you watch the whether; but remember, it's my call. Keep me posted.”

As I closed the channel, Abby said, “I don't see why we can't come it. The rain will be through, and 2000ft is easy IFR conditions – you were so insistent we get our instrument ratings.”

“Our FAA approval requires full VFR for landing.” I said. “Pretty much, clear conditions. More to the point, you know what our approach angle is – we'll come in steeper than the space shuttle. We can't use the glidescope anyway.”

“Still,” she said. “It shouldn't be so hard. We've got the GPS, and the inertial unit.”

“Besides,” I pointed out, “I'd have thought you'd want to stay up here. If we have to scrub, we'll get another day in orbit.”

“Yes, well,” she said. “The landing ought to be fun, too. You know I like a challenge.” I nodded; that much was true.

“There's something else,” Uncle Robert said. “What if it doesn't clear up? I know you didn't make arrangements for any diversion airports.”

“If we have to land elsewhere,” I said, slowly, “We'll figure that out then. We can made Kennedy or

Edwards without too much trouble; I haven't spoken with NASA or the Air Force, but I don't think they're going to leave us stranded up here, if it comes down to it. Mounting a rescue mission would be one thing, but if we only need to use their runways. But we'll deal with it as it comes up."

The next orbit, we were close enough to to see the front coming over Texas; much of the southwest was covered by broken clouds. Susan confirmed that the forecast wasn't getting any better, and said that the control tower was putting more pressure on her to make a decision. "They say they've got airlines calling them, and several flights waiting elsewhere, needing to know."

"And they've got an airport to run." I said, knowing exactly what Clyde must be saying. He could be so eager to have us, when he thought about the benefits – but wasn't going to put himself out too far for us. Besides, he did have hundreds of passengers to think about. "The forecast hasn't gotten any better than last time you checked?"

"Not really," she confirmed. "Most of the west is solid IFR."

"Then we'll scrub for the day." I decided. "Let the airport know. And start getting reports for the next couple of windows."

"Already working on it." she said. "I guess I won't be seeing you tonight, then."

"No, but soon enough, honey." I said. "As nice as it is up here, I'm looking forward to being back together." We signed off, and I turned to Abby and Uncle Robert. "Well, you heard that. It's going to be another day, at least. We should still work on landing preparations, and get those suits properly stowed. We should do a supply inventory, too, to make sure we're on mark with reserve. How do we look on thruster fuel?"

"We're fine," Uncle Robert said. "The forward hydroxide tanks are at 59%; aft is 52%. Fuel cell reserves are normal. Everything else looks fine."

I looked at the overhead panel, with the life support gauges "Life support reserves are good; actually going slightly slower than expected. It looks like it's about time to change the CO2 scrubbers,

though." I looked at Uncle Robert. “Since you changed them yesterday, while we were out, I guess it's my turn. But continue system inventory; make sure there aren't any problems cropping up.” I unhitched myself from my seat, switching off the main life support system, and the circulation fans; the air in the cabin would be more than adequate while I changed the filters.

The scrubbers themselves – two of them – were located above the galley, right next to the air vent. I opened the panel and removed one, then floated to the floor. We had built several storage lockers into the deck, and I opened one, stowing the removed scrubber on one side, and pulling a fresh one from the other side. Checking to make sure it was, in fact, fresh, I slid it into place, then did the same with the second one. I reopened the valves took a tub to make sure everything fit, and put the panel back in place. Switching the life support fans back on, I watched the gauges for several minutes, until I was satisfied CO2 levels weren't going to start rising. “Well, that takes care of that.” I said. “How does everything else look?” When Uncle Robert confirmed we were in good shape, I said, “Then I guess ... everyone just keep doing what they're doing. And enjoy the ride.”

We did a few more housekeeping tasks, after that, they're really wasn't much to do “We should have brought along a TV or something.” Abby said.

“Where would we put it?” I asked.

“Well, we'll need something, if we're going to carry passengers sometime.” she said. “Besides, I thought you were going to bring a cd player along?”

“I didn't expect us to be up this long.” I admitted. “Next time.”

We had brought a deck of magnetically-backed cards, and Abby and Uncle Robert were playing something for a while. “Next time we'll have to bring poker chips.” she said.

“Maybe.” I said. I was just watching the scenery out the window. It was fascinating – so much, and it all went by so fast. Such a beautiful place, I thought, from afar. Why do we have to fight so much over it?

And the stars were so vivid, and so numerous – especially at night. I could make out many of the constellations, especially of the zodiac; the north polar one were mostly out of view around the horizon, and the southern ones, I only knew of, and couldn't recognize them. In many cases they were as easy to make out as from the ground; they were, after all, the brightest of the stars – but others were hard to find out of the sheer number of stars.

And there were so many satellites up here too – although I couldn't make any out, except occasionally for a fast moving point of light. Somewhere there was the International Space Station, and the Hubble Space Telescope.

I could see why this was such a good place for a telescope; the view was just so marvelous. The Hubble. Somehow my thoughts began returning to it.

At some point, if we were going to make more than a couple of simple tourist flights – we were going to have to try an orbital rendezvous. Hubble would be as good a target as any; although I would have to check it's orbit. But if we could reach Hubble, it would be a good one to visit.

And with that, there was another thought. Hubble was due for one final servicing mission later this year, a mission which had been off the schedule for a time, after Columbia. If we were going to visit Hubble, we might as well off to give NASA a lift, so they wouldn't have to use the space shuttle. Even if a rescue mission was required, it would be easier for NASA to mount, as they wouldn't have to prepare two shuttles essentially simultaneously.

I had avoided working with NASA previously, for a couple of reasons – the same bureaucratic stubbornness I had dealt with at the FAA, for one. For another, like the X-Prize, this was meant to be a private space venture, not government funded, and I had wanted to avoid government involvement. But now would be the time to discuss working with them. I had made a few contacts at NASA, in part as I had been collecting information for Icarus. When we got down, it might be time to make use of them.

The rest of the day, and the following night, was mostly uneventful. We all were pretty much acclimated to weightlessness, and part of me was sorry to be returning – but I wanted to see Susan, as well I hoped the next day would dawn clear.

It didn't, of course, but it quickly showed signs of changing. It was still a little overcast when we told the control tower that we were coming down, but clearing fast; and by the time they informed Susan that airspace was closed, there were just a few thin clouds overhead.

"Alright," I said. "Let's go home. Deorbit burn in twenty minutes. Radio checks." Once again, all thee of us conducted check calls, two channels to Susan, and the control tower – now relayed through our own comms equipment. "Radio checks complete. Abby, bring us to retrograde position."

Abby punched the stationkeeping controls, and we yawed around, keeping the Earth overhead. "Retrograde confirmed. Positioned for deorbit."

"APU status?" I requested. This was our biggest concerns – diesel engines are not made to operate in space – nor are they meant to be stored in a cold vacuum for several days. We had done all the calculations and testing e could – but we would have a serious problem if they didn't start.

"I've had the warmers on for about the last hour." Uncle Robert reported. "All temperatures are ready."

"Then go for prestart." I said.

"APU prestart." he said. "Flow looks good." he reported, after the pumps had had a minute to run. "The fuel is liquid, at least."

"OMS status?" I asked.

"Pressurized and ready." Uncle Robert reported.

"Capcom, this is Icarus." I requested.

"Susan here." she said.

"Please confirm 380 seconds for deorbit burn." I said.

“380 seconds.” she confirmed. “You've got about six minutes.”

“Very good.” I said. “Status for deorbit?”

As with launch, she polled the other controllers, closing with “Capcom is go. You are clear to deorbit.”

“Icarus is go for deorbit.” I said. “APU's?”

“Ready for start.” Uncle Robert reported. “Start one ... now.”

I could feel the distant vibration as the starter motor kicked on, but didn't quite catch. Crank-crank. Come on, I thought, come on. Crank-crank – and then the deeper vibration as the fuel ignited.

“We have APU 1 start.” Uncle Robert reported, then confirmed that it appeared to be running normally. The other two were as hesitant to start, but they both did. The hydraulic system quickly pressurized, and Susan confirmed that the controls worked – now relying only on the surface position indicators.

“Two minutes to deorbit.” I said. “If anyone has any reason we should stay in orbit, say so now.”

“I'd like to stay,” Abby said. “But flying back will be fun, too.”

“I'm sure we'll be back.” I agreed. “Uncle Robert?”

“Let's go home.” he replied.

“Right.” I said. “Deorbit in one minute. Setting computer countdown ... OMS control to automatic. Thirty seconds. Twenty. 10 ... 9 ... 8 ... 7 ... 6 ... 5 ... 4 ... 3 ... 2 ... 1 ... ignition.”

The thrust of the engines was vastly less than the mains, but still enough to push us into our seats as they slowed us down just enough that we would begin And then they stopped. “Deorbit burn complete.” I reported. “Capcom, how's our track?”

“Icarus, I'll have that in a moment.” Susan reported.”Burn looks good.”

“Let's have re-entry attitude.” I said, and Abby switched control to manual, and pitched us over. Earth disappeared out of the top of the windshield, and there was nothing but stars. There was the

briefest of sense as the thrusters stopped us, right in position.

“Reentry angle,” Abby confirmed. “35 degrees positive.”

“Very good.” I said.

“Icarus, Capcom.” Susan said. “You're track looks good. Atmospheric interface in 35 minutes.”

“Copy that.” I said. “Systems check?”

Uncle Robert gave me a quick report of several critical systems, then we coasted, slowly descending towards the atmosphere. Periodically Abby would make a slight adjustment to pitch, compensating for the curvature of the Earth. I watched the calculated altitude of the computer screen – interface was defined as 400,000 feet. I also watch the inertial speed; it would start to slow as we encountered slightly thicker atmosphere.

Just after I noted altitude on the screen, Susan came on and reported, “Icarus, you have atmospheric interface.”

“Atmospheric interface,a acknowledged.” I said.

“Track looks good.” she continued. “Blackout approaching.”

“Acknowledged.” I said. “We'll see you on the other side. Abby, attitude?”

“Attitude steady.” she reported. I changed the computer program for entry phase, then looked out the side windows and saw Earth, pitched well behind us. I hit another switch on the communication overhead; a wide-band radio receiver that would give us an audio feed as we came through blackout. It was quiet. But looking at the inertial speed indicator, we were already beginning to slow.

In a moment, a light static began to come from the speaker, and the speed was dropping more quickly now.

“Control, approaching blackout.” I said. Nothing. “Attitude?”

“Holding steady.” Abby reported. “She's starting to try and pitch down, though.”

I could start to feel the acceleration of the atmosphere, down into the seat and forward into the

harness. Out the side window a reddish glow was starting to come from the underside. I watched the other indicators – external pressure was beginning to rise as well, and the static had built to a quiet scream – we were becoming a fireball. There was now a strong red glow out the side, and well up the front windows.

"Switching roll to ailerons ... now!" I reported,a s the pressure built up. We were slowing fast, now, and descending into thicker atmosphere.

"Got it." Abby acknowledged, and rolling became a bit smoother. In another moment, I did the same for pitch, and said, "Begin first S-turn."

"Turning." she reported. Up to now, we had been holding a steady direction; Abby rolled us sharply to the left. I watched as she pulled back on the yoke, then the artificial horizon, at nearly a fifty degree bank, as we used the lift vector to dump as much energy into the atmosphere.

"Coming up on 180," I said, watching the inertial heading. "Begin reversing."

Gently, but quickly, Abby rolled Icarus out, and up in the other direction, as we plunged through the atmosphere. Besides dumping energy, the maneuver also pushed us a little farther north, and onto our targeted track to Texas. Once more, she rolled out right on heading.

"We should be coming up on the end of blackout." I said, watching the speed. Indeed, the g-force was reducing, and the static beginning to diminish.

"Reducing pitch," Abby reported. "Entering second S-turn."

There was a screech of static from the comms radio, then"Icarus, are you there?" from Susan.

"Capcom, this is Icarus." I replied. "We have you. Clear of blackout." I changed computer programs again, then switched on the store-bought GPS unit mounted on the dash. It didn't read anything, for a moment, then one satellite, two, three. It had us, and automatically loaded our planned track. "Beginning terminal energy management phase." I announced, then looked out the window.

The view was turning sky color, and Abby was still rolling through the second S turn; when she

came out, our nose dropped below horizon. “We're on track,” I reported. “Adjust five degrees left.” I switched to the tower frequency. “Domingo Tower, this is Icarus on approach. Do you read?” Nothing, so I repeated after a few second.

“We read you, Icarus.” replied the controller, just as Abby began the third S turn. I glanced as the inertial speed; we were dropping below mach 2.

“Switching pitot system on.” I said. “Radar altimeter, on. Tower, request altimeter setting.” They gave it to me, and I acknowledged it as I entered it. “Tower, this is Icarus. Request landing clearance.” This was, of course, just a formality – it's not like we could wave off.

“You are cleared to land.” they said. “We have you on radar, descending fast.”

“Track to setup heading.” I said, giving Abby our final vector. The GPS had calculated the two vertical alignment cylinders we were aiming for; we would arc around one, and onto runway alignment “Turn to final in one minute. Speed, mach 1.2.” I began looking out for the airport – there was Domingo, among a spread of other towns, and the buildings of San Antonio further south – and there was the airport. Watching the GPS, I gave Abby time cues, then signaled her to turn; she did so, smoothly, pitching up, and further reducing speed. “We are subsonic,” I reported as I watched the runway come around, and into perfect alignment. “We're a little high, though. Arming airbrake, landing gear.”

“Hold brake,” Abby requested, adjusting pitch, “Just a touch, now.” I pulled back gently on the airbrake.

“We are on final.” I announced over the radio. I continued to adjust the brake, as Abby requested, and watched the runway approach. I began reading out airspeeds and altitudes. “Begin preflare.” Abby did so, just a little more pitch, just a little more speed dropped off. “Automatic brakes armed. Four hundred knots.” We continued to slow, but we were a little high; I increased the brake. “Three fifty knots. Three hundred.” Abby was beginning to pull the nose up, and airspeed was dropping

quickly now. “Extending gear.” I called, and the ship rumbled as they came out; I could feel the pitch effect from the increased drag. “Airbrake full,” then as the gear lights indicated locked, I said “Gear down. Two hundred knots – begin flare.” We were on the verge of the runway threshold, and now Abby pulled the nose up, our vertical speed began to reduce, a slight shaking as the lifting body began to stall, and then THUNK as the main gear hit the ground, and the nose gear settled. “Autobrakes active, airbrake full.” I said; Abby was now pulling the yoke completely back, to maximize resistance from the control surfaces; Icarus rumbled as she coasted down the runway and came to a stop. “We're down. Stop confirmed.” I said, over the radio, then to Abby, “Very nice flying.”

“Thank you.” she said.

“Begin securing systems,” I said, already flipping switches.

“APU shutdown.” Uncle Robert reported. “Thruster's depressurized and safed. Fuel cells are off; we're on batteries.”

“Icarus, this is the tower. Very nice landing.” the controller came on and said.

“Thank you.” I replied.

“How soon can you be off the runway?” they asked.

“About twenty minutes,” I said. “As we discussed beforehand.” The controlled made some kind of annoyed noise before acknowledging. We had briefed them, of course, but I couldn't blame their impatience. But it would be a few minutes before the skin of Icarus would cool enough to allow the ground crew to get close. Meanwhile, we finished shutting most systems down while the tow vehicle came out. Once Peter, who had ridden out with them, cleared it, they hooked up, and began to tow us off the runway. Once they reported we were clear of the runway, I called the tower again. “We're clear.” I reported. “And done. Thank you for all your help. Repeat, Icarus is off the runway.”

“Copy that. Tower out.” the controller said, then reopened the airport; they were quite busy for some time after that, lining up traffic to start bringing it it.

We were towed over to our hangar, and parked in front. “You should be good to come out.” Susan reported. We're bringing up the ladder now.”

“Acknowledged.” I said. “Shutting off life support. All vents open.” There was a slight hiss as pressure equalized. I unstrapped my harness, and said, “Well thank you. Excellent job, everybody.” I had to hold on to the chair as I stood up; it felt very strange to be stuck to the ground, once again. I climbed the ladder and opened the hatch, slowly climbing outside. I opened a storage locker right under the hatch, and pulled out a thick, insulated carpet, and threw it out over the top of Icarus, before stepping out onto it. Then I helped Abby and Uncle Robert out, and walked over to the stairs. There was some press waiting by out hangar, and we all waved to them as we came down.

They swarmed towards us as we walked towards their hangar door, so I turned to them, and indicated we were ready for questions. We got several; one asked, “You've now flown the first privately built spacecraft into orbit. How was you flight?”

“It was great,” I said, “And I can't wait to get back. And I hope that, soon, all of you are able to go up, as well. It's really incredible up there.”

Another reporter spoke. “So what makes it so important to go up there, while as some have said, there are still many problems down here?”

So Jessica hunt had already gotten to them, as well. While we were up, Susan had been keeping us posted; Jessica had continued to protest, and given several statements to the press, and I was hoping to have a chance to answer just such a question.

“Contrary to what some would say,” I began, “That question is essential to everything we've done here. It's not a question of one or the other, doing this and not doing that. Humankind is what we are - as successful as we are, as comfortable as we are, because we have always tried to be more than we are. In doing this, in trying to be more, to show people that was can do more than we dream possible, I am trying to make us better as a species, as a people. Continuing test flights of Icarus won't put bread on

peoples tables, or roofs over their head (and indeed, I could do better for my own accounts if I plied my talent elsewhere.) But when humanity reaches out to space, I think we'll find, I think we'll make it a better place – and we'll make ourselves better for having tried. I can't say – and won't venture to guess – what resources, advantages we may find – I honestly don't know. But I do know that Columbus set off on his westbound trips with less certainty of what was over the horizon than we have now as we look out into the stars. I promise nothing except that I will do my best; I see no certainly except of great risk. But I also believe that, If we are bold enough to take the risk, the rewards will be more than we can imagine."

I took a few more questions, then turned it over to Abby, who was obviously itching to take the floor, and once more held court with the reporters. She showed the confidence she'd always had; but now she was beginning to exhibit a true swagger. And why not – she had piloted Icarus, too and from orbit – Even NASA astronauts don't do that, relying instead of the computer autopilot for guidance.

I listened for a moment as the reporters asked about spaceflight, and what it was like to fly Icarus. "It's better than a Harley Sportster with an Corvette engine," she said. "Being on top of that rocket, inc control of it's every movement – and one wrong twitch to send you out of control – it's like nothing else." And she went on to describe, in similarly exciting terms, the freedom of weightlessness, euphoria of looking off into the void, and the exhilaration of reentry.

After a few moments, I slipped inside and found Susan and Hank, and tried to gather up a few others, detailing what needed to be done once Icarus was brought inside. "We need to pull the engines and figure out what happened, first of all; Abby's spacesuit glove is stored in the airlock locker with a stain of fluid from around the engines on it."

"That's going to push back our launch schedule." Susan pointed out, a bare hint of sadness in her voice.

"Don't worry, honey," I said. "You'll get your chance to go up. But we need to get cracking to get

things flight ready again. We also need to go over other systems, and make sure there aren't any other problems that cropped up." In short, we would start postflight work tonight.

And so, we hopped to it. Icarus was brought back inside the hangar not long after the press had dispersed. Preparations were made to remove the engines, one by one. Other inspections proceeded more quickly, as tiles and heat shield pieces were inspected visually, and access panels opened and systems checked.

A visual inspection of the rear of Icarus revealed none of the leaked hydraulic fluid Abby had seen, but the number three engine nozzle was hanging limply downwards, and it's mount showed signed of considerable vibration and stress. The oil-stained glove from the spacewalk was taken by Susan to one of the back labs, where she wiped off a few samples, ran tests on some, and sealed others into vials; she reported back to me as we got ready to leave.

"It definitely looks like hydraulic fluid," she said. "I compared it to all the fluids used on Icarus, and that's the best match, by far. But it'll have to be run through a proper chemical lab to be sure. I can fly it up to Loudoun, I've got a little better equipment up there; or we can ship it to an outside lab."

"Might as well ship it outside." I said. I knew what equipment Susan had, up at the other building, and while good, it wouldn't be a substitute for a professional facility. "Send along some samples of fluid from Icarus' Hydraulic system, and some unused fluid, as well. Ready to go?"

She nodded. "Want to get some dinner?" she asked.

"Sure," I said. "But I'm still a little wobbly from the flight; and we've got to get an early start in the morning – I want Icarus to launch again as soon as practicable – so somewhere close." I climbed into my truck, and it roared to life as Susan climbed in the other side.

"You're the spaceflyer today," she said. "Your choice." So, I picked out a diner we both enjoyed, and were there much later than we should have been, talking about Icarus, spaceflight, and many other things.

After that, work proceeded quickly on Icarus. The rear of the number three engine had sustained additional damage during reentry, as the nozzle had been oscillated back on forth – Abby said she had noticed some slight oscillation late in the reentry – and much of the piping and other components had been further torn. All this complicated confirming the problem – we would never be able to pinpoint the exact point of the break – but sample analysis confirmed that the leaked fluid was hydraulic fluid.

A week after landing, Uncle Robert pulled me over to the half-disassembled engine. "Look at the mechanical shutoff valve," he said, pointing. "It's part of the automatic safety system – which mechanically triggers engine shutdown if certain sensors trigger." It was one of the most important safety systems, and a simple, electromechanical system – several sensors would trigger it, shutting down the engine, before the flight engineer could even recognize the problem. It was limited to the most critical of failure modes, as it couldn't be bypassed, but was meant to shut down the engine before a small problem could get very big. "This one shuts off the Oxygen supply; another one – back there – shuts off the hydrogen. They're both triggered – the safety cutoffs, that is. Further, the delay timer on the hydrogen supply is also run out."

In the event of an emergency shutdown, the spring timer would cause the hydrogen supply to cut off a few seconds after the oxygen flow, critical in this type of engine. Simultaneous cutoff of propellant and oxidizer leaves combustion chamber components extremely hot, and cutting off hydrogen with pure oxygen in the chamber can actually cause the metal itself to ignite. Dumping extra hydrogen to the engine helps cool components down, even in an emergency cutoff scenario. But the spring timer only triggered in an engine-initiated cutoff - all other shutdowns were controlled by the flight engineer. "That means that the mechanic cut-off is what shut down the engine." I said.

"Exactly," Uncle Robert confirmed. "Which means something triggered it – most likely hydraulic failure – and it appears to be what actually cutoff the engine. That seems to back up the hydraulic failure theory; we haven't found any other problems with the engine."

I nodded. “Still, without definitive proof – ie, failed component – we must be careful.” I said. “We need to be sure and check over the rest of the engine, for any other problems. Why doesn't the auto cutoff display on your panel?”

“I guess we didn't think it needed to be indicated,” he said, shrugging. “Engine shutdown's pretty obvious when it occurs, and tends to leave plenty of indications.”

“Still,” I said. “It might have made this a little easier to track. How hard would it be to install some kind of indicator?”

“Easy,” he said. “Just put a relay on the spring timer.”

“We'll do it, before we launch again.” I said.

Continued inspection of the engine didn't find any other problems, and we eventually agreed that hydraulic failure was the likely cause; we inspected the gimbal hydraulics on the other engines for signs of stress or incipient failure, but didn't find any. We discussed reconfiguring the gimbals, to better lock the engine in place when that should happen, but decided it would require a complete redesign of the back end of the engine, and Abby pointed out, “She flew well enough as it was, afterwards.”

The problem in the other engine was easier to find – and much more difficult to deal with. The oxygen turbopump had blown out completely, and had apparently come very close to catching fire; a significant portion of the engine compartment had been filled with both high-pressure oxygen, and hot, hydrogen rich steam from the preburners. “If Robert hadn't shut the engine down so quickly,” Hank commented, “It could have been a major fire. As it was, only a small amount of steam escaped, and the flash was minimal.”

“But enough to destroy the engine.” I said. Uncle Robert, Hank, Peter, Susan, and I were looking over the opened engine, along with a couple of techs. The inside of the engine was partially blackened from the failure. Considering the damage, separating initial failure from further damage could be2

difficult. “Any idea what the cause was?”

“Either a seal failure on the pump side,” Uncle Robert said, “Or a failure of the turbine bearings themselves. We're certain it was a failure in the pump O2 – since much more of that seemed to escape into the engine compartment – and that matches with the readings I was getting when I shut down. I was getting erratic readings on the oxygen pressure for about twenty or thirty seconds before it went bad. I shutdown as soon as I saw turbine temp spike, then fall quickly.” The pressure from the preburner steam would have fallen as pressure drained out of the system.

“More important is two questions” I said. “Could it have been related to the first failure – something misaligned due to vibration, say? And second, is it likely to repeat?”

“Unlikely it was connected to the first failure,” Uncle Robert said. “Erratic readings don't show up for well after a minute past that. Further, the turbopump is far enough away from the rear of the number 3 engine, and the engine mounts suppress the worst of vibrations. I don't think enough would have been transmitted to cause a significant problem – and if it did, it would have caused more than one indication. Not other failures, necessarily, but other erratic readings. I didn't see any.”

I nodded, and he continued, “As to the engine itself, we're running them at pretty high temp and pressure levels, and with the flight engineer manually controlling engine operation, it can place a strain on components. Something just gets too hot, and a seal fails. I think the best we can do is to review the seals and bearings on the other engines, and make sure everything is to spec."

“Right.” I said. “Then we get on it. This engine is a wash – we'll have to put the spare in – but don't cut short the postmortem. If there were any other seals close to failure, we need to know it. And have Loudoun begin working on another spare.”

Assessment of the other engine seals didn't show any problems; and we poured over the sensor data from all the engines to identify any discrepancies or problems. There didn't appear to be any fundamental problem with the engine – in fact, the simple electrical feedback controls had worked

remarkably well – but something had just gotten a little out of bounds. I didn't like it, but the only way to fully validate the engine was continued flight testing.

We also pinned down several other minor issues that had arisen. One fuel cell had shown a significant dropoff in efficiency halfway through the flight, which was traced to poor zero-gee geometry internally; we left redesigning the plates to the next design. A hydrogen peroxide sensor had also indicated a possible leak; but we confirmed our initial assessment, that the sensor had failed. And there were several other issues. Hank pointed out that he had had similar problems for the aircraft he had homebuilt; never this complicated, but they weren't Icarus. With a line on everything, we planned the next flight for just under two months from our first one.

I also contacted NASA, proffering my idea to provide access to Hubble for it's final servicing mission. We certainly had their attention – they hadn't missed our flight – but they were very concerned about trusting such an important spaceflight to such an unproven craft.

"The space shuttle itself is still very much an experimental spacecraft," I pointed out, "And will remain so until it's retirement. And the shuttle also poses known concerns for this operation – we had less heat shield tile loss than documented on any shuttle mission."

"The shuttle has still served many more successful missions," my NASA contact replied. "And worth the calculated risk. Further, who would operate such a flight – our astronauts haven't been trained on your equipment, and we're not setup to monitor your telemetry."

"We would fly, the mission," I said. "Three crew on our part. Two NASA crew members would then perform the spacewalks, and handle the actual repair. We'll be your taxi."

But NASA – with typical bureaucratic indifference – wasn't biting. They'd rather take the risk of Flying in Atlantis than flying with us. Besides, their mission was now only months away, and well in preparation stages. But I continued to work on selling the idea to them. And I worked on making contacts with NASA, as well; we would need their knowledge, and experience, in future flights – and

they were open to hearing from us.

And of course, we continued preparations for Icarus's second mission. Hank would Captain, Susan would be First Officer, and Peter would be flight engineer; of course, I would be Capcom. We ran simulator sessions of every phase of flight, and every conceivable emergency; considering the first flight, we gave particular attention to engine failure scenarios. It made for many hectic weeks; full days of flight practice followed by full nights of engineering work – there were whole weeks I didn't leave the airport, except for the occasional trip to get lunch, at Susan's insistence.

A week before the second flight, we had a final planning meeting. The engines had checked out, and were now installed, all first-flight problems ironed out; and we were going full-bore towards flight.

I gave a summary of the flight plan. "It will be a five day flight, with stocks for ten. NASA has now positively assured us that we can land at Kennedy, Edwards, or White Sands at our discretion; they request a full day's notice at Edwards or White Sands, but Kennedy is available as a takeoff-abort site. They're also ready to support a return-to-base suborbital flight here. That will give us more options in the event of weather or other problems. However, our FAA restrictions, including clear weather operation under 50,000 feet will still be in effect for any landing site."

"Flight objectives include a more thorough checkout of all systems," I continued, "As well as a demonstration that Icarus is capable of sustained orbital flights. We will also include two planned orbital changes, to verify full functionality of the OMS. In short, I expect to declare Icarus operationally ready after this flight. We've all done an excellent job getting all of the first flights problems worked out, and I want to complement everyone. But I don't think it's going to get any easier for was while; just remember, this is what we've all been working for for the last eight years."

"I understand why you want to push, Dan." Peter said. "But at this point, I begin to wonder if you're just trying to push NASA to see your point of view, and commission us to service Hubble. But I don't believe, when we started, that a major government contract was one of your objectives."

“NASA should have us fly the Hubble flight.” I replied. “And I hate seeing bureaucrats ignore the obvious. As for government contracting, it was always a prospect for orbital flights, and possibly one of our best, surest customers. But you're right, Peter, we're trying to build a private spaceflight industry. But the prospect for such a high-profile mission is impossible to ignore; especially for Icarus's first 'working' flight. If I'm pushing hard more more flights, I don't intend to do so at the cost of safety, and if anyone thinks we are going too fast, they are free to speak.” I looked around the room; no one said anything. “And we may not get it. But convincing NASA we are ready for Hubble is only one of the reasons I'm pushing this flight; the commercial market dictates rapid turnaround. If we can't achieve that – yet – we'll hold the flight. But turnaround is one of our objectives, and it's one of the things we need to work on.” Peter nodded, and I continued. “I'd still like to achieve a two-week interval between flights; if spacecraft status and flight readiness indicates; but at the moment that's still an ideal; we don't launch if it's not safe. Therefore, I want everyone to give me their status reports now, in particular engine status.”

Uncle Robert reported the engines were as ready as they were going to be, and Hank said the airframe was good to go; Peter said all electronic issues had proved minor and been ironed out. Susan said that the fuel cell problem was pending but not a flight risk; Troy said we had the money, and now all the investors were looking for an encore. “Then we fly.” I said. “Up until now, we've given the secondary crew significant simulator time. Now – unless any of the prime crew feels they'll need to back out – or fails medical over the next two days – the prime crew will fly all simulator operations. For the flight, Abby will pilot the Baron on chase for launch and landing, and I'll be capcom. Any questions?”

We went over everything, and afterwards, Susan and I went out for a date – possibly the last before she launched into the great beyond. We were just going to go somewhere local, but as we were walking out of the hangar, she said that we ought go down to San Antonio. “We haven't been in a

while, and I'll be making my first flight next week. It calls for a celebration."

"That it does," I agreed. "Hop in." I started the truck and pulled it out onto the main road, and over toward the road to San Antonio. "Want to try and catch a movie?" I asked.

"No," she said, after a moments thought. "I thought we could just checkout town, and spend some time together. We have bee busy."

"That sounds splendid," I said, turning onto the highway. The entrance ramp – a state highway – had a sharp turn to the end, a tight turn and a short acceleration lane. I checked the lane, then downshifted into first, and the engine roared as it powered into light traffic. I hit second with the long dogleg shift and ran the revs up before dropping it into third, and pushing the truck up to eighty – the truck roared without overdrive, and we flew down the highway. "I haven't been pushing too hard?" I asked, "Have I?"

Susan shook her head. "We all want this to succeed as much as you do." she said. "You are pushing hard, but we all want it. We want to see Icarus fly again; and I think a bit of you and Abby's impatience is rubbing off on me – I can't wait to go up."

"I've told you so much about it." I said.

"And we're all pushing hard." she said. "You've convinced us – you've done that much, at least. Just make sure you're not cutting safety off."

"That's one of the things I worry about." I said. "It can be so easy for a company to say they mean for safety, it insist on safety rules being followed to a T, and yet on the floor, expecting production that just isn't compatible. I count on you to tell me what people are saying on the floor. Do people have safety concerns they're not willing to bring up to me?"

"Not that I've heard," she replied. "They want the project to succeed as much as the rest of us; and I've worked in labs that were worse than you on safety. But you are working everyone hard, and everyone is working themselves hard. I do think Icarus is ready for the next flight. You're not running

the engine too hard?" the last a comment on my pushing eighty, and the roar of the trucks motor.

"It'll be fine." I said. "But no, it doesn't like to be run like this, and I try not to. If you do think I need to delay things, let me know. Besides that, if we are running it too hard, I think you would say that we need a break. So shall we not talk about Icarus until we get back to Domingo?" the suggestions was a little hard for me to make, and I wasn't sure I could, but Susan agreed wholeheartedly, and said I was learning. In the end, we couldn't keep talk completely away from Icarus – we couldn't help talking about Susan's upcoming flight – but we did pretty well.

A week later, the day dawned bright and clear, and we prepared for flight. Once again, Jessica Hunt was protesting out front of the terminal – I began to wonder if she was still staying in a hotel, or had gotten an apartment in town, at this point – but as Capcom I didn't have time to deal with it. I ignored her, and advised the airport to do the same.

I checked with the crew once they were fully ensconced in their spacecraft. All systems were coming up normally, and radio checks were clear., and they turned environmental systems to internals, and completed pressure checks. The tower notified me that the airport was now closed, and I checked with Hank, in the Captain's seat; they had notified him as well. I authorized the tow vehicle – an airport vehicle with airport employees – to spot them on the runway. Then I commenced ground crew checks; the technicians in the field verified that all was nominal, and the launch monitoring camera was in place.

I looked at the first of the two televisions which showed the feed from the runway camera, positioned just at one corner of the runway, behind Icarus; everything was nominal.

"Baron, ready for takeoff." Abby said, over the radio.

"Request clearance for tower for 10,000 feet." I said, and she did so. In a moment she began down the runway. I watched her on the other monitor, which showed a camera feed from the control tower.

And then, final checks; I got clearance from all stations and relayed those to Hank, who

acknowledged it with a “Go for flight. Begin final countdown.” Within a few moments, and right on time, Icarus began down the runway. I watched as she lumbered slowly at first, mighty hydrogen engines glowing their faint blue flame, then picked up speed, rotated, and lifted off the runway – rather like a massively overweight ballet dancer completing moves that would have been a challenge for a talented performer. The first monitor – which had gone out as soon as rocket ignition had knocked over the camera – had gone over to flight profile plot. I watched it as the Icarus accelerated, then said, “Icarus, Capcom. Approaching Max-Q. Prepare to throttle back.”

Susan came on, acknowledging, “We see it, throttling back ... now.” I watched the telemetry coming off, showing them right on course.

“What kind of monster did you build?” Hank asked, and I said nothing, instead giving and listening to the routine flight reports.

Then Peter said, “We have auto shutoff on engine one.” and I glanced at the controllers panels to see the readouts, and the light come on. They were already past two-engine press, and Hank quickly called for orbit, but I leaned over the controllers panel.

“Any indications?” I asked.

“Not yet,” he said – one of our technicians - “but I'm watching the others right now, and they all seem nominal.”

“Right.” I said. That had been my instruction to them, and one of the things we had focused on in simulator testing – once and engine was confirmed shutdown, make sure the other engines are running normally; the failure can be solved later.

Watching the trajectory, I saw they were low – potentially a larger problem – and advised, “Hank, Capcom. You're flying low: increase pitch to five point two five.”

“I see it,” Hank replied. “Working on it. I think I've got it.”

“Attitude better,” I said, watching the indicators, “But you're still a little low. Watch it – if you hit

apogee too soon, you won't make orbit." There were so many things that had to be balanced to reach orbital trajectory.

"I know, Dan." he said. "I'm working on it. I think I've got it positive ... now."

I watched the monitor for a moment before confirming. "One hundred seconds to MECO ... Mark." I watched the indicators as it counted down, then MECO was indicated. "Do you have tracking?" I asked quickly.

The technician delayed a moment, then said, "Still working on it."

Uncle Robert cut in, "Inertial indications positive, on orbital course."

I nodded. "Let's get some tracking." I said. "Icarus, we confirm MECO, systems appear nominal. Working on tracking now."

"I'm getting tracking information now," Travis, the technician, replied. "They're off course, but orbital trajectory."

"Alright" I said. Give it to me. Do you have a plot for burn for original course."

"One moment," he said, then "Here it is." I relayed the information to Icarus. It took two burns, and more than an hour, but they were finally in their intended orbit.

"Excellent job, everyone." I said. "Begin first day checkouts, and enjoy the ride."

"We're on it." Hank said, "You know, you really did design a monster."

"Try sitting on a firecracker sometime." Abby cut in. "Almost ready to land, by the way."

"Don't mind her," I said. "And she probably has, by the way."

First day routine focused mostly on basic systems checkouts, and everything appeared fine. I asked Susan how she liked orbit, and she told me to ask her again tomorrow.

"A bit spacesick, are you?" I asked.

"You could say that," she replied. "But worth it, for the view. Even if this doesn't go away."

"It will." I said.

“You sure?” she asked.

“Yes, I am.” I said, remembering my flight. It hadn't been bad, particularly, just persistent, popping into awareness at the most inconvenient places. And of course, even Uncle Robert had recovered. And she was right; the view was more than worth it.

I went through the checkouts with them, then asked Peter, “Is it all you've hoped for?” I remembered that he was a longtime space aficionado.

“It's so much better!” he exclaimed. “The view alone! And weightlessness – the books never said it was like this!”

“Well, enjoy it. You've earned it.” I said, thinking, we all have. “Susan, this is Capcom. Come in?”

“Susan here,” she said, clearly enthralled. “Dan, this is – how can I describe it? I've never seen anything like it – you're words couldn't do it justice. But then, who could? I'll get back to you, honey – I just can't miss the view. Is that South America?”

I smiled and let them enjoy the view. I listened for a few more minutes – long enough for Abby to come in – then passed capcom off to Uncle Robert. I had other things to do.

I called Dr Martin, my main contact over at NASA, and asked him if he had seen report of our launch. He said he had, and congratulate us on our achievement; he pointed out that, at this point, the six of us were eligible for astronaut wings.

“We know.” I said. “After this mission, all six of our trained space crew will have flown; we've elected to have one wings ceremony following the flight. But that – besides your view of todays launch – is not why I'm calling.”

“You're launch was impressive, as are all space launches,” he admitted. “To build a spacecraft to reach orbit, and return safely, is no small accomplishment. But as you say, that is not why you called. What, then do you want to ask NASA?”

“I simply wish to remind them of my standing offer to provide transport to Hubble for the final

servicing mission." I said, most matter of factly. And something else, I had only recently thought to threaten – except, I do not make threats, I only state facts. "And beyond that, I wanted to inform NASA that, regardless of their confidence in our abilities, we intend to make our next flight to Hubble, including a spacewalk to this historic spacecraft, regardless of their decision."

"NASA would remind you that the Hubble Space Telescope is United States Government Property," Dr Martin reminded me, "And unauthorized approach would constitute trespassing on said property."

"Trespassing laws envisioning property on terrestrial surface. Let alone the public affairs implications of prosecution of such a case." I said. This was an angle that I, inspired partly by Abby's aggressive ways, had recently begun to consider. We could now reach orbit, previously NASA and a couple of other government's exclusive preserve, and it was time for a little arm twisting. "Does NASA really want to be in the position of bringing charges against the builders of the first successful commercial spacecraft – builders more than interested in working with NASA on future developments, mind you – for such a minor orbital exercise?"

"NASA has severe concerns about safety of such a mission," he repeated the official line, "and would certainly hope you don't intend to push legal boundaries. After all, you publicly admit that two of the four engines on your initial flight failed to complete their firing."

"Legal boundaries are nothing to us," I said, "when they stand in the way of crucial progress. And we have now safely reached orbit on two occasions. We also demonstrated that Icarus is a suitable platform for EVA. As far as flight safety, we have now demonstrated twice that the Icarus can reach a safe, designated orbit; our continued operations on this flight will demonstrate our ability to change orbits precisely and efficiently. As emergency precaution on reentry, I would like to point out that NASA's plan already envisions launching a rescue mission with a second shuttle: an admittedly daunting – and risky – maneuver. Even assuming our flight poses more problems than NASA is comfortable with – how much easier would it be to launch a rescue mission without also supporting

two shuttles."

"Now you sound like you're trying to sell us on rescuing you." he said.

"I only want to point out that NASA has never supported two shuttles in simultaneous flight." I said. "We have all abort scenarios ready, and available for NASA approval. The worst case scenario would be a single shuttle flight for crew rescue – without the burden of also supporting a stranded vessel. It's a win-win for NASA; we're the ones taking the risk."

He paused, and sounded like he might be considering it. "I'll run it by the NASA administrator," he finally said. "The top of the agency. But I can't guarantee you anything; flight crew safety is our number one priority."

"Just get me a meeting with him," I said, "And I'll do the rest."

Less than an hour later, I received a call. Mike Griffith, head of NASA, wanted to meet with me "As soon as possible," regarding our venture into commercial spaceflight. I told him – or the receptionist on the phone – that I could fly out to Canaveral immediately, and meet them first thing in the morning, and they were agreeable. Almost immediately, I began checking out the Baron, and relayed NASA my takeoff time. Checking my flightplan, I could easily make it on one tank of fuel; as soon as I received special confirmation of permission to land and KSC, I filed my flight plan, and took off a few minutes later. I watched the lights of East Texas and the gulf coast fade away. I was following an instrument flightplan, but as with Icarus Project guidelines, was hand-flying the plane – anything to get more experience.

I was nervous with excitement: I was to meet with the head of NASA. Finally, I might have gotten through. Of course, they could just be calling em in to tell me that spaceflight was their preserve, and we should just 'bugger off;' but face to face time was all I needed.

I watched the analog gauges of the Baron, focusing on keeping a precise flight path and altitude. In time, the west coast of Florida came into view and, crossing it, I radioed Canaveral.

"KSC, this is Icarus Project Baron, requesting approach clearance, per executive permission." I requested.

"This is Kennedy space center, please hold one moment." the controller responded, then "Could you please repeat your approach code." I did so, and he said, "Code acknowledged, verifying now." After another moment, the controller continued, "Code acknowledged and accepted. Please state aircraft type and cruise speed and await further instructions."

This had all been included in our earlier negotiations, of course, when we had received the code to begin with, but I forced myself to be patient. "Aircraft is type Beech Baron, currently cruising at .. 1-7-5 knots." The controller acknowledged and began to vector me in; out of the left window I could see the light of Orlando ahead. I reduced power and flew as directed.

I reported when the runway came in view, and then thought, the space shuttle lands here. I'm about to land on the very same runway. I followed the controllers instructions, and soon was set up on short final. Flaps to approach, gear down. Watch the runway. It was a clear night out, and though I was watching the glidescope for landing guidance, I could already see the full lights of the very long runway ahead. My nose was just a hair above the horizon, and I took one final check of my approach attitude, and confirmed when ATC requested. I watched the distance gauge, then extended flaps to full, and pulled the throttle back. "On final approach now." I announced. I was pitching up noticeably, but could still see the runway above the nose; less than a quarter mile, now, and the threshold was disappearing under the nose. I checked the glidescope and applied just a bit of rudder to compensate for a bit of drift, and one final check of instruments for landing status, and then, full cut on throttles, begin to flare, feel the increased lift, drag on wings, stall encroaching and the slightest tap as the landing gear touched down on the runway, full elevator as I applied full breaks, then release as speed decreased, and a coasting turn onto the taxiway.

On parking the Baron, I was shown to the VIP quarters as Kennedy, and warned not to leave until

summoned in the morning; I didn't The next morning I was brought to meet Mike Griffith, head of NASA, and his deputy administrator, Shana Dale. Mr Griffith said, “I understand you have a proposal for NASA.”

“I assume your deputies have briefed you properly, if not, the fault is on them.” I said. I had quickly learned one technique for dealing with bureaucrats: blame the subordinates. “I'm here to receive your response.”

Mr Griffith looked at me for a long moment, then at his deputy, then back at me. He finally said, “It seems that you have offered to provide transport for the upcoming Hubble Service Mission. And, it seems you have the vehicle to do it.”

“We've been up once,” I said, trying to point out that I had now been in space, and he had not, “And are on our second test flight now. As long as things go well, we're ready to launch to Hubble on our next flight.” Then pointed out several of the advantages for NASA to him.

“I see.” he said, and further questioned me, going over many of the same issues I had gone over repeatedly with his subordinates. In fact, I was impressed with his knowledge, and was patient with his questions. “What, then, do you ask for this. Speaking hypothetically, of course.”

This was something I hadn't been asked – but something I had thought about, and thought about more on the flight east. “Flight costs first, of course,” I said, and stated the fee, including the cost of hydrogen, oxygen, and other consumables, various other costs, and of course a modest profit margin, as well. “And – when NASA is done, we'd like to take possession of the telescope.”

The last I has only conceived recently, and spoken of with none, but thought it could be quite profitable – and a sure way to keep the 'scope in operation for an extended period. Mr Griffith asked for clarification, and I provided it. “Once NASA has completed it's operations with the telescope, we would take possession and control of it. We'll take full responsibility, the same as any other private satellite; all we ask of NASA is the necessary support, information on design and operation of the

telescope. This would allow NASA to focus on continuing to advance space science with the James Webb telescope, while we can make the capabilities of the Hubble available to a wider and winder audience."

"And what would you gain from this?" he asked.

"Well, I assume you've seen our reports," I said., "I have high hopes for the future space exploration can bring to mankind. The same goes with here. Of course, from a commercial standpoint, we know we will gain greatly. Leading a mission such as this can only increase our profile. And gaining Hubble when NASA is done will allow us to provide an immensely valuable service to the astronautical community."

"Even so," he said. "You're asking to risk American astronauts on a highly experimental spacecraft," and pointed out many other failings to our plan. To these, I pointed out that I had already flown on Icarus, and would not have done so if I did not believe her to be safe; and that all precautions would be taken into consideration.

In the end, he couldn't promise anything, but did express direct interest in our efforts. He offered to send an observer, from the astronaut corps, to see the rest of our flight and make recommendations. I accepted, and wound up waiting in Florida one extra day before flying back. After checking in with Mission control and Icarus, I spend the day touring Kennedy space center, and taking in all the finer points of NASA spaceflight.

I left the next morning, Astronaut Kevin Grant as a passenger. Full throttle I sped down the runway, then kept it's centerline as I ascended, before turning off to the west. We spoke about spaceflight on the flight back to Texas; Kevin had completed one spaceflight, considerably longer than mine, but had not done a spacewalk; he had served as pilot. We shared our memories of space, and spoke extensively of the difference in Project Icarus, and NASA's spaceflight. He was also an ex-Air Force pilot, and spoke of combat flights over Iraq; I was very interested to hear those tales, and told him so.

Soon enough, we landed in Texas, and as soon as I could secure the aircraft, I walked into our hanger, followed by Kevin. I pointed out the features of our control, commenting, “I know it's a lot less than you have, but we rely on the flight crew to monitor things very closely – the flight engineer has access to all data, and full abort authority.

I got on the radio, of course, and asked Hank and Susan how things were going up there. They gave me a good report, and I asked, "Susan, how about the space sickness?"

"I think it's gone," she said. "I guess when you're falling forever, you stop noticing after a while."

"And has the view gotten old?" I said.

"Not yet." she replied.

Kevin, the astronaut, asked if he could speak with them, and I gave him a mike. "Come in, Icarus? This is Kevin, a NASA astronaut, and on behalf of NASA, I'd like to congratulate you on your achievement."

"Thank you," Hank acknowledged.

"It's really something up there, isn't it?" he said, and Susan agreed. "Did I understand that you were a little bit spacesick earlier?"

"A little," she admitted. "But I'm over it now."

"When I went up, two years ago," he said. "I felt bad for the first four days. Not good for a pilot - and a bit embarrassing after ten years flying fighter jets. So remember, it gets the bet of us. But I'm sure you're busy up there, so I'll let you get back to work."

I got back on and checked on their status, the first days worth of checkout tests, making sure they were on track for the first orbital burn that night. "How was it talking to a real astronaut?" I asked, after going over everything else.

"Not as impressive as the view up here." Susan replied.

"I know what you mean," I said, "I'm less in awe than I might have been a few months ago. After

all, now we can count ourselves among them. Alright, I'm giving you back to Abby now; keep up the good work up there."

After that, I showed Kevin around the hangars, our offices and fabrication facilities first, then the large hangar that housed Icarus between flights. I finished by showing him into the simulator. "Not exactly the easiest way in." he commented, climbing down the ladder.

"No," I agreed, "but given the lifting body shape, it was the best place to put the hatch." I shrugged. "It's not bad once you get used to it." I pointed out the egress locker, right next to the door, with its insulating carpet to allow quick exits.

"It's pretty tight in here, too." he commented. "Not much bigger than the shuttle's flight deck, but it's all you've got."

"It's better in orbit," I said, "As I'm sure you know. But it's still tight. While we were up, my sister kept bumping into the walls doing backflips. It'll be tight with five, I'm sure, but manageable - it's big compared to Apollo, after all."

He nodded as he looked around. "Where do you eat?"

"In here," I said, knowing this would be one of NASAs concerns - loose food particles can make a real mess of controls, and they require food be kept on the Shuttle's mid-deck. "Very carefully. And we've picked our menu to take it into consideration; alot of the looser options you bring up on the shuttle, we've excluded."

He looked over the control panel a moment; we were now sitting in the pilot's seat, and he commented on how "cobbled together" everything looked; I admitted it did, but said it all worked. After we climbed out, I showed him around town a bit, then said he could stay at me and Susan's apartment while he was here, unless that conflicted with NASAs policy.

"Actually, that probably would." he said. "Favors from prospective contractors, or some such; I couldn't guess the actual rule."

I shrugged. "We're pretty informal around here," I said. "And anyway have never been able to draw a hard line between 'home' and 'Icarus.' But there is a motel in town. Now, you'll be staying to watch the rest of the flight operation?"

"Affirmative," he said, "And make a recommendation to NASA on the possibility of future cooperative operations."

I nodded, then made reservations for him at the motel in town; then we returned to control for Icarus' first orbital change.

Back in the Capcom seat, I began reading off data to Icarus. "You're currently in a circular orbit at 190 miles, ready to boost to a 250 mile circular, on same inclination. Hold for burn instructions."

"Acknowledged," Hank said. "That matches our data."

I watched my screen as the burn calculations came on the screen, explaining to Kevin, "We try to run everything from Icarus, but we've left most of the course-plotting to down here. The computer up there isn't that powerful, as such things go." The data starting coming on the screen, and I read it to the crew; Hank acknowledged each datum as he entered it into the computer. "Alright, Icarus, here's your burn info. Time to burn, 1-8-0 seconds ... mark. Burn times, 7-4 seconds, mark. Burn heading Prograde plus zero. Copy?"

"Acknowledged." Hank confirmed. "All data entered. Flight engineer reports OMS ready for firing, all systems secure. Attitude is set."

I glanced at the systems controller, who confirmed that everything was on track. "Control confirms, you look good for burn."

"Acknowledged," Hank replied. "We are going for burn." He gave counts every thirty seconds, and announced when he switched burn control to computer, then gave a ten second countdown before announcing, "OMS ignition positive." The two maneuvering engines burned, accelerating Icarus, to a slightly higher speed. The systems controller confirmed that both engines were operating properly, and

all other systems were nominal. Hank gave a countdown as the seventy second burn expired, then "OMS cutoff. Burn complete."

"That is confirmed," I said, looking at the systems station. "Estimate forty five minutes to second burn; confirming trajectory now." In a moment, the radar plot came on screen, along with information for the second burn. "Burn in forty three minutes. Trajectory looks good."

"Confirmed and acknowledged." Hank replied.

Peter came on suddenly. "I'm getting erratic readings on one electrical circuit. Power dropping now, I'm switching off of that circuit. Running tests now. Confirmed, main circuit C has lost power. Repeat, power loss on circuit C."

"Acknowledged, power loss of Circuit C." I read back, as I looked over at the systems console again.

"I see it," the technician reported. "I'm trying to isolate the cause now."

"What is it?" Kevin asked quietly, in a tone that said we were free to ignore him if we didn't have time to respond.

But I did have a moment, and it would give me a chance to order my thoughts. "Icarus has three duplicate power circuits for electrical power. She can operate normally on two; a few systems would have to be shutdown on one circuit. One has failed, we don't know why, yet."

"Are you going to abort?" he asked, and I knew what he, and NASA, would think.

"Don't know yet," I said. "We want to isolate the problem first. It may be something we can bring right back up. Even if not, Icarus can operate normally on two circuits; we envision emergency abort if we're down to one."

"And if they both fail?" he asked.

"We designed as many redundancies as we could, and still keep under weight. The maneuvering thrusters have their own battery and dedicated circuits for manual control, and the radio has a backup

battery, as well; they can deorbit without primary power."

"What about life support?" he asked.

"Also has a secondary battery." I said. "And the emergency system has a 24 hour tanked supply, with a separate vent, relying on tank pressure to ventilate the cabin. Enough for them to make it back." That system had been one of the things considered for elimination as a weight saving measure, but had been kept.

"Still," he said. "Failures have to be taken seriously. You have to think about an abort, at least."

"And we are." I said. "The final decision rests with Hank, as Captain. But we're still making that assessment." I turned back to the consoles. "Peter, anything?"

"Nothing yet." he said. "It may have been a failed relay, or something that got jostled loose during the burn."

"Recommendation?" I asked.

"I don't think it's a problem." he said.

"Understood." I said; I agreed with him. Kevin was right, but NASA didn't abort flights for every small failure, either. "Hank?"

"We'll continue the program." he said. "But we'll keep a close eye on it."

"Acknowledged, one moment." I said, checking with the rest of the controllers, all of whom agreed. "That's affirmative. But keep an eye on it over the second burn."

"Acknowledged. Icarus out." Hank said.

The second burn went off without a hitch, and once tracking confirmed their orbit, we closed the days activities and switched to night operations. Uncle Robert took over at capcom, and only the systems station remained manned, with the INCO console slaved to it.

But as the flight continued, problems continued to crop up. A relay on the starboard OMS engine failed on the second orbit change. Peter was able to bypass that, but other problems cropped up.

Another hydrogen peroxide tank sensor failed, and other problems cropped up. On the fourth day the main fan for the life support system failed; that was easily fixed from on board - all components of the system are accessible from the flight deck - but it was still one more thing. Through it all, though, all of us on the ground tried to sort through the problems, identifying the causes of several, and pinning down several more. Peter worked busily as well, pinning down the failures and monitoring all the other systems, keeping them functioning. And I did my best to coordinate it all, piping information up to Icarus, and between controllers - and making sure that none of the problems threatened the crew.

For all the problems we'd been having, we half expected bad weather on the landing day, but it was clear. The deorbit burn went as planned, and Icarus descended into the atmosphere, and into blackout. I nervously watched the radar track on one of the big screens, and the timer, as Icarus became a giant fireball as she braked through the atmosphere.

But when they had resumed contact, Susan immediately reported, "APU 2 has failed; hydraulic pressure is dropping. We may have a leak, Peter is trying to isolate."

I immediately looked over at the systems panel, which was showing the dropping hydraulic pressure. If it kept dropping, they would lose control in about two minutes, well short of landing. "Peter, what do you have?"

"I'm not sure," he said, "All valves on the failed unit show closed - I'm re-trying them now."

"Hank - control status?" I requested, knowing that the controls would quickly become sloppy as pressure dropped.

"I've got it, for now," he replied. "But I'm starting to feel the loss of pressure."

"I'm resetting a couple of valves," Peter said. "Wait, that might have it. Pressure stabilized, rising. I've set 1 and 3 to high, rebuilding pressure. I breathed a sigh of relief as Icarus made contact with the tower, and completed an otherwise excellent landing.

Following the previous flight, we had decided Icarus would be towed off the runway immediately,

and I authorized the tow vehicle to approach and hookup, and the airport was open a few minutes later. It was still some time before the crew emerged and returned to the hanger; when they did, I asked Susan what had happened.

"About a minute before we came out of blackout, the engine overreved and blew - but Peter had already reported a drop in hydraulic pressure. He thinks something may have interrupted the flow, and the engine failed as a result."

"And you're alright?" I asked.

"We're all fine," she said. "It was just tense for a moment."

I flew Kevin back to Kennedy the following day; during the flight, I asked him what he thought about our operation.

"Well, it's not quite like NASA does it," he said. "But you get the job done, and you're quite efficient at it. I can't fault your concern for the crew, either. While NASA might have aborted earlier, I never felt like you were pushing the schedule to complete flight objectives."

"I know the Icarus very well, and we've gone over many of the failure scenarios personally." I said. What I didn't add was that we also expected some failures, given that these were test flights. "What will you recommend?"

"That NASA should consider joint operations, and other coordination." he said. "But I can't promise that they'll listen to me, and I can't say how soon they'll be interested."

"That's no more than I expect." I said. "Would you fly aboard Icarus?"

Kevin thought a moment, then said, "Yea, I would. Having seen the effort you've put into it, and you put in to flight."

"Thanks for your vote of confidence." I said.

When I returned to Texas, the process of pinning down and tracing malfunctions began. It appeared Peter had been exactly right on the APU failure; once the turbine load dropped off, the engine

overreved and blew. The continued loss of pressure was a larger concern; we were quickly able to track the point of loss to a valve that had failed to close completely; re-cycling the valve had fixed the problem, but would it happen again - and would it fail to close for good the next time?

Other problems traced to failed relays, burned out components. We replaced them; the larger concern was why so many malfunctions had occurred on this flight. More system inspections were necessary, complicated in some places by difficulty accessing components.

And the engine failure on launch was a larger concern; also, two other engines had shown erratic readings, though peter had been able to bring them under control. Once again, all engines were removed and partially disassembled, and many twenty hour days followed.

And we remained in touch with NASA. After consideration, and based on Kevin's recommendations, they invited us to Kennedy to discuss "Possible cooperative efforts and public-private partnerships. Susan and I went, flying first to Leesburg to pick up Troy, then down to Florida.

Once again, we met with Mike Griffith, head of NASA, as well as the Head of Contracting for the department. Mr Griffith began, explaining that "NASA is eager to work with private enterprise to further the nation's space agenda; we have several programs in place to promote such partnerships, and seek opportunities; some of which, I would note, you would have been eligible for during your development process."

I was aware of some of these programs, but had as one of my objectives had been to demonstrate what private enterprise could do; besides such collaboration was apt to bring government oversight and regulation, which was apt to cost as much as we might receive in grants. We built Icarus to the highest standard, of course, but NASA would never have gone for diesel powered APUs. But I judged better than to tell a government bureaucrat that you've got a problem with how he does things, so I continued to listen.

He continued, "Now you have accomplished what we hoped to see out of such partnerships, you

have successfully reached orbit, and demonstrated your ability to work and maneuver in space. My reports from Kevin Grant, who observed your recent mission, are positive. The short of it is that we are willing to consider coordinated or joint operations. However, we are as yet unsure of where such missions might be. Our main need for manned spaceflight is crew transport to the International Space Station. That, however, requires transport of at least three crew members; your specifications for Icarus indicate that it can accommodate two, at max, with an operating crew of three."

"That's right," I affirmed, launching into a brief discussion of the lift capabilities of the Icarus spacecraft. "Demonstration of technology was something we felt to be of a high priority; and payload capability was established very early in the design cycle. One of the missions we did envision, however, was the satellite repair role originally envisioned for the Shuttle."

"Unfortunately, we don't have any such missions on the plate at this time." Mr Griffith said. "Most satellites are not designed for in flight servicing, and remaining shuttle flights are reserved for space station construction."

"There's the Hubble flight." I said. "As I pointed out, we would be ready to provide transport to the telescope for the final servicing mission."

"Yes, well," he paused. "The Hubble poses several ... issues. To begin, that mission is already well in advanced preparation stages; we're ready to launch Atlantis to Hubble in August. Second, and more importantly, while we are eager to find ways to work together with the Icarus project, including possibly lifting NASA astronauts, we do have concerns. While our observer was impressed with your recent spaceflight, we have concerns, particularly with the number of failures you had during the mission."

"Icarus is an experimental spacecraft, which has just completed it's second flight," I said. "I believe Columbia had it's share of issues during initial test flights. One of which, I believe, would have caused an abort - and loss of vehicle - had controllers realized it's severity at the time. And shuttle missions

continue to have their share of malfunctions and problems."

"That is true," he admitted, "But is also part of the problem. Icarus requires additional testing, and that could easily push a Hubble servicing flight beyond the acceptable window. The same would go for an abort or other mission-ending event on an Icarus-based flight."

"The same would go for a shuttle flight," I said. "Which brings up another advantage of using Icarus to reach Hubble: if there is a problem, either in the early stages of flight, it would be relatively easy for NASA to reinstate the shuttle mission - or stage a rescue. If anything goes wrong on the planned flight, NASA would have to cancel the Hubble mission completely."

"You say that like preparing the shuttle for launch is the work of a day." he said. "But it's a several month process from planning to launch; final vehicle prep is several weeks."

"But that's my point," I said. "You can have Atlantis - or Discover or Endevour - preparing for launch on the next shuttle flight. If there is a problem with Icarus, it could be rescheduled to a Hubble launch within a month or so. If there is a problem on orbit, it would be much easier to prepare for a rescue mission than the currently envisioned 'emergency' launch."

"Perhaps," he admitted. "But the fact remains that we don't feel Icarus is ready for such a mission, and requires more test flights, and will not be ready for such a mission."

"We don't," I said. "While we're still reviewing data from the previous flight - and of course undertaking round-the-clock assessments of the condition of the spacecraft - we believe Icarus is ready for working flights. We'd like the first to be at the behalf of NASA; but we're sure we can find other interested parties. In addition, unless we find a more interesting destination, our next flight will, very likely, be towards the Hubble Space Telescope."

“As you were told before,” he replied, “That could be construed as trespassing on government property.”

I shook my head. “You wouldn't want to bad publicity of such a prosecution,” I said. “And we

would – of course – be careful. The Hubble is an invaluable scientific instrument; we don't want to damage it. But as far as Icarus as an experimental vehicle – and like the Shuttle, Icarus is still an experimental vehicle – our next logical mission objective will be an orbital rendezvous." Here I aimed my main argument, thought. "We've demonstrated we can reach orbit and return safely; and you've already indicated an interest in contracting with us. We're offering you the perfect opportunity to do so. This mission – this opportunity – is all upside for both of us. Yes, for us it's an opportunity to work with the world leader in space exploration, and to further refine our techniques and procedures. For you, it offers a safer alternative, with more ready backup option, than a shuttle mission."

There were other arguments, of course. NASA argued that it the servicing mission was too far along in planning. I pointed out that we had planned our missions in a matter of months, with "years of long term planning as guidance," and that most existing elements of the mission plan could be used – transfer two crew from the planned mission to Icarus, reassign the rest of the crew to an ISS mission. "Repair procedures would be essentially the same, only the schedule would have to be rearranged." But repeatedly I pointed out the advantages of the mission, for both parties, and NASA had shown that they wanted to work with us; I was able to use that to force their hand. In the end, the agreed in principal to such a mission.

After that, it was a matter of working out details; some now, some over the next month. Now the Contracting director came into play. Money wasn't the issue; Griffith admitted that, if this worked out, it would prove a great savings, and a first step on a promising path. But transfer of the Hubble to the Icarus Project was much more problematic. Government regulations closely regulated transfer of functional equipment and property to private citizens, and made no provision for spaceborne equipment.

That wall once again. There wasn't a regulation for it, so it just couldn't be done. Well, the way to deal with bureaucrats is persistence – and bulldozers are often handy, as well. I reminded NASA that

our request was that such transfer only occur once NASA was otherwise ready to decommission the Hubble, and that the Hubble would remain in space. “It's not like we could turn around and sell it to the Chinese.”

“No,” he said, “But you could transfer control, and the technical knowledge of the telescope and its operation.”

“And US based companies are quite eligible for such contracts, and such clearances,” I said. “We're willing to undertake all that.”

“Why are you so interested in this?” Griffith asked.

“The same reason we built Icarus, to advance human spaceflight.” I explained. “The Hubble is a remarkable instrument, and despite the pending deployment of the next generation of equipment, we believe Hubble can still do a great deal of important science. We simply don't think it's really ready to be dumped into the ocean.”

“I applaud your sentiment,” he said, “And your persistence; clearly one of the reasons you've gotten so far. Alright,” now he glanced at the contracting director, “No guarantees, but we'll see what we can do. If we can make it work, it could also benefit both of it.”

We spent three days in Florida, consulting with NASA officials on several levels, from the administrators who would oversee NASAs portion of the mission, to the technicians and controllers who would be in support. A number of details were worked out, though many questions were left open.

We spoke about them on the flight back up to Virginia, our own concerns whether Icarus was up for the mission. Chief among them was the equipment Icarus would have to carry, the fresh components to be installed in the telescope.

“You did a good job pushing this,” Troy said, “But aren't there some technical questions on our end that need to be addressed?”

“I was thinking about cargo space,” Susan said. “I hadn't realized the number of parts we would have to carry up to Hubble; Icarus doesn't have any cargo capacity at all. And that plus a five person crew. Add to that supplies for a maximum-endurance mission. It's not going to be easy to make it all fit.”

“Not to mention we can't exactly back out now.” Troy said. “NASA is impressed with us now, but they won't be if we turn around and say we can't actually do it.”

“No, it won't be easy,” I admitted, “And I don't like overselling Icarus.” In truth I had given little thought to the technical requirements of the flight, except reaching orbit. “But it's a risk we have to take. We may have to push things to make it all work, but we will do it. Besides, this actually gives us a little longer before we have to launch again – we've got at least three months.”

The six of us who had flown in space were now eligible for astronaut wings. Abby, Uncle Robert and I had been eligible since our first spaceflight, but I had decided to wait until we all had been up, and we had arranged a large ceremony. It was with the cooperation of the FAA, but we were responsible for the ceremony and press conference following. I had initially planned a relatively small even, but had been contacted by several VIPs, including congressmen, and I saw it as an excellent chance to take advantage of our currently high profile, and make some very valuable contacts. The final plan called for a press conference, awarding of the wings, followed by a large reception.

The day after we arrived, Abby, Hank, Uncle Robert and Peter flew up in the Learjet for the ceremony; they gave me a quick briefing on the progress of the work. The ceremony was the next day.

It was our first really large press conference, and in truth I was a little nervous. But I spoke of humanity reaching for the stars, and quoted John F Kennedy, “Who sent us to the moon with the words 'We do these things, not because they are easy, but because they are hard.' And so it is with us. It is a challenge, a challenge to us, and a challenge to humanity. A challenge which will allow us to grow, to become more. We must push ourselves, or we become lazy, we must try and grow, or we shall quickly

diminish to nothing." I took a number of questions, but once again it was Abby who was the real star of the press conference, enthralling reporters with tales of the exhilaration of launch, being at the controls of a rocket, precise moves to reach space, always an instant away from losing control; and of the serene vastness of looking off into space, and back at "this precious Earth."

Afterwards came the ceremony; at our request, Kevin Grant, the astronaut who had observed part of our previous mission, would award the pins. NASA had objected when I first made the request, on the grounds of Federal Rules regarding activities of federal employees and any action where the government "could appear to be granting special recognition," but had quickly been persuaded; for myself, I felt it fitting that the wings be given by someone who already had them.

I wanted for all of us to receive the wings at the same ceremony, to signify that all of us had equally earned them; but of course, the actual awards would be given one at a time, and I elected to have it done in order of mission-crew – ie first mission, Captain-First Officer-Flight Engineer, second mission. Same order. Abby pointed out that this meant I would still be receiving my wings first, and I said nothing.

The actual ceremony went quickly, with Troy acting as narrator and explaining to the press why we were doing it this way, and what each of our roles had been. Afterwards, we began the reception. We had worn our flight uniforms, now decorated with our wings, and we headed into the reception, followed by the invited guests.

Abby led into the room and quickly began to circulate, reveling in the attention, and showing off her flight suit and astronaut wings. I went much more nervously – I don't generally like crowds – but there were people here I wanted to talk to. A handful of Congressmen were here, eager to be seen as part of "the next big thing" in technology – and Republicans wanting to promote private enterprise in place of "bloated bureaucracy." I didn't share their disdain of NASA, but did believe in the power of private enterprise; and I wanted to see what some of them felt about Icarus.

I spoke with one conservative representative from out west, who was very impressed with our efforts, especially pointing out “How much less you've spent as opposed to those boys over at NASA.”

“Well,” I said, “We've got a long way to go.”

“Still, two spaceflights in a month. That's a lot closer to routine that NASA manages.” he said. “They said they would do that with the Space Shuttle, but that never worked out”

“The shuttle remains an experimental vehicle,” I said. “As does Icarus.”

“Nevertheless,” he said.”I certainly hope you're trying to do more than that. I understand you've been having discussions with NASA?”

“Yes, we've discussed several ... joint missions.” I said. I wanted to be careful here, NASA had not been ready to publicize their consideration of using Icarus for the Hubble servicing mission, and I hadn't said anything about it at the press conference earlier. “Things are still in the planning stage, of course.”

“Yes, well, I would hope they do more than talk about it.” he said. “It could save this country a good deal of money.”

“It could,” I said, but this was the opportunity was looking for. “But of course, NASA being what they are, some 'guidance' from Congress might be helpful?”

“What exactly do you mean?” he asked.

“Only this,” I explained. “Congress has already directed NASA to engage in cooperative efforts with private ventures. Continued support – perhaps with words of Congressional support for our efforts could do a great deal to help our cause.”

“Are you saying they're being bureaucratic?” he asked.

“No more than most federal agencies,” I said, “And we are working on several possible joint efforts. But clear direction from congress could also smooth the way. Also, another question is technology; Icarus has made the most of publicly available information,” well, not all of it exactly public

information, but close enough, “But NASA has been working on spaceflight for upwards of fifty years. Icarus could profit greatly from access to some of their newest insights in materials technology, propulsion, and other things.” That was one of the other things I'd discussed with NASA, and they'd been open to that as well – in some ways more open that to a Hubble mission. But government regulations restricting much of that information were clear. And the congressmen pointed that out to me. “We're all US citizens,” I pointed out, “And willing to undergo background checks, the same as any other private sector employee with a need to access that information.

“I'll see what I can do,” he said. “But don't worry, I'm very interested in the success of your project, and I know several others who are, as well.”

Another I spoke with was the congressman who represented the area of Texas around San Antonio, including Domingo. He was a Democrat, and mostly interested in what we could bring to his district.

“It's wonderful what you've done for the region,” he said. “That airport has been something of a ... problem for several years. There just isn't the business around to support it, and it's in too good shape to simply abandon. You know the air force made some major upgrades not long before they abandoned the base?”

“I was aware of that,” I said. “And we greatly appreciate the quality of the facility; Icarus requires a good condition runway, and a large hangar.”

“But tell me, you do plan to stay in Domingo after your initial test flights?” he said. “You did make a point of mentioning that the Icarus is only a prototype, experimental spacecraft. I hope you're not thinking about moving elsewhere before continuing flights, like that brand new spaceport they're building up in New Mexico?”

“We don't know, for certain,” I said. “For the time being, we have no plans to move. Icarus is an experimental prototype, but we hope to make several additional test flights out of Domingo. Longer than that is, I will admit, a little more open – we will consider all possible launch sites. As our

requirements evolve, we will likely require more specific support infrastructure – and a longer runway. Domingo Regional Airport will retain compelling advantages, of course – the New Mexico site is somewhat more problematic for orbital flights, as much of the launch trajectory comes over the continental United States; but with other purpose-built spaceports on the horizon, we will have to keep our options open."

"Well, I hope you don't wind up having to leave Domingo because of inadequate facilities," he said, "Especially when you've found them superior, so far."

"I hope we don't." I agreed. "It's just a question of whether the airport is able to grow along with us."

"Well that," he said, "Is something you shouldn't have to worry about. Keep me posted – along with local authorities, and airport management, and I'll see what I can do. Here, this is my private office number; it'll get you by some of my assistants." This was the first direct, clear contact I had received, and I knew it was a big privilege, this entree into a congressman's inner circle. But there was always a quid-pro-quo, and though I disdained the game, sometimes it had to be played – and his seat wasn't the most secure in the state.

"Thank you," I said, knowing this was the most delicate of times in cultivating a contact. "But what about you and your campaign? We're not in a position to offer direct support, but perhaps we can offer help in other ways?" I quietly nudged him towards the front of the hall, where much of the press was concentrated. "It could only help you to be visibly associated with us in our moment of success?"

"Of course," he said.

"And if you would like to come and tour our facility, I'm sure that could also be arranged." I offered, "With a suitable contingent of press nearby, of course." He liked that offer even more.

I made several other contacts, not so close as this one, but promising, before the reception broke up. We flew back to Texas in both aircraft the next day, and began the process of finishing repairs on

Icarus, and planning for a mission to Hubble.

"So, where do we stand on the work?" I asked the group, a few days later.

"We're zeroing in on the system failures." Peter said. "Most of them have proven to be minor things – burned out relays and the like, though a few things still elude us. The bigger concern, of course, is the sheer number of problems."

"Do some of them seem to be related?" I asked.

"A few," he replied. "A couple of things clearly trace to the loss of power on circuit C; and there are some maybes. But some others seem to have been independent failures; were checking over some of the other electronics to see if there are any other problems that didn't turn into failures."

"What about the fuel cells?" I asked. "Susan?"

"They still dropped off more than they should have," she said. "Even considering the revised data from your flight. It wasn't a problem on this flight, but it's going to get worse on longer missions. For the Hubble flight, it shouldn't a problem as long as the flight remains within the planned time. If we have to stretch it while waiting for a rescue flight, though, it could become a problem."

"We'll have to work out a power-saving protocol, in case it becomes necessary." I said. "What about the fuel cells themselves – is there any way to fix the problem?"

"If we redesigned the cells from scratch, most of the power issues would go away." she said. "I already see a number of places to make improvements, mistakes I made. We'd probably drop a couple hundred pounds as well. But designing and testing a new set of cells would take time."

I nodded. "We want to avid that, if we can. Maybe you can mitigate the problem, even on a temporary basis?"

She nodded. "There are couple of things I could try, but they may or may not work."

"See what you can do." I said. "What about the engines?"

"They're all out." Uncle Robert reported. "We've pinned the failure on number one to the oxygen

turbopump; the automatic cutoff got it before any more damage was done. The pump will have to be replaced, but the rest of the engine appears fine; still zeroing in on the exact cause. And we're inspecting the other engines as well."

"Good." I said. "Make sure there isn't any unnoticed damage. We don't want an avoidable problem with NASA watching. What about the APU that failed?"

"Definitely a turbine problem," Hank said. "Once the fluid flow was interrupted, resistance on the pump dropped to nothing, and the engine blew within seconds. A rev limiter would have prevented the problem, but I'm not sure the turbine could have been restarted."

"Might be worth installing them anyway." I said. "What caused the loss of pressure?"

"Don't know; the engine failure shook things up back there. Could have been a transient blockage. I'm already looking into the limiters." he said. "I've been checking the numbers from the diesels themselves; and they're working even better than we expected. They're rugged little things."

"Alright, it sounds like were making progress. Let's get Icarus flight-ready again." I said. "What about the Hubble mission. Now NASA has sent us several packets on mission requirements – how does it look?"

"Well," Uncle Robert said. "You've been doing the orbit calculation, but it's a bit of a higher-energy orbit we have to reach. On top of that, we'll really be pushing weight. The numbers aren't complete yet, but we may wind up going over."

"Beyond that," Peter pointed out, "Where are we going to put all the stuff that needs to be brought up – or do you want to just stuff it in the cabin, like an overloaded car?" I laughed at that image; remembering other students filling their cars to go home at the end of the semester; I'd always just been able to load up the bed of my truck.

"That cabin is pretty tight with three." Abby pointed out, "It'll be worse with five, and for longer. And the airlock is tight enough, whens suiting up; we might be able to fit the stuff in there, but it'll be a

squeeze once the astronauts go in to suit up."

I nodded. "Weight will be the first issue. We can't remove backup systems, and we've had too many failures to carelessly remove extra weight. Still – is there anything else we could remove?"

Everyone thought for a moment, then Uncle Robert shook his head. "I don't think so, not if we still want some margin of safety. We might be able to remove some of the emergency systems – the emergency oxygen system comes to mind, those air tanks are heavy – but we'll really miss them if we need them."

"Well, we told NASA we could do it," I said, "Now we just have to figure out how."

A couple of days later, some NASA officials came out, two mission managers and several engineers, to observe our operation, and the Icarus spacecraft. Nothing was finalized, as yet, but the great inertia of NASA was beginning to lean that way.

But the culture clash was evident. The two mission managers couldn't believe we operated Icarus with just six controllers – I pointed out that many of those functions were taken by the flight engineer, right on the spacecraft.

"And what about a flight director?" one manager asked. "I notice you have seats for Capcom and INCO, but nothing senior?"

"The captain on the flight has final authority, based on information from ground control and his flight engineer." I said. "We've tried to follow the air traffic model, with the pilot as final authority, rather than a mission control-centered system. On the ground, however, the Capcom also acts as coordinator for the ground control station."

"But psych profiles indicate the pilot – participant in the spaceflight, would be more hesitant to scrub – NASA prefers those decision be made on the ground, by people with a bit of separation from the – exhilaration of the mission."

"If anyone involved with spaceflight isn't exhilarated and excited with it, they should find another

business," I said. "And aren't your mission commanders entrusted with the split-second decisions that must be made, including launch aborts?" But the managers were still skeptical.

The engineers were even more skeptical as they examined the partly disassembled Icarus – especially when they saw the APUs. "Diesels?" One said, "You fly diesels?"

I shrugged. "They work," I said. "Although getting them to behave on an internal oxygen supply was a bit of a problem. We had a failure on our last mission, but it was a turbine problem and has been addressed; so it won't repeat. We didn't want to use hydrazine, because of it's toxicity and stability issues; any alternative fuel would have required custom-designed APUs. Diesels allowed us to adapt off the shelf units." I shrugged. "And we've tested everything."

The returned to Florida after a couple of days inspections, and we heard from NASA. They weren't exactly thrilled with their teams report – one engineer said something about the "duct tape and bailing wire" nature of Icarus – but despite great concerns, they did elect to proceed. It seemed that several members of congress were urging NASA to undertake a high-profile cooperative effort with us, and indicated that not doing so could jeopardize their funding. So I flew out to Florida, picking up Troy along the way, to negotiate our final deal.

When we got their, Director Griffith cut to it very quickly. "My managers and engineers have serious concerns about Icarus. However, congress seems to think it would be irresponsible to spend hundreds of millions to launch to Hubble, when you can apparently do so for much less. Even so, it poses a great deal of risk."

"There is always risk." I pointed out.

"Yes," he said, "Also something Congress does not always understand. And in the end, the risk may be worth it. Still, NASA will retain the authority to cancel the mission, of safety grounds, and you must understand that would probably be the end of the Hubble servicing mission; it would be difficult to reverse direction once again."

“Cancellation should be a mutual discussion,:” I said. “But those are all details to be worked out, and I assume that is what you brought us here for.”

“Yes,” he said, “Then let us begin.”

Negotiations took two and a half days. While we had already agreed in principal, the devil was, as always, in the details – and NASA being NASA, all details had to be explicitly enunciated.

The eventual transfer of the Hubble Telescope proved to be less of an obstacle in the negotiations – we would have to receive clearances anyway,. And congressional support always helps things. Besides, NASA would have the right to delay that, indefinitely, as long as they kept the telescope operational.

But the bigger sticking point was final authority over the mission. NASA was insistent on that, considering us contractors working on their project. But I pointed out that that was exactly what we are – contracted to provide a service, in this case, transportation to the Hubble. “We're the experts on Icarus, with all it's flaws; we're the ones to make the decisions on the spacecraft's operation. That means the Captain. The repair process itself is your responsibility, of course, NASA's to guide or abort; and of course we'll provide full updates to NASA mission control of the operation of the spacecraft. But the spacecraft is our job; the repairs are yours.”

They were stubborn, but so was I. But bureaucratic stubbornness can come from massive inertia, while I was right; and NASA's inertia was moving towards this mission. In the end, they had no choice but to agree. A deal was signed and publicly announced; when departed to return to Texas, two senior engineers accompanied me, as liaisons. NASA astronauts would be along as soon as they were assigned.

We quickly began working out the flight profile and plan, though we still had major uncertainties on how some things would be done. (We couldn't let NASA know just how unsure we actually were) and designated crew. I originally was going to assign our number 1 crew to the mission, Abby, myself, and

Uncle Robert; but Abby said that, with Icarus heavy, we needed our two best pilots on the flight.

"Trying to bump me from the mission, are you?" I asked.

"Not at all," she replied, though I knew she thought my ego got in the way sometimes – but so did hers. "I'll be on the mission regardless. But I think Hank is the better pilot, and he's also flown Icarus."

"If you go," I pointed out, "You'll still have the controls, and you're right, you are our best pilot."

I could tell from her face she beamed at that, but she brushed it off. "Better to have the two of us." she said. "Besides, you've said how important this mission is – at least as much as the first one. And we may need you on the ground to deal with NASA."

She was as persistent as I could be, and was probably right. Hank, however, still thought Icarus was a "beast," and said he'd prefer to let Abby captain the mission; Uncle Robert said he wasn't ready to go up again, just yet. I thought he'd been more bothered by zero-gee than he let on and said so; he said it was the small space of the cabin more than anything. "Leave spaceflight to you younger guys." he said. So the crews were set, Abby would be Captain, Hank First Officer, and Peter, Flight Engineer. The backup crew would be me as Captain, Susan and Uncle Robert. As soon as we had draft flight profiles, we began simulator sessions, focusing particularly on the precise launch and careful maneuvering necessary to rendezvous with the Hubble.

There were also other steps with working with NASA, particularly the long and complex process of receiving security clearances. I tried to deflect some of the more invasive personal questions, with some success – since NASA was now dependent on us to reach Hubble – and otherwise focused on helpfully providing the required information, demonstrating my loyalty, patriotism, and honesty.

And we continued to wrestle with the twin problems of weight reduction, and finding space for the replacement parts. (Peter suggested arranging an unmanned rocket launch with the equipment, but we didn't think NASA would go for that.)

Susan was working on the fuel cells, another problem. "I tried flushing them with a couple of

different solvents," she told me. "I've an idea where the problem is, and I was hoping I could clear some of the buildup, but the effect was minimal."

"What about reversing the process?" I suggested, "Running the fuel cells to electrolyze water."

She shook her head. "It's not a deposition from the main reaction, but more a degradation of the plate material. Besides, the cells aren't design to contain hydrogen generated that way." I knew what that would mean: they could explode.

"Where do they stand on consumption?" I asked. "If we have to extend flight to the maximum?"

"Close, very close," she said, "If they follow the previous mission rates. But I think they'll fall lower than that, and quickly begin to underpower."

"Well, keep on it." I said. "See what you can do."

A couple of days later, one of the NASA engineers mentioned to me that he understood we were having some problems with the fuel cells. "Just minor," I said. "Have you spoken to Susan about it?"

"She's the one who was telling me." he said.

"Then you know it's just a minor power dropoff." I said. "You're welcome to have a look at it. I believe Susan has a grasp of the problem, but fixing it without completely redesigning the unit is a separate problem."

"I'll see what we can do." he said.

But that brought a call from Adrian Watkins, the NASA manager who was directly overseeing NASA's part of the mission. "I received a report from one of our engineers," she said, coldly, "That you were reporting a problem with the fuel cells on Icarus."

"Yes," I said. "We did mention it to him. We were given to understand that you would be willing to offer assistance on technical issues."

"Assistance: yes," she said. "But a fuel cell problem is more than a minor issue. From what my engineer tells me, it sounds like a serious problem. Loss of power would jeopardize the mission."

“It is a power droppoff,” I said, “And we are working to resolve it. If we cannot, we are also working on contingency power saving plans for all scenarios, included a prolonged wait for rescue.” I didn't mention that the power savings would include such items as the microwave and most onboard lighting, and three of the five computer systems.

“What, exactly is the problem?” she said.

“We've just seen a power loss on both missions.” I said. “We don't want to redesign the cells, so we're trying to find a way to maintain output.”

“Redesigning the cells could severely delay the mission,” she said, and I agreed; that was why we were trying to make the existing cells work. “But it's against NASA policy to fly with such questionable systems.”

“The flight decision is not yours to make,” I pointed out, knowing I was on chancy ground here. “We're not going to launch unless we are completely comfortable with the safety of the ship and crew, but we comfortable with the existing fuel cells. We do, of course, welcome any assistance your engineering department can render.”

“I will review their reports, and I am keeping an eye on your operation.” she said. “Which brings me to something else – it would appear you have yet to indicate how you intend to transport the gyroscopes and instrumentation up to the Hubble; it leads me to wonder whether you are, in fact, capable of this mission.”

“We're getting that together, as well.” I said. “Our priority, as agreed initially, is to resolve the issues from the last flight.”

“Well I want to see those plans very shortly.” she said. “You are right, the mission is yours to fly, but it's up to me whether NASA is along when you do launch. If I'm not satisfied you're ready, I won't hesitate to pull the plug on our end.”

“I understand that.” I said, “And we'll keep you posted.”

A few minute later I spoke with Abby, Hank and and Uncle Robert, about the stowage problem. “NASA's starting to get on us about that, I'm not going to be able to stall them for long. What about weight?”

“We're over, but not by much.” Uncle Robert said. “I'm looking at anything that can be shifted, but there's not much I can lose. We could drop two of the emergency tanks, leaving a twelve hour emergency supply, instead of twenty four. That should still be enough for an emergency reentry – especially with options for Edwards and White Sands.”

“Maybe,” I said. “But remember, those figures are for a three man crew – it'll be quite a bit less with five.”

“I'm pretty sure we're not going to be able to store it in the cabin,” Abby said. “Even if NASA were to go along with it, there just isn't space. And you remember how tight the airlock is with the spacesuits off.”

I nodded. “Is there any way we could increase the size of the airlock storage locker?”

Hank shook his head. “That's the main equipment space behind there – its' packed tight. Same for the space behind the galley – life support – and cryogenics, and a few other things, behind the lavatory.”

“If you really want to talk about structural modifications, I was looking at some of the designs the other day,” Abby said, “Isn't their a gap in the aluminum frame a few feet behind the airlock?”

“There are several, all over the frame,” I confirmed. “It's not a solid shell, but has has gaps for lightness without sacrificing structural strength.”

“Of course, of course,” she said, almost dismissively. “The question is – what's right under that gap – is there any way we could put a small equipment bay in there?”

“That's mostly conduits,” Hank said. “Power lines, hydraulics, control lines. It's still pretty tight, though – there isn't a lot of space. Even if we could make room, it wouldn't be a small thing to move

things around. And we'd then have to configure some kind of bay doors – I'm not sure it could be done in a couple of months."

"Would we?" I asked, thinking. "Have to make doors, I mean? Most of that gap is covered by the radiator panels. If we kept a small equipment bay under there, we wouldn't have to have additional coverings at all – that's just a thin layer of composite under there, not heat shielding or structural."

"I'm still not sure we could make room," Hank said, "And even if we could, it wouldn't be a small project."

"Even so," I said. "It might be worth looking at. We've got to go somewhere with it, and we can't just tie it to the top.

NASAs astronauts arrived a few days later, along with a n engineer expert in fuel cells. The engineer went immediately to talk with Susan, and I spoke with the astronauts.

There were four NASA astronauts, two prime crew, and two backups. Clint Eastman, Astronomer, and Martin Crossman were the prime crew, and Harry Akira and Beatrice Jones were the backups. Clint and Martin had both flown before, and had participated in previous servicing missions.

"I'm honored to have you all," I said. "I'm sure this change of plan hasn't been easy for you; but we're working to make all aspects of the flight a success."

"It's more than not easy," Harry pointed out. "The original plan was to divide the spacewalks up among five of us, and we've been training accordingly. We've been cross-training in walks as it is, but five spacewalks on one mission is a lot."

"Don't worry, Harry, we'll make it work." Clint said, before turning to me, said, "But now it's up to you to get us there."

"Yes, well, first things first – I'm sure you'd like a look around?" I said. They agreed, and I led them first to Icarus "She's a bit ugly, and she flies like she looks, but she'll do the job. Come on up." I led them up the ladder, over the top, and down the hatch. Clint, like everyone who came on board Icarus,

made comments about access. I shrugged, saying “It's not to bad once you get used to it.”

“Where's the mid-deck?” Harry asked.

“There is none. Galley's on this side, lavatory on the other, and this here,” I said, tapping on the open airlock hatch frame, “Is the airlock.” I glanced inside; one technician was standing in the airlock, and had several panels open; I could see the edges of another's shirt, working deep in the equipment spaces.

“It looks ... almost like a cross between the shuttle and, I'm not sure, a DC-3.” Clint said, with a look at the instrument panel. Tapping on the edge of the single monitor, he asked, “Is this a TV screen?”

“Yep.” I confirmed. “We had to improvise on some of the controls, but we've focused on reliability above all. It's not exactly NASA's way to work, but older equipment can tend to be more reliable, which was our priority. Even so, we've included extra back up systems, just in case.”

“What about here?” Martin asked, stepping into the galley. “This almost looks like it could fit in on the shuttle. Except this? A Sharp microwave? - looks like it could be as old as the shuttle.”

“Oh, yes. We got that new at K-mart – thirty bucks.” I said, and a couple of them looked at me like I was joking. But I wasn't – it had been the cheapest one they had – no electronic controls, just the mechanical timer. “Seriously. Getting a microwave with space-qualified electronics is almost impossible – NASA orders most of that stuff custom. The best alternative we could find was to get a low end model with mechanical controls – it's not radiation sensitive at all. We just had to modify the power supply to run off DC.”

“I hope the rest of the ship isn't as improvised.” Clint said.

“As needed,” I shrugged. “As I said, we don't have quite the same set of contacts as NASA. But we tested everything doubly, as a result.”

After that, I gave them a tour of the rest of the facility, then we discussed plans from here until launch. They would travel between Kennedy and here; continuing training in the repair procedures

there, and flight procedures for Icarus here.

That night I spoke with Susan and the NASA engineer. “I agree with Susan's assessment that that existing cells would be adequate, even with the reported power drop,” he said, “But if they were on the shuttle, they wouldn't fly. I also agree with her assessment of the problem; NASA has encountered similar effects, though not on the same scale. A redesign of the cells should eliminate it, but there probably isn't time for that.”

“So what are you suggesting?” I asked.

“Well, it's up to you.” he said. “You could fly with them, and keep an eye on them, though I wouldn't advise it. But there may be another possibility.” I asked him what it was, and he continued, “Given the power, weight and size constraints, the Space Shuttles fuel cells could be used as replacements. The shuttles power requirement is much higher than yours, so that wouldn't be a problem, but the cells are slightly smaller, and much more efficient. Looking at your schematics, I'm fairly certain they could be installed with minimal work.”

“But would they be available?” I asked. I hadn't asked NASA for shuttle parts, and I didn't expect them to pull them from flight vehicles.

“There are several spare units ready and tested, both at Kennedy, and in the hands of contractors. NASA has spares for most systems on hand.” he said. “As to their availability, that's not up to me; but I will recommend that they be offered.”

“Thank you.” I said. The request caused a minor concern at NASA, and another round between me and the program manager, Ms Watkins, but was eventually approved – with the contingency that it would come out of our mission compensation. (It also caused a minor row between the NASA and the contractor responsible for the fuel cells, but that was – mostly – not our problem.) NASA soon sent the fuel cells, and several engineers to oversee their installation. This also caused some argument between the engineers and our technicians, but Hank resolved that.

Meanwhile, we'd concluded that the best solution for the replacement equipment was Abby's suggestion, to cut a small equipment bay just behind the airlock. This was also a major job, but one we felt comfortable with – it would affect neither the structural integrity of the craft, or its aerodynamics – and we agreed that we should have designed it in in the first place.

Through all that, we were busy running simulations. Both crews flew, and both repair teams, through all phases of flight.

One morning, my crew – the backup crew, was in the simulator, with the prime repair team, practicing launch procedures. This was mostly for our benefit, but it was important for both of them to be familiar with the ship and it's procedures. I was flying this run, carefully watching the controls and screen for flight cues, making fine adjustments as Susan switched the controls over to thrusters.

"Two minutes to MECO," Uncle Robert reported. "Engines on track." He paused. "Single engine press to MECO."

"Understood." I replied, and watched the screen indicator and inertial guidance. I barely looked out the screen; I hadn't spent much time with the simulator visuals, the simplest, four color representation of the Earth (Seas blue, Land orange, Space Black, Stars – and occasional surface features, white) and focused on keeping Icarus on course as we rapidly gained speed, watching for an engine failure the instant it might occur. Uncle Robert began counting down, and then "MECO. We have MECO, all engines showing shutdown."

"Confirmed," I said, checking my own panel. "Capcom, this is Icarus, we have MECO. Request tracking and OMS burn information."

"Icarus, tracking now." Susan said.

"It seems like you've got a lot of complex procedures, here." Clint said. I glanced back at him; it sounded like he had been waiting for a good moment to talk.

I shrugged. "We're doing a lot more manually," I said. "Minimize computer load, and reliability, as

I said earlier. Minimize risk in case of computer failure."

"Not to mention hand flying the ship." he said. "I don't think the shuttle can be hand-flown on launch." I motioned him to hold on, Susan was coming back on.

"Icarus, track confirmed and within parameters." she said. "Inclination is low by .12; calculating adjustment in first burn. Please wait for burn instructions; calculating now."

"Understood." I replied. After a moment, she gave first burn instructions – a single burn to place us in orbit; but she apologized, we'd have to wait to correct inclination. I read back the information to her, then updated the (simulated) NASA mission control in Houston. Then I turned back to Clint. "Hand flying Icarus, during atmospheric flight, was always a part of the plan. I didn't feel we had the computer capacity to react quickly enough for a digital autopilot, and I didn't feel like trying to program one, either."

"You programmed all of that, as well?" Clint asked, eye raised.

I nodded. "And the aerodynamic calculation we used for the design, and most of the simulator program itself." Tapping on the center console, just above the keyboard, I said, "I used to have this kind of computer when I was a kid; I grew up working it in basic, wanting more, I delved into assembly language. It came in handy here. But then, Icarus started out as sketches in my notebook, back in high school."

"I begin to understand how you've managed to accomplish all this." he said. "I've flown several times, but I'll admit to you what I'd never admit to my wife – I don't understand most of the systems on the shuttle. I'm an astronomer and an astrophysicist, not an engineer – nor a pilot. You seem to be all of those things."

"Well, some more than others." I admitted. "As far as pilots, you'll have your best we have with Abby – she was actually at the controls on our first mission. But thank you. Icarus has been a lot of work. Anyway, back to work. Susan?"

“Icarus,” she replied.

“Let's fast forward to the first burn,” I said. “Simulate short cycles on orbits; lets focus on burns this run.” I could have added 'exaggerated rates on failures' but didn't; that was standard operating procedure. Almost all of our simulated missions came to numerous failures. This one was no exception, as I counted down to OMS start “5 ... 4 ... 3 ... 2 ... 1 ... ignition” and nothing happened.

“Reading failure on OMS system,” Uncle Robert reported. “Total power loss.”

“Acknowledged,” I said, thinking quickly. We needed to raise our orbit somewhat, or we would reenter by perigee. “Configure for RCS positive translation burn, uh,” I thought again, relative thrust levels, plus orbital altitude and atmospheric thickness, running the calculations in my head and checking them, “six minutes.” At the same time I was changing the computer program and entering the required information. I paused, asking Susan, “How many seconds is that?”

“Three-sixty” she replied, after tapping out on the pocked calculator velcroed to the panel.

“I could do without the metric system for a good decimal system of time.” I said, as I finished entering the information into the computer. I had set a countdown of zero, so as my finger hovered over the <enter> key, I said, “Ignition, now” and pressed it. Then, I hit the comms, and said, “Susan, we have an OMS failure here, completing initial burn on RCS, 6 minutes.”

“We see that, Icarus,” She said. “Complete loss of power on OMS. Calculating burn now.” After another moment, she said, “Update burn time to four twenty seconds, that seven minutes, twenty seconds. That should put you close to required orbit.”

“Copy that, changing burn time.” I said, my fingers on the keyboard. When the burn was complete, I said, “Capcom, track us.” then turned to Uncle Robert and said, “What can you see on the OMS?”

“Nothing,” he said. “The whole system went dead as soon as it got the startup signal.”

I nodded, still thinking quickly. But this was a crucial point. The OMS could be out; physically we could continue the mission using RCS burns. They would be longer, and a little less efficient, but the

rear RCS used the same peroxide fuel as the OMS, so that wouldn't be a problem. But it would be one fewer safety factor, and the RCS was not designed for such long burns. If they failed, it could leave us unable to maneuver, waiting for the slight atmospheric drag at this altitude to slow us enough to reenter – or worse, unable to avoid colliding the the Hubble, if it occurred during rendezvous. Of course, this was only a simulation, but that was the point, to prepare us to make these decisions when we were doing the real thing.

"Capcom," I requested. "Time to next burn?"

"Still tracking," Susan said, then "We've got you. You're still a little low, short circularization burn on one orbit, about eighty-eight minutes."

"Copy that, one orbit." I said. "Do you see anything on the OMS?" A captain needs the information first to make the decision; but I thought it over; even if we aborted, it would still be several orbits before we could return to Texas, which would be time to identify the problem. But NASA had been clear – while the mission was our discretion, with five spacewalks, another one couldn't be added. "Robert, anything yet?"

"Negative," he replied. "I'm not reading anything at all on the OMS."

"Right." I said. We couldn't risk it on RCS only. "Capcom, give is the info for that circularization burn, then calculate the next available window for return. If we can't find the problem with the OMS by then, we'll abort and return."

"Copy that, understood, Icarus." Susan said. After a moment she gave me the burn information and the return window, and acknowledged, "Abort if failure not identified by window minus 1 hour." Uncle Robert then continued to find the problem, but after several minutes, Susan came back on and said, "Breaking the wall here," a reference to the fourth wall of theater, and a note to us that this was a simulation, not a mission comment. "The failure is a complete, irrecoverable failure of the OMS system. Do you want to skip to the abort point and run the landing."

“Sounds good.” I agreed, “Fourth wall repaired.” I turned to Clint and Marty in the back. “I guess this is it. OMS is out for the duration. Calling abort. Robert, prepare for reentry. Capcom, Icarus is aborting. Repeat, we are aborting.” I signaled the same to Houston, then began the process of bringing the ship back down. The window gave us a night landing – our FAA certificate was for day flight only, but we were allowed to make a night approach for a safety failure on orbit – and Domingo airport had almost no traffic late, anyway. Other than that, and a few tight moments as I killed speed late, and came in to steep, it was a routine simulated landing.

After we exited, we discussed the operation, and the abort. One of the NASA administrators asked if an OMS failure was likely, and I said “Should be about the same as on the shuttle. But I know you practice such scenarios as well. The larger question is, was I right to call abort? I had decided before Susan gave us the simulator update that, if the OMS couldn't be brought back online, we would abort. Was that the right decision?”

Abby, of course, thought we could have continued with the mission, but I reminded her of the risk of RCS failure – and the fact that her position as captain depended on everyones confidence she wouldn't be reckless with it. The rest of our people were divided; it was an open question how many prolonged burns the RCS system could withstand (ground level testing had given the RCS at least ten minutes on a sustained burn) and the NASA people – engineers and managers – thought I was right to abort.

I nodded, reminded people of the added risk of the night landing, and the fact that we could have extended the mission to continue to find the problem, and wait a few more orbits before aborting. Then I said. “Alright, that's it for that one. Let's go with prime flight crew, secondary specialist crew. After that, the secondary flight crew will head to Houston for NASA procedures training, focusing particularly on Hubble repair procedures, and our responsibilities during the spacewalks. Everyone understand?” When they nodded, I added, “Alright, good job this morning, everyone, lets get to it.”

Houston, where NASA astronauts undergo most of their training, is far enough from Domingo that

we usually stayed a few days. We received briefings from Hubble specialists and technicians on the operation of the telescope, and the upgrade and repair procedures for the mission; and we observed Harry and Beatrice practice the repair procedures in the Neutral Buoyancy Laboratory, the large swimming pool NASA uses to train in spacewalk procedures.

Our agreement gave us full authority over training and qualification of the Icarus's operating crew; nevertheless NASA pushed us to undergo certain portions of NASA training. For the most part, I resisted this; it was important to establish our independence of operation. However, I made sure to avail myself of the vast knowledge base NASA had, including the finer points of operating procedures.

As days went by, I spoke with Uncle Robert and Hank on the status of the repairs and modifications to Icarus. We were standing on top of the ship, next to the airlock hatch. There was a large opening cut in the composite paneling, with wires and pipelines exposed. “We've been able to reroute most of the lines and things, but will test everything – particularly hydraulic pressures and fluid flow, before we assemble the compartment; then we'll cut new composite panels around it.”

I nodded. “What about the fuel cells?” I asked.

“They're working better than expected,” he said. "Peter had a bit of a time adapting the connections and voltage outputs to our needs; NASA uses a much more consistent set of voltages than we were able to. But they've done something else – they're lighter, and more efficient, so we've been able to replace the supply tanks with smaller ones, as well. It pretty much takes care of the weight problem as well.”

“Excellent.” I said.

We continued flight training, Abby and her crew getting about two thirds of simulator time; and all six of us rotated trips to Houston, and less frequent flights to Canaveral, for operations briefings. One day, Ms Watkins, project manager for NASA, was onside, observing. Abby was in command with the prime crew; we threw multiple failures at her on launch, and additional problems after the first burn. Her decision to continue the flight was defensible, but borderline. At the completion of the simulation,

however, Ms Watkins told me she wanted to speak with me in private; we went into one of the offices.

"You're prime pilot's willingness to continue in questionable circumstances is starting to cause a significant degree of concern," she said. "And has led some of us to wonder if her assignment to the flight should be reconsidered."

"Abby is our best pilot," I said, "And if she is more than a little bold with the spacecraft, I would expect that is also true of most of your best astronauts."

"Which is one of the reasons we put finial mission authority in the hands of personnel on the ground." she said. "No one wants to call a flight abort, but it is a decision that must be made dispassionately."

"We've already discussed this," I said, "And we have chosen to give that authority to the Captain, and setup our operation accordingly. Additionally, our setup means the crew on board always has more information than those on the ground."

"Then perhaps she should be moved to the Pilot, that is First Officer's spot." she said, correcting herself; we insisted that Icarus designations be used for crew positions, instead of NASA equivalents. "You say she is the best pilot, and you admit Icarus is a handful to fly. That might be for the best."

"And it might not," I said. "The decision is mine to make, as agreed. Abby will command the mission as long as my group is confident in her performance – and we continue to be. Is there anything else?"

There wasn't, and I thanked her for her advice.

I'd had to defend my people; and I still felt comfortable with Abby's performance. However, I did think she was pushing it a little to far, and I spoke with her privately, after we debriefed, telling her I appreciated her desire to continue the mission if at all possible, but reminded her that the lives of the crew were her first priority.

"You brought me on to be bold, even reckless, when necessary," she said. "The things you didn't

think you could bring on to this project. That's exactly what I'm doing."

"Bold is one thing, and appreciated – and one of the reasons you're commanding this mission instead of myself." I said. "But bold is one thing, stupid is another. I expect you to bring Icarus back in one piece. One of the reasons for all this training is so you know what decisions to make when we do it for real."

"I'll be in command," she said, "And I'll fly Icarus the way I think it should be flown. And I will bring it back in one piece."

Preparations continued; the equipment bay was completed, and other adjustments and tests were completed. The mission was scheduled for early September; almost a month later than the originally planned shuttle flight; the added time had given us a little better ability to get everything on track. But launch day low overcast, as did the next two days.

The second evening, looking out at the sky with Abby, I said, "We're cutting it pretty close. If we can't launch tomorrow morning, we'll have to delay another week."

"We'll be ready to go in the morning." she said. And she was right; early morning weather reports showed the clouds had cleared. Icarus was rolled out before dawn, and the sun was just creeping over the horizon when the five crewmembers climbed in and secured the hatch. Prelaunch preparations proceeded as before, except additional radio checks were completed to NASA Control in Houston. Then, time precisely calculated to best catch Hubble's orbit, Abby began the countdown, and the four engines ignited, and Icarus rumbled down the runway, and lifted up into the sky, banking smoothly onto course.

Increased press attention to this flight had led me to assign Susan as Press Contact; she was now over at the main terminal, narrating the launch for the assembled press and cameras; I acted as Capcom and had a direct voice line with Susan, keeping her updated.

All went well as the Icarus climbed out of sight and into space; remembering earlier engine failures,

we crossed our fingers as the craft ascended, even as be busily monitored and supported the complex craft; there was an audible sigh of relief when all four engines were still running when MECO came.

But then, when Abby went to fire the OMS engines for orbital insertion, alarm lights went off, and Peter reported that he had lost power to the OMS engines. Abby quickly called for and RCS burn for orbital insertion; when it was complete and tracing confirmed, we quickly conferred with Peter. He didn't have any luck at first. Uncle Robert suggested depressurizing the peroxide feed which did nothing, and the technician at the systems station reported some erratic readings, but Peter had already seen them.

"Abby, what's the plan." I said. "It's up to you."

"Just give me the tracking information." she requested, and I did so, along with her first return window. "We'll continue once we get those boosters fixed. Peter?"

"Negative effect on hydroxide feeds," he said, audibly nervous; in fact, I thought Abby's voice had been as nervous as I'd ever heard. I was certainly nervous as I contacted NASA control and advised them of the situation, telling them the earliest possible window for a return, but that no decision had been made.

Then Peter continued, "The hydroxide system didn't even hiccup; there might be a problem with their power feed. Let me try resetting the system entirely. Shutting down, now." It would take a couple of minutes to completely cycle the system, and I certainly felt my heart beating hard before Peter announced he was bringing it back up. "Well, here goes. Powering OMS back up ... now." I held my breath, "And it looks like it's coming back up. OMS reading normal, pressures resetting." I breathed a sigh of relief, still watching the orbital track on the screen.

"Got the problem pinned down?" Abby requested.

"Not yet," Peter admitted. "I'll have to look at the recorded data; but the real test will be on the next burn, if the engines do the same thing."

“Got that, Capcom?” Abby said. When I acknowledged, she continued, “Get us the next burn data for Hubble rendezvous; we'll proceed to that point. Until then, Peter will review the OMS data to see if he can pin down the cause. Hank, would you please give Peter your seat?”

“Of course,” Hank said. “Unstrapping now.” The flight engineer's console didn't have an interface to the flight computer, and Peter was soon in the seat, calling up computer data. He didn't come up with anything conclusive, but saw some things that he thought suggested an isolated power aberration. “We'll have to see when we do the next burn”

That didn't come until the next day; so the crew unstrapped and enjoyed their first day in orbit, as they completed the process of securing Icarus.

We crossed our fingers the next day, as we prepared for the burn. Abby gave the countdown, and then, “Ignition. Confirmed, we have OMS ignition.” and I knew I wasn't the only one to breath relief there in control.

A total of four burns was necessary to reach the Hubble. Peter closely watched the OMS status during each burn, and we switched some data channels, normally used for launch information, to monitor them more closely from the ground.

When the last one was completed, already evening on the third day of the mission, I said, “You look good up there, orbit is on track. You should rendezvous with Icarus in twelve point five hours” They were slightly behind the Hubble, and would overtake it over the next several orbits. “Your trajectory on launch was excellent, Abby; four burns was the minimum we could have made intercept with. Off even a little bit, and we would have had to add at least another burn. Even NASA was impressed.”

“Well of course,” she said. “I told you I was your best pilot.”

“I never doubted it.” I replied. “How is it up there?”

“Tight.” she replied. “This thing is small with three people; with five there's barely room to leave our seats. Two weeks up here are going to get tight.”

“Remember, it's more than twice what Apollo astronauts had in the CM.” I pointed out.

“Yea, and they had the LM, too.” she said. “But it's good to be back up here.”

“I'm sure it is.” I said. “I want to review the plan for the next two days. Tomorrow, after breakfast, you'll rendezvous with Hubble, and make sure your orbits are exactly synchronized; after that you'll be stationkeeping until departure. The rest of the day will be spent preparing for the first spacewalk. The following day will be the first spacewalk, including securing Hubble to Icarus, and spacewalks will be every other day after that. Assuming everything goes to order, you'll deorbit two days after the last excursion.”

“I got it, Dan.” she said, “Remember, this is my mission.”

“I know,” I said, “Just making sure you're on track.”

Icarus picked Hubble up on radar before breakfast the next day; a couple of fine adjustments were needed and performed by the RCS thrusters – all routine.

Peter reported some erratic readings on a couple of other components, however, and continued to monitor them. Abby completed the final rendezvous maneuvering, using the RCS to precisely synchronize orbits; they were now just under 150 feet from the telescope. But as they went through all their checks, Peter reported that some relays seemed to be “acting up,” and they didn't respond when he tried to reset them. They were noncritical as they were, but did raise a bit of concern.

Clint got on the following morning and we went over the spacewalk procedure once again; he sounded anxious to get out, and when I asked his what he thought of Icarus, he said simply, “Small.” Then they were in the airlock to suit up.

The first walk was the most dangerous one, both by itself and because of divergence from NASA's original plan. As Icarus didn't have the remote arm of the Shuttle, Clint and Martin would have to fly out to the telescope, tether it to Icarus, and after Abby maneuvered closer, attach three booms. NASA hadn't liked the procedure, preferring work to be performed in the relative safety of the payload bay,

but Icarus didn't have that option. Further, they had to do so with the Gemini-style hand thrusters we used, NASA having decided back in the eighties that the MMU was too dangerous for practical use.

First, though, while Martin checked the equipment in the bay, Clint hooked on a long tether and maneuvered himself below Icarus, for the NASA mandated visual inspection of the heat shield. NASA had insisted on this, despite our authority over flight operations, because it would be a major factor in whether they would launch Endevour on a rescue mission. As soon as Clint reported that the shield appear "Intact and in excellent shape," NASA stood down the waiting shuttle; they would roll it back to the Vehicle Assembly Building as soon as we landed, and reconfigure it for the next ISS mission.

After that, Abby maneuvered closer to Hubble, and both Clint and Marty floated over to it, attaching the first tether. Once Abby was close enough, Martin returned to the equipment bay and pulled the first boom out. He locked it into place on a clamp that had been added at the same time as the equipment bay (and secured right to the aluminum shell), and extended it. A sensor gave Abby fine guidance to move closer, and Clint and Marty could adjust the Hubble's position to fit it on a clamp designed to be compatible with the end of the shuttle's arm, and able to carry the telescopes weight. In theory, it was simple, but in principal, it wasn't so easy.

"Not quite." Clint said, after the third attempt." We're within about two feet, but every thrust you make is too far."

"It's as fine as the thrusters can go." Abby said. "Are you ready for another pass?"

"We don't have enough play in the boom." he said. "Hold stationkeeping. I'm going to try and pull them together. Here goes." Hubble was heavy, and Icarus much heavier, but in space the tiny force of an astronauts pull can move mountains, if very slowly. The problem was stopping Hubble if it came too fast to the boom – or overshot the connector. "To much, wait," and I could hear grunts, then "There, it's on and locked. Securing the mount. Alright, Marty, help me with the securing belt." This crude part of the connection had given NASA particular heartburn, but they had made it work – and it

was better than Hubble suddenly breaking loose. Connection of the second boom went easier, but there was still some play, and jostling necessary, and then the third. "We're secure." Clint reported. "Beginning procedures." With the connection time, this was the longest spacewalk of the mission, and both astronauts were relieved when it was done.

Afterwards, I was already looking ahead to our next mission. I had already gotten some calls from customers who had made advanced reservations, asking when we were going to start their flights; with the publicity of this launch, I started getting more interest. I told them that Icarus was still in an evaluation and testing phase, but that decisions would come soon.

However, I considered the initial test period complete – the first two flights would be the only pure test flights. This was a work mission, and I wanted our next flight to be, as well. We had demonstrated rendezvous capability, and now our ability to support multiple, extended spacewalks; a visit to the space station was the next logical step. But should we take fare-paying tourists, or offer services to NASA for crew transfer?

I decided to raise the issue with NASA first, since we were already in the midst of one joint mission, But they were skeptical, pointing out the need for the proper docking port, system and life support compatibilities, not the mention the difficulty of docking, and the risk to the station from a failed attempt. "Besides," of of the station managers pointed out, "Our near term crew transport needs are scheduled for space shuttle flights. It's the longer term we need transport ability.

Then space tourists – they would pay additional money, and we could get an extra fee for the first flight. But a station mission would still be best, and from what Abby was saying about how tight crew quarters actually were, would probably be necessary. I continued to push NASA.

"The docking port is easy to configure, I included that in the design," I told them. "And our atmosphere is configured to what NASA has published, and can be easily adjusted if necessary. As far as precision maneuvering, we've already got the Hubble. And Russia has already sent up tourists.

Station managers gave a litany of counterarguments, most of which were weak on technical grounds, and easily argued away. Then they said, “And Russia has sent up one tourist at a time, after six months of training. You're proposing sending up a total of five crew untrained in station procedures and activities. We can't risk the station.”

I said it would be as good a chance as any to demonstrate Icarus's ability to serve as a crew vehicle for the station, and said, “We could just fly up there, and give a knock on the door.”

The managers didn't find that amusing, but did admit that a demonstration mission might be appropriate. And I called my contacts in Congress, mentioning to them what I had proposed. NASA agreed to let us dock, and give us all information required – but cautioned us that we would be closely supervised while up there – and could be held liable for any damage we caused.

I then went through the list of current applicants, selecting from among the earliest applicants, but also considering other factors, including fitness and space station knowledge, and offered them trips to the ISS for an additional 20 million, and began preparation for launch as soon as we could turn Icarus around. I told Uncle Robert I wanted to try for the two-week window, if it was possible.

But the current mission was not going as smoothly as it could have. The second spacewalk went perfectly, and Peter reported that the shuttle-design fuel cells were performing even better than expected. But he was also watching erratic readings from several other systems. “I double-checked the numbers,” he reported late in the second spacewalk, “Because I was surprised when I saw the first set. But it appears correct – thruster fuel consumption is almost twenty percent above what it should have been as of Hubble docking. We're down to about forty percent of original.”

“Will that leave enough for the rest of the mission?” I asked. It wasn't yet a critical point – docking would see the largest fuel consumption – but there was still a lot of mission left.

“I'm going to have Abby go over the numbers tonight,” he said. The thought made me chuckle; Abby had never been very good at math, and she wasn't much better now – but as Captain, she had

final responsibility for fuel and all other calculations. “But it looks to me like it's going to be very close. We should be fine, as long as we don't have any delays, or run into other problems; but we will go into our reserve. That's assuming current consumption rates continue.”

“We've got to watch that.” I said. “If it even looks like we're going to go into reserve, we're going to have to go into propellant-saving mode – or scrub the mission.”

“Our captain won't like that.” he said.

“She'll make the right call if it comes to it,” I said, only slightly doubting that it was true. “But we should conserve propellant, first.” I thought another moment; NASA had declared Icarus fit to return; though Endevour was still on the pad, she was being stood down – and we no longer had to think about remaining aloft until she could launch. Even so, we had a mission to finish. “Get a fuel-saving plan ready as soon as you can, to present to my sister.” Thinking of the near-disastrous Gemini-6 mission, I asked, “There's no sign of any firing thrusters, are there?”

“I thought of that,” he said, “Nothing – and no thrusters firing to 'compensate' for an undetected firing. I also crosschecked the thruster firing telemetry with the inertial navigation data – no indication of thrusters failing to shut off on time.”

“What about thrust times to delta-vee?” I asked. “If they were a little short, it could indicate more thrust was produced than necessary.”

“It looked fine within the precision available,” he said. “Although there could have been a slight extra that wouldn't have shown up on these clocks. But you should have seen Abby with the control yoke – she's pretty deft with it.”

“I'm sure she is.” I said. “It might be worth asking her if she noticed a discrepancy from the simulator data.”

“She didn't.” he replied. “It could be a pressure leak from the tanks, but it's even enough, front and back.”

“Keep an eye on it,” I said, “And advise the captain. It's up to her.”

The next morning, Abby announced that she was going to put Icarus on fuel-saving mode – instead of keeping oriented to the planet, tail to direction of travel, she would allow Icarus to drift, the planet rotating around her, thrusters only firing if their rate of rotation picked up.

NASA was not happy with her decision, asking if there was a problem they needed to know about. I told them it was just a preventative measure, pointing out that they had already approved such an orientation in the event a rescue would become necessary.

“But that was without Hubble attached,” Ms Watkins said. “That raises additional implications for air resistance and tidal forces.”

“The standard attitude – with Hubble attached – is already a high-resistance position.” I pointed out. “And a free rotating attitude was analyzed by your technicians, and was well within safe limits” I didn't add that I thought those limits were more conservative than even I would have set.

“Even so,” she said. “I trust you will keep us posted if any problems arise.”

“I will keep you advised.” I said. Actually, the thruster fuel situation didn't worry me as much as some of the other irregularities Peter had picked up. But he was keeping an eye on things, and we had sufficient redundancy to reenter if necessary. But I still worried about my – the ship.

The third and forth spacewalks went well, although I could tell Clint was a little fatigued from the last one – and he said “I like it better when the Earth stays right overhead."

That night, as with all mission spacewalks, Clint gave a lengthy report to NASA. Afterwards, they called me, asking what the situation of Icarus was.

“We're nominal,” I said. “The same as we reported this morning. Why?” Nominal wasn't exactly the way NASA might have put it – we were seeing more than a few erratic readings, and two minor failures - not to mention the thruster fuel problem – but they were updated.

“Four spacewalks in seven days is just a little fatiguing on the crew.” Ms Watkins said. “And they

need some rest – another day – before the final spacewalk."

"That can probably be arranged," I said. "Let me check with everyone here, and I'll get back with you in about fifteen minutes." She acknowledged, and I called up Icarus. "Abby, this is Capcom. Come in?"

"Icarus here." said a clearly tired Abby.

"NASA would like to know if you think a rest day could be inserted tomorrow," I said. "Before the final spacewalk."

"Yeah, their boys aren't showing as much toughness up here as they'd like to think." she said, and I could hear a couple of protests in the background. "But I think that can be arranged. It's been a long week, and it might give Peter a chance to get on top of things."

"How do things look up there?" I asked.

"Oh, they're fine," she said. "A few minor things, but nothing important." That wasn't quite accurate, of course, but close enough.

"Alright, I'll let NASA know they can have their day." I said. "Adjust the schedule accordingly up there." No one on the ground had an objection, so I notified NASA that their request wouldn't pose a problem.

After that, a day of rest, and a day of preparation for the final spacewalk, Icarus prepared to raise Hubble's orbit. At the low orbits used by the Shuttle, the Space Station, and many other vehicles, slight atmospheric resistance is enough to cause orbital decay. So, everyone at their stations, Icarus prepared for an OMS burn – two would be required to reach the new orbit. After this, only one would be necessary, to deorbit Icarus.

"One minute to burn." Abby announced. "Computer locked for ignition sequence."

Suddenly, Peter said, "Abort burn – abort burn." When Abby acknowledged and shutoff the countdown, he said, "We have loss of pressure in the starboard OMS primary pump. Repeat, loss of

pressure in starboard primary pump."

I acknowledged the message, then requested calculation of new burn, at ten minutes; the orbit was close enough to circular we wouldn't have to wait a full orbit. "Status of port OMS engine?"

"Port looks good, running full checks now." Peter said. I asked Abby, who agreed a burn in ten minutes would be adequate.

"Peter, can you pin the problem down?" I asked.

"Negative, but I had to shut the engine down, we were starting to lose peroxide." he replied.

"Copy that." I said. "Just make sure we don't have the same problem with the other engine." Orbital adjustments with the added mass of the Hubble were enough to deal with; I didn't even want to think about doing them on the RCS. "We've got new burn data ready," I said, and relayed it.

Peter re-prepped the engine, and once more, Abby said, "One minute to burn on one engine. Computer locked for ignition sequence. ... thirty seconds ... twenty ... 10 ... 5 ... 4 ... 3 ... 2 ... 1 ... ignition." and the thruster lit, for a normal, if long burn. But would the long burn overload the single thruster?

Forty five minutes later, we found out, as Icarus circularized the new orbit. Peter had yet to find the original problem, and we were hesitant of trying more proactive tests for fear of losing additional propellant, and we calculated the burn for one engine. And it went successfully; NASA confirmed a few minutes later that our new trajectory was exactly what they wanted to see.

The final spacewalk started with one surprise – the airlock wouldn't cycle – and it took Peter half an hour to find the problem, bypassing one relay and resetting two others. "I'll have to operate it from here," he said, "But it should be fine."

"What if it fails to cycle?" Clint asked. "Abby?"

She didn't say anything for a moment, and held my breath. This was a crucial decision – if the airlock wasn't able to return to normal cabin pressure, it could jeopardize the astronauts. Peter assured

her he had it under control, but she still hesitated a long moment, before saying, “I think this is NASA's jurisdiction. Clint?”

Clint called NASA, and there was a lengthy delay as they contacted me, and I contacted Abby, then relayed her original decision back to them. I added my own comments. “This is your phase of the mission. The airlock can be cycled by the flight engineer, and a backup remains; he believes it's one of the circuits in the control panel itself. But this one is up to you.”

They gave the go-ahead; Icarus couldn't deorbit with Hubble still attached. The repair procedure went smoothly, and the release of the booms much easier than their attachment, as Abby gave Icarus slight thrusts away from the telescope.

But we held our breaths – and I knew they did over at Houston, too – as Clint reported he was locking the hatch in place, and requested Peter begin pressurizing the airlock. Peter announced that the airlock was pressurizing, then said it was at suit pressure. Clint took his helmet off first, and announced, “Smells like pure O2 to me.” and Martin took his helmet off to. “Alright,” he said. “We're ready. Let's start cycling this over.”

Now the real test. “Cycling airlock, now.” He paused a moment, no doubt watching the controls. The pure O2 to normal atmosphere cycle is slow, to allow the astronauts bodies to acclimate, so it was a few moments before any effect would be apparent. Finally he answered, “Appears to be pressurizing normally. Will keep you all posted.” The cycle, though slow, finished fine, and we all breathed relief as Clint opened the hatch, and he and Martin floated back into the main cabin. “Well, that was exciting.” he said, before confirming with NASA that the repair had been completed.

After that, NASA then checked out the upgraded Hubble; upon reporting that everything – especially the replaced gyros – were functioning normally, Abby used a thirty second RCS burn to gain some separation from Hubble before deorbit. Peter spent the remaining day checking out several scenarios on the failed OMS engine, but finally reported, “I think it may be a seal failure or something.

Electronic components check out fine, but the pressure loss suggests the pump is compromised. We probably won't know until after we land."

"Copy that, Icarus," I said. "Computing for single engine deorbit." But the single engine burn went fine, and once again Icarus plunged through the atmosphere for an early morning landing under thin, stringy clouds. I watched on the large screen as the tiny shape of Icarus made her turn to final approach, then grew quickly before Abby announced, "Beginning preflare ... right on track ... gear down ... flaring, give me speedbrake, full flare, and there is is."

"Touchdown." I reported. "Excellent flight, Icarus." But the malfunctions still had me worried.

The next day, we debriefed on the successful mission, and discussed our next flight. "NASA reports that the Hubble is performing completely satisfactorily, and the process was a complete success; Clint and Marty are recovering from their strenuous schedule, though Harry and Beatrice seemed quite disappointed not to have flown."

"I don't blame them," Peter said. "They were assigned to their first mission, then got bumped from it when you talked NASA into giving it to us."

"And only a fraction of astronauts ever actually fly into space." I said. "In any event, we need to turn our attention to the next launch. I'd like to get it turned around as soon as possible, but given the malfunction list, I don't think we're going to make the two week target."

There was a slight chuckle around the table at this; Uncle Robert said, "Two months might be more like it."

I nodded. "Yea, I was thinking thereabouts. But if we are to turn private spaceflight into a viable enterprise, we will need to improve on that; but first we need to solve these malfunctions. What do we have on the list?"

Peter ran down the issues with the mission, starting with the OMS issues and the airlock problem, then the lesser issues. "Thruster fuel savings protocol worked well enough – we still had several days

worth of fuel."

"The airlock was a critical issue, but we may be able to move it towards the bottom of the list, since the next planned mission includes docking at the space station." I said. "Some surface work reconfiguring the airlock to mate with the ISS will be more important."

"Didn't you already do it to NASA specification?" Abby asked, and indeed it was true – we had already built the docking port to the same specs as NASA.

"Yes, but NASA doesn't exactly know that." I said. "I'd rather not give away all of our secrets – and not everything I got was completely public information." Airlock design specs aren't exactly top secret, but they did take some digging. "Besides, now we have NASA's own, official specs to work with, and we can make sure everything conforms exactly. They will want to inspect it before we launch, to make sure we're not going to damage the station when we hook up. First priority should be the OMS and thruster issues – we're not going to launch again unless we get that pinned down."

"I hate to say it," Uncle Robert said, "But I think there should be a concern as to launching again, in general. We've had increasing numbers of failures on each mission; most of them have been relatively minor, but some have not – and some of the things we thought we'd fixed last time did recur on this mission. We'll track these down, but I think there will be more next flight."

"What are you saying?" I asked. "That we should give up, when we've come so far?"

"Not at all." Uncle Robert said. "As a prototype – as an experimental vessel – Icarus has come farther than many of us could have expected. As a working spacecraft, she leaves a lot to be desired. I don't think we'll get your desired turnaround, and I don't think we'll escape multiple failures."

"Where do you think the failures are coming from?" I asked.

"I think some of the problems are coming from the improvised nature of parts of the spacecraft." he said. Adaptations and modifications needed to make components work together – the number of voltage adapters itself is a problem – not to mention components that just weren't designed for

operation in zero gravity – not to mention launch and reentry conditions of 3+ gees."

"You've been talking to the NASA engineers too long, Robert." Abby said. "Icarus is a perfectly good ship. If it takes a few more working flights to iron out all the details, so be it. But I think she's ready to be put into service."

But I nodded with Uncle Robert. "You might be right." I said. "We've succeeded using off-the-shelf components, but some of them may not really be up for the job. The question, then, is what should be do next? Do we think about retiring Icarus now?" I was looking forward to my next spaceflight.

"Not necessarily, if we can work out the existing bugs." Uncle Robert said. "A few more flights – working testflights, as Abby might say, will provide greatly worthwhile information. But we should start turning our attention towards designing a successor ship to Icarus, using what we've learned – and our new contacts at NASA. With flights under our belt, we may be in a position to use more purpose-designed equipment."

"It may be time to do that." I admitted, "I've already got some ideas for improvements we could make. And we might even be able to make the flight deck bigger." I paused. "But we'll still continue flights – we'll work towards this next flight, then begin thinking about future redesigns, and then continue flying Icarus; I think at least six to ten flights total would constitute a worthwhile program." Most everyone agreed with that, though Abby was eager to just get on with spaceflight. "We'll rotate crews again for the next flight; the backup crew for Hubble will be prime. I'll be captain, Susan will be First Officer, and Robert Flight Engineer. We'll begin flight training with those crews as soon as I finish up on flight procedures. The ISS poses an additional challenge; it's in a higher inclination orbit which will take more energy to reach – Robert, I don't suppose you've had a chance to go over launch trajectory calculations yet?"

"No," he said, "But as long as we're not flying as heavy as we were this time, we just be able to

make it – just. But we'll have to be ready to abort, as well."

"Understood." I said. "Well, I guess that's that – lets get Icarus ready to fly again."

Once we calculated it, the launch profile was tight, but doable - and we wouldn't have to carry the extended supplies needed for the previous mission. I negotiated with NASA, and we eventually planned for a six day mission – launch, one day to close on the station, three days docked, and deorbit the day after undocking. And I stepped up my flight practice, especially in the simulator.

It was a week before uncle Robert and Peter began to zero in on the thruster problems. Uncle Robert called me over to show me what they had found. "We've been disassembling the failed thruster," he said. "And we just found this." he pointed out the parts spread out on the table, in particular the main pump. It was a simple, electrically driven pump, pressurizing the hydrogen peroxide for the injector. He pointed to the base of the impeller. "The bearings failed; the impeller is completely frozen. It must have happened once the system was pressurized; the pump reaches it's highest temperatures then. During firing, the rapid flow of fuel cools the unit. Holding pressure, it's still under load, but the heat has nowhere to go."

"Could it be related to the other problems?" I asked.

"Not likely." Peter replied. "Even if the bearings were having trouble for a while, it wouldn't have had much of an effect on the electrical system. There would have been a slight increase in load on this side, but I didn't see that; and nothing would have been seen on the other side. I'm still checking the electronics, but I don't see any way this could have caused a loss of electrical power."

"I think it was an abrupt failure, anyway." Uncle Robert said. "These types of bearings tend to fail quickly if they overheat. And there's no way it would have been related to the increased fuel consumption: that was proportional for RCS and OMS burns; and these pumps are isolated from the supply when the OMS is offline."

That worried me, seriously. "So we've got multiple, unrelated failures here." I said.

“It looks like it.” he said. He nodded, and I asked about the likelihood of the other pump failing.

“Hard to say,” he said. “Both pumps were well under design lifespan; but we're not exactly using them as intended. They could be wearing out a lot faster than we expected, and the other pump may be close to failure. Or it could have been a random problem. It'll take a little longer to pin down the actual cause of failure, if it was a pure overhead, or if the seal failed, or what.”

“Still, better to be safe than sorry.” I said. “We should plan on replacing both pumps before we fly again, unless you can find clear indications.” He nodded. “And keep trying to find the causes of the other failures.

My concerns increasing – multiple failures – I spoke to NASA. I was careful not to show the depth of my concerns, or the seriousness of some of our findings, but did seek their input, and their thoughts on building a second Icarus.

Ms Watkins – now not directly responsible for the outcome of our mission – openly complimented me on the work of my team, and the performance of Icarus. “I might have aborted the mission at a couple of points, but I think you – and your sister - were right not to.”

“Thank you.” I said. “But as I said when we were planning the previous operation, Icarus is an experimental prototype, and it may be time to consider building an improved vehicle.”

“Of course, NASA welcomes your efforts, and thanks you for your valuable assistance,” she said, “But we do have many of the same concerns, and could suggests some directions you could take.”

“I'm sure you could.” I said. “The question is, what assistance could NASA provide us? If we mean to use more space-tested equipment, we could benefit from your expertise, and contacts.”

“Some of NASA management has considered the possibility.” she said. “And you'll probably be able to reach some kind of deal; I'll pass your interest along up the the management tree. For my own view, it may be time to put Icarus in a museum, and build your next spaceship.”

Consideration was indeed passed up the NASA grapevine, and once again I entered discussion with

high levels of the agency. They were eager to provide assistance, of various types, but there was clearly much to be worked out – they seemed almost intentionally vague about what they would be able to offer.

And continued malfunction assessments on Icarus weren't promising. Peter hadn't found any indications for the first OMS failure, and thought it was just a random electrical failure. “A relay may have failed to activate, or something.” he said, and I hate unanswered questions. Ground tests of the RCS system showed increased consumption, but there were no clear causes; Uncle Robert suggested that it could be wear on the units, slight leakages, loss of pump efficiency, and the like.

“But the thrusters shouldn't be near wearing out.” I said. “Any sign of why they could be doing so so fast?”

“They may be less tolerant of conditions than we had hoped.” he said. “Also, as you well know, many types of systems can see a slight reduction in efficiency as they 'break in'. I know you've seen the same sort of thing with your truck.”

Indeed I had; I remembered installing the new water pump – at first, it cooled the engine down great; the temp gauge never got close to mid, but it got warmer after a while – parts could be like that. “Maybe we should try giving a unit thorough cleaning,” I suggested, “See if that improves things. Hydrogen peroxide thrusters shouldn't leave significant deposition, but there may be some.”

But it all added up to exactly what Uncle Robert had said; Icarus was successful as an experimental prototype, but needed to be far more reliable before she could be used commercially. I talked about it with Susan over dinner one night; we had taken a rare trip down to San Antonio in my truck, and were eating at one of the cities outside Mexican eateries. “It's nice out here,” she said. “Up in Virginia, it'll start getting too cold to eat outside, soon.”

“Yea,” I said. “it's like it's summer all the time. I don't know, though, I think I like the seasons.”

“Maybe,” she said. “But I don't think we could launch the Icarus in snow.”

“That would be something,” I said, “Icarus taking off in the middle of an ice storm. Maybe someday ... I wonder what the FAA would require for deicing?”

“I'd be more worried about the runway on landing.” she said.

“That would be a problem.” I said. “But speaking of Icarus, what should we do with the ship? It seems like for every problem we solve, we find another.”

“Robert may be right,” she said, “Retire the prototype, and start thinking about where to go next. We knew when we were putting her together that this was prototype work; that alot of these systems would have to be redesigned, preconceived. It may be time to do that.”

“What about this mission?” I said, referring to the upcoming ISS visit.

“I think we should go for it,” she said. “I think Icarus can make another flight; perhaps a few more. But as a prototype; knowing her retirement could come at any time.”

“I dunno,” I said. “I've begun to wonder if even this flight is worth it. Between the OMS problems and all the other niggling things, I've begun to wonder if even one more flight is worth the risk.”

“You know what your sister would say to that.” she said.

“My sister would keep flying Icarus until pieces started falling off. Large pieces. Like fuel tanks.” I laughed at that, thinking of the fuel tanks, deeply embedded within the structure of Icarus. “You know I like to be a bit more careful.”

“Or a bit more than careful.” she said. “You have a tendency to be very overcautious. I believe that's why we brought Abby along in the first place.”

“Hmm.” I said. “And yet I took the risk of climbing in Icarus.”

“You're willing to take the risks you think necessary.” she admitted. “But it's the other ones you avoid like the plague.”

“I suppose that's it, though,” I said. “The reason for my hesitation. We've proved our first point, that a private group, narrowly focused, can build a working spacecraft. Is it necessary to continue to

fly Icarus, now that we've done that? Is it worth risking a failure that could set human spaceflight back for a generation for a few more flights? I don't like to risk my life, but failure could cost so much more than that."

Susan shrugged. "Every flight we get more attention, more PR," she said. "Which could translate into more money you can raise – I believe you said yourself that building a practical version of Icarus could cost much more than building the prototype – and we'll still need every million dollars you can raise. Further, we've gotten a great deal of useful data from the first three flights; I think we'll get more from more flights."

"Then what do we do with Icarus?" I said. "After we finish flying her?"

She shrugged. "Put her in a museum." she suggested. "Didn't NASA suggest that?"

"Yea, I suppose they did." I said, thinking, but which one. The Smithsonian would be the prime recipient, but I had a problem with their policy of not operating the 'artifacts.' they were right to try and protect important historical artifacts, but even so, an aircraft, a working airplane, is meant to soar through the air, not decorate a hangar.

Still, it would be fitting tor Icarus to be displayed alongside the Space Shuttle Enterprise, Wright Flyer, and Enola Gay. I called the institution to inquire if they would be interested in Icarus upon her retirement. They were, and discussions commenced.

Meanwhile, continued debugging of the spacecraft went, well, as well as could be expected. That is to say, they continued to find as many problems as they solved. I was hesitant to have Icarus fly again - though the more hesitant I became, the more certain I was that I would fly the final mission, the risk was mine to take – and finally I decided that this would be Icarus's final flight.

Abby openly questioned my decision, saying "I thought we all made the decisions around here."

"One more flight is worth it," I said. "And I never said I wouldn't make unilateral decisions when i thought it necessary. This isn't just about the continued safety of Icarus,but what's best for the future.

Once we retire Icarus, we can focus full attention to improving the design, and turning a promising prototype into a viable commercial spacecraft."

"Up to now," Abby said, "I've been – mostly – impressed by you're willingness to let loose control to the rest of your team. But you've always been there, ready to take it back at a heartbeat, haven't you?"

"I only want what's best for Icarus," I replied, "And for human spaceflight." Looking at everyone else – and specifically away from Abby, I continued, "If anyone has any other ideas, I am of course open to hear them. But I think we're fast approaching the point where the risks of flying Icarus are quickly approaching the benefits, and we do need to design a successor."

There were good opinions on both sides, but in the end everyone knew we had to stop flying Icarus sooner or later, and sooner would mean we could turn our full energies onto the next phase. I told the Smithsonian that "Most likely, after the next flight, Icarus will be yours."

"Yes," said my contact, one of the curators at the Air and Space Museums Dulles Annex. "But how do you plan to get it here?"

It was not a small question; it wasn't like we could just put our spacecraft on a truck to move it. But Dulles International Airport was capable on handling Icarus – it could land the shuttle, in an emergency – and would be quite capable of handling Icarus on our return from the ISS (I had already decided I would definitely be flying the mission.)

But the FAA wasn't so sure. Dulles airport was outside of several parameters of our airworthiness certificate, they said, and they could never condone operation of such an experimental vehicle into that site – even with the Smithsonian recommending for the operation.

Dulles airport also got into that – they liked the idea of us landing the 'spacecraft of the year,' as they called us – at their airport. They're not exactly a low profile airport – after all, they serve the nations capital – the airport had after all been designed with future use as a spaceport in mind.

But the FAA was as rigid as ever, and they had a point; any flightplan into Dulles would take us over heavily populated areas. I pointed out that the most dangerous areas of flight would be further uprange, where we were traveling an hypersonic velocity, producing massive plasma during reentry, but they would not budge.

And they had a point. Any error on my part could send Icarus crashing into hundreds of homes, schools and businesses. One of the reasons Domingo Regional was such good location for our operation was the relative desolation of the surroundings; that wouldn't be so flying into the heart of Northern Virginia.

Still, I saw no other way to get Icarus there – and the romance of landing Icarus right in the nations capital was compelling. I called my contacts in congress, and while results were slow, the FAA was besieged. They granted conditional approval, and I began the process of coding Dulles airport into the simulator, and preparing our revised flight plan. And spending a great deal of time at the simulator controls, practicing flying the thing – because I had to match my sister, and truly master Icarus.

Final preparation for launch were well under way when as final arrangements with Dulles were worked out. They didn't have near the ability to close their airport that Domingo Regional did, but as a larger airport, were able to create somewhat more flexibility on that – having two parallel runways always helps such things – and things were, in time, worked out.

Icarus, for her part, was a mess. The docking hatch was ready, but there were still ... concerns. The OMS power failure was still unexplained, and we couldn't check every relay in the ship. But the flight was on.

And in due time, it was time for the flight. This would be our first flight carrying paying passengers, and I selected them carefully from the top end of our list. Our contract terms had specifically stated that flight order would not be in order of contract, but 'operator's discretion,' and I wanted to pick carefully our first passengers. The fact that this would be our final flight for some time

made the decision particularly important. I considered all aspects of their applications, including their objectives for the spaceflight. Some of them had scientific projects they wanted to conduct while in orbit, and I had to discuss those with both NASA and the Russian Space agency.

Finally, I chose two highly qualified passengers. Both were successful in business, and also had long histories of interest in spaceflight. One, Raymond, had built a successful software company, providing a variety of programs to business. While he had little skill in engineering or advanced mathematics, he had focused on providing business software support to a number of firms in the aerospace industry. They formed the majority of his customers, and he sought to further increase his standing with them.

The other, Dr Lydia Carpenter, had described herself as “a chemist first,” who had turned her Ph.D work into a multimillion dollar business, and planned to use her time at the station doing further materials work, checking out some aspects of her earlier research she hadn't been able to explore at the time.

They had both come down to Domingo two weeks before launch, and received training in procedures, flight expectation, and several safety briefings. This included a three day trip to Houston, to received briefings from NASA on space station procedures and policies.

On the day of the flight, they were both waiting when I arrived at Icarus at the end of the runway; Susan and Uncle Robert were already inside. I shook both of their hands, and once again, welcomed them to the ranks of soon-to-be astronauts.

Ray said, “I was a little surprised when you offered me the spot,” he said. “I remembered you had said I wasn't the first one to make a reservation.”

“I wanted our first passengers to be high-profile spaceflight supporters, not just rich tourists looking to one-up their buddies.” I said. “You've both given concrete support to the aerospace industry, and Dr Carpenter hopes to directly utilize her research while we're up.” One of the technicians was motioning

for me, and I said to the passengers, “We'll be boarding in just a moment.” The technician handed me a radio. Uncle Robert was on the other end. “We're just about ready up here.” he reported. “Fuel tanks loaded and pressurized, internal power reading normal.”

“I'll be up in a moment,” I said. “I've just got the walkaround first.”

I handed the radio back to the technician, and slowly performed the preflight walkaround inspection, taking careful note of the visual condition of my ship, as well as the equipment (such as the rear camera) positioned around the runway for launch. Then I motioned to the passengers that it was time to board. I went first, then helped them down the ladder into the flight deck of Icarus, taking a moment to make certain they were properly secured in their seats. To save weight, and space, two passenger seats were lower on the deck than the crew seats. Then I secured myself into the Captain's seat, and began final preflights

We completed all checks, APU's started and hydraulic pressure, and then, carefully watching the display for optimum ISS intercept, I began the countdown, “10 . 9 . 8 . 7 . 6 . 5 . 4 . 5 . 3 . 2 . 1 . ignition. We have ignition.” I held control as the engines thrust me back into my seat, slight thrusts on the rudder pedals to keep us on the centerline as I watched our airspeed climb, and then, end of runway rapidly approaching, rotation speed, pull back on the control yoke, nose wheel lifts off the tarmac, then the main gear with a firm push to the seat cushion, and we were airborne. “Gear up.” I requested, and Susan acknowledged. I watched airspeed increase as we climbed, then began a slow roll to heading, and flattened us out with an eighty-four degree pitch.

“You look good, Icarus.” said Abby on Capcom.

“Copy that, control.” I said. “Thanks.” I continued to watch the controls, keeping Icarus on course. Hank was right, this thing was a beast; I felt like the slightest nudge would send us across the sky, even as the massive power drove me into my seat. I almost felt I could feel increasing engine power, though I knew it wasn't the thrusts that was increasing, but the rapidly dropping weigh of Icarus.

“Approaching Max-Q.” I announced.

“Max-Q,” Susan confirmed, hand on the throttle lever, “Throttling back ... now.” I felt the reduction in thrust and the change in the Icarus pushing through the still dense atmosphere, and reminded myself 'you're wearing Icarus like a skin – don't move the controls, move the ship.' I watched the attitude indicator and the computer display to keep us on course, bouncing us from one edge of the parameter to the other.

“Past Max-Q,” Susan reported, “Throttling up.”

“Acknowledge throttle up.” I said, focusing on the control of the spacecraft, letting the nose down it by bit, keeping our heading on the required track The sky turned from blue to gray to black as we gained altitude and the pitot instruments lost effect, and Susan began to change from aerodynamic surface to thruster control.

“Watch yourself on thrusters,” Abby said. “They're touche'”

“I gotcha.” I said, feeling the thrusters full on- or full off nature – but I knew it was still the engine gimballing I was relying on.

“Three engine press to MECO.” Uncle Robert reported, and the gees steadily increased. “Two engine press to MECO.”

“Acknowledged.” I said, focusing on the controls. As hard as Icarus had been to control in the atmosphere, she was harder in space, with the angular thrust of the engine gimballing and thrusters were keeping us on course. Slight, purposeful nudges on the control yoke to keep Icarus on course, drifting high again, pitch down, so quickly dropping below and another higher pitch, gentle tugs, now, not to much on the thrusters.

“Problems on one!” Uncle Robert reported suddenly, and I felt the shift in thrust, the slightest yaw left ans engine one's thrust reduced, and I adjusted the controls, almost by feel. Almost. Uncle Robert continued, “Trying to hold it – reducing oxidizer we're losing it. Engine one out – one out. Shutting

down now."

"Shutdown on one copy, "I said. "capcom, we have failure on one."

"Copy failure on one, "Abby said, with no small part of excitement and disappointment. I hardly noticed; I was struggling to keep control of the spacecraft, which was now pitching and yawing; I scanned the gauges, keeping us under control and on course. I scanned the gauges, velocity, thrust, computer data. "Press – press for orbit. Give me data." Susan quickly punched the keyboard. "Pitch up five degrees, and I did so, feeling like I was on top of a firecracker. Our pitch was now just below zero, gaining as much velocity as we could,.as fast as we could; now I was focusing on the computer display and it's guidance information.

And then Uncle Robert reported, "Approaching MECO, throttle back on mark ... three ... two ... one ... mark!" and I noted as the thrust dropped off; then dropped to nothing half a moment later. "We have MECO."

"Right," I said. "Copy that, we have MECO. Capcom, orbital projection, please."

"We're working on it." Abby said.

I watched the inertial gauge and breathed a sigh of relief; it looked like we had it.

"You're close," Abby said, "But on track. Hold for burn info."

"Copy that, Capcom." I replied. "Give us burn data as soon as you can." I began thinking about the possible orbital trajectories we could have; we'd been back and forth on heading; inclination could be off the map. But with velocity, I'd calculated enough orbits to know we were withing OMS range.

Abby was slow to get back to us, but she reported about the same as I'd expected. "Icarus, you're a little off on inclination. Thirty second burn in eighteen minutes will put you on stable orbit. Still working on intercept plan."

"Copy that," I said, "Just give us the data." She did, and I conducted the burn, pushing us into a low, but stable orbit; then I requested data for our ISS burn.

In the meantime, I said, “Well,. Everyone, it looks like we've reached orbit. But we're still waiting on confirmation, so I do ask you to remain in your seats.” At this, I looked back at our passengers. “We'll confirm trajectory for ISS in a few minutes.” I breathed a sigh of relief.

In a moment, Abby reported, “We've got you in orbit at 190 by 150.” That was low. It would be stable, for a few orbits, but would quickly decay. She gave me the rest of the orbital parameters, inclination and altitude changes we would need to reach the ISS. “We're still working on your burn sequence, but it looks like it's going to be about six.” Six burns was a lot – had I been that far off on our launch?

“Alright,” I said, after Abby finished giving the info for our first burn, “Everybody just sit tight for a moment. Our first order of business will be to raise our orbit a little.” I turned my head back towards the front, at the overhead panel. “Let's begin flight checkouts. Life support, pressure holding steadily, flow normal,” and we checked out the other systems, before we initiated the next burn, and pushed us into a higher orbit.

Abby came on afterwards, and said, “You look good, Icarus; we've got your burn sequence. Five more burns, and it looks like rendezvous will be delayed by about fifteen hours.”

I wrote down the burn information as she read them up, then i read it back to her; then I looked them over. The inclination change we would need was close to the edge of what we would be able to make, but we would be able to do it, within thruster fuel margin. I was glad we were running the shorter flight time, and had less weight to haul – the changes would have been too much on the last flight. “Notify NASA of our updated rendezvous time; they may want us to stand off before docking, as that will be within their sleep time. Ours as well.”

“Will do,” she said, before adding sarcastically, “Nice flying, Dan.”

“Hey, I got us here.” I replied. “And you didn't have an engine failure while trying to reach rendezvous orbit.”

“We certainly simulated it enough.” she said. “Capcom out.”

“Alright,” I said. “Our next burn won't be for a few hours. Susan, let's pitch over and give our guests a better view. As soon as we have attitude, you're all free to unstrap.” Still on manual, I pitched Icarus downwards so Earth filled the screen, watching indicators as we pitched over, then space came back into view and I stabilized the rotation, then activated stationkeeping mode. We were now flying upside down and tail first. “The seatbelt sign in now off.” I joked, unstrapping myself and pushing up from the seat. Floating, and pushing myself away from the overhead panel and backwards, I rotated to look at our two passengers. “It looks like we'll be an extra day to reach the station, so that will extend our mission time by a day. We're still planning to stay there for three days. Meantime, it's a bit tight in here, so be careful, and keep yourselves away from the front panels; but it's a heck of a view. As they unstrapped and pushed themselves out of their seats, I extended my hand to each of them, in turn, and shook them. “Welcome to orbit.”

Abby contacted us, once she had spoken with NASA; they did want us to wait until later in the morning to dock, so we would orbit with the station for a while after rendezvous; I spent some time going over the schedule to figure the night burns we would need to make, especially the critical rendezvous itself. The next day went smoothly, except for a lot of bumping in the small flight deck; Abby was right, this was too small for five people, and moving around always required a bit of jockeying and coordination – but we were all amazed by the views from orbit. Once again, we slept in the seats, and of course we had to return to the seats for the orbital burns.

We kept a particular watch on the OMS engines, Uncle Robert watching the power relays, and keeping a close eye on the pumps. A slight adjustment of burn timings allowed us to make our approach to the station just after normal wakeup, and as we did so, I kept my eye on the screen, currently showing radar information, for detection of the space station. It flashed, there was the return, and I locked on it, beginning a flow of range, bearing, and relative motion indications, using the big,

blocky text-graphics characteristic of this particular computer system. I now had Icarus pointed in the direction of the station, and I was also looking out the window for the first sight of the station as we approached.

And there it was, first just a point of light, but already visibly shifting against the background stars, then growing closer, a perceptible sense of width, then the first aspects of shape could be made out. The large solar panel on the side, and the multitude of station modules attached to the central core.

As we approached, I set one of the communication channels to the space station frequency, and called, “International Space Station, this is Icarus. Come in?”

After a moment, a voice came on with a thick Russian accent. “Icarus, welcome. We've got you on radar.”

“Copy that.” I replied. I then notified Capcom, then NASA directly, that we had contact with the space station. Once we were within a few hundred yards of the station, a final firing of the RCS system was needed to bring our course to exact match. As agreed, we would then hold off on docking until the afternoon, at a time convenient for the station crew; I had Icarus positioned behind the station, and under the docking port, and now oriented towards, so most of the windows showed a view of deep space.

We had a late breakfast, then while Uncle Robert was changing the CO2 scrubbers, Susan and I embraced while looking out one of the overhead windows. “It's so vast, so immense out there.” she commented.

“You should see the view from outside.” I said, thinking of my spacewalk – and not thinking about how close I'd felt to throwing up. It was like looking into infinity, and total emptiness.

“It must be something.” she said. “But this, is all amazing. You know, I thought It'd be a little less amazing the second time, but it's just as beautiful as I remembered.”

“I don't think this could ever get old,” I said. “But I suppose we can ask the crew of the space

station, when we get there. But this is better than the first time – now I have someone to share it with." I smiled at her, then embraced her more tightly, and we kissed. "It is beautiful, honey." and we just stared out at the stars.

After lunch, we began docking preparations, coordinating with NASA and the space station crew. When the station – now one of the NASA crewmembers – confirmed that the station had activating the docking guidance signal, I gave Icarus a thrust towards the station. I watched the radar display more than the station out the window, remembering what I had read about Gemini 4's first attempts at rendezvous, and the crew would thrust towards their spent rocket stage, and find themselves moving away from it – orbital mechanics are such that the movements needed are often counterintuitive; radar ranging and guidance information is necessary to complete successfully. We were getting that information from the computer screen and radar.

With careful thrusts, I brought Icarus under the docking port, and held her steady there, then switched the computer display to show the guidance beam being transmitted from the station. "Check docking port ready," I requested, and Susan confirmed it was clear and set.

Watching the beam I guided Icarus upwards, with slight side-to-side thrust to keep us in line, and watched the approach speed. "We're drifting a little to port." I commented. "Range, thirty feet." The thrusters were set in translation mode, so I pushed gently forward on the yoke to slow our rate of approach. "Twenty feet ... fifteen ... ten" I slowed us again, approaching at a crawl, and gave one more side thrust to keep us in line. On the screen, a larger circle appeared around the guidance mark, showing our precise alignment as we approached the station. "Five ... four ... three ... two ... one ... contact!" and we locked only the station with a gentle thud. "Secure docking port. Securing thrusters; guidance computer to standby." I switched the radio to the ISS channel, and reported, "ISS, this is Icarus. We show a clean, secure connection."

"We acknowledge, Icarus. Confirming now." the station commander reported. "We show you

locked in place."

"Thank you." I said, then reported same to our mission control; the station crew would give similar reports to NASA and the Russians.

We wouldn't go right over to the station, however, per NASA procedures, we had to make certain our ship was secure and everything was set. Uncle Robert depressurized the RCS system, and powered all thrusters down completely, and a number of other systems were placed on standby. Almost an hour later, we were ready to open the hatch, and I reported so to NASA.

"We'd like one more check on your environmental status," the NASA control requested. I suppressed a hint of annoyance; I had assured them enough times that we had constructed Icarus's systems to NASA parameters; but I reported to them the cabin pressure, and partial pressures of nitrogen and oxygen.

The controller acknowledged, then another controller reported, "Icarus, you're clear to open hatch."

"Thank you." I said, unstrapping myself, pushing up, over, hand-walking off the overhead panel and ceiling, then pushing down and giving a slight roll down to the floor. I deflected myself off the floor and pulled on the airlock hatch handle, opening it. Then I floated in, to the panel. There was a button on the side which looked like it had been hastily added, which it had before this flight, along with a pressure gauge. I pressed it, and looked at the reading on the gauge, normal pressure. I then pushed the comm control and requested, "ISS, this is Icarus. Please confirm that the hatch is open on your side." Opening sequence for the hatches were important; first the station would cycle theirs, as they were equipped to verify pressure in the gap, then I would.

The Russian came on. "Ve are open and ready." he reported.

"Thank you." I said. "I'm opening our hatch now." I closed the panel cover, then floated up to the top of the airlock, pushing off the two spacesuits stored there, and took a grip on the outside hatch. Bracing myself against the walls of the airlock, I pulled it open, pushing the hatch upwards.

I looked down as I did so – pushing on the hatch had sent me slightly downwards, despite my bracing – and I saw Susan's head coming through. “Hey, there.” I said as I pushed off one of the spacesuits to reverse myself. I looked upwards, into the docking module of the space station. Here we go, I thought to myself as I guided myself through the hatch, and saw a a stoic Russian face there, waiting for me. “Velcome to the space station,” he offered. “I'm Dmitri.”

“Pleased to meet you.” I said, extending my hand, and offering him a handshake. He took it, and I asked, “May I bring the rest of my crew aboard?”

“Yes.” he said, and I called down into the airlock, “Susan, come on up.” I heard her acknowledge, then looked around the station's docking port. “You've got a lot of space in here.” I said, Dmitri mostly grunted. He backed into the next module as Susan came up, followed by our two passengers, then Uncle Robert in the rear; I introduced them all to to Dmitri.

“I'm to take you up to the main compartment.” he said. “Be careful as you pass through; the station's not made for visitors.”

“We understand.” I said. I followed as he pushed through the hatch, and we made a snake going through the station; we'd placed Uncle Robert in the rear for exactly that reason, so he could keep an eye on our passengers.

The station compartments just felt so much bigger as we glided through them, I'd give a push coming through a hatch, gauging to reach the other side, and just glide along, arms outstretched, judging as I came into contact with the far wall. This wasn't the same as moving around the small cabin of Icarus, but I had already experience a bit of movement in microgravity, and had an idea what to expect; but looking back at out passengers as I passed through a hatch, I saw them sometimes trying to “swim,” Dr Carpenter especially, but once I saw Ray frantically trying to paddle himself back on course, without effect.

Finally, Dmitri led us into the main chamber of the the station, which comprised the living quarters,

and was the largest on the station. Two other astronauts were waiting there, both wearing NASA flightsuits. But one, a tall male, was wearing a Guns-'n-roses hat, and smiling broadly; the other, a female with long, flowing air, was looking almost disinterested.

The male introduced himself as Gary Ragle, commander of the space station, and introduced Patricia Lynne, the third station crew, saying, “Don't mind her, she just wants to get back to her research,” and gave her a playful nudge – but perfectly calibrated not to send either of them flying across the room. I introduced myself and my crew, including our two tourists. Commander Ragle then said, “You got here at a good time – we saved lunch for you.”

“Thank you, Commander Ragle.” I said.

“Call me Gary.” he invited. Pulling himself over to the galley, he said, “I don't know what you brought on your ship, but we've got a pretty broad selection up here.”

“We've pulled from the NASA list,” I said, “And since our last mission, NASA has been helpful in letting us piggyback orders onto their own. But we've kept the selection a lot tighter, since we don't have a separate middeck.”

“You'll have to show us around your ship,” Gary said, as he and Patricia prepared food for everyone. “There's something exciting about hopping in an improvised, hot rod of a spaceship and launching into orbit. The shuttle is a fine ship, but is so staid and, well, eighties.”

“So's your band.” I said, pointing to his hat.

“You listen to them?” he asked.

“Hate 'em.” I said. “But that's alright; I won't say anything against our host's band. Except that they, too, are eighties.”

“Yea,” he admitted, “But they're definitely not ordinary.”

I nodded; in a few minutes, Gary and Patricia brought out the food. “We don't get private visitors up here,” Gary said. “It's pretty exciting, isn't it, Dmitri?”

The stout Russian grunted; then said, “We've brought a few up.”

“Yea,” Gary said, “But they've come up on your own rockets. These guys built their own ship to fly up.” Looking at me, he added, “And you've spacewalked, too, haven't you?”

“Yea, once.” I said. “On our first mission. We had two separate engine failures; the first shook the ship pretty good, and we went out to inspect it before reentry. Building Icarus has been exciting, but the truth is, is is rather put together with duct tape and bailing wire, and has had more than her share of problems. We lost another engine this flight – that makes four failures out of sixteen total engine firings – and are somewhat keeping our fingers crossed we don't have any more problems.”

“Still,” he said. “There's nothing like flying a brand-new, untested spacecraft. I like my cars fast, my planes new, and my spaceships filled with fuel.”

“Motorcycles?” I asked.

“Of course. I've got two. A big Honda, and a Harley Touring bike. You ride?”

“No, but my sister does.” I said. “When she can afford to get her bike back from the mechanic. You seem a lot like her.”

“She commanded the Hubble mission, didn't she?” Patricia asked, and continued when I nodded. “I hear she's a bit reckless.”

“Well, yes.” I said. “She'd bold, where I am not.”

“It's pretty bold climbing into a spaceship made with duct tape and bailing wire, and launching into space.” Gary said.

I shrugged. “It needed to be done.”

Dmitri reminded Gary, and Gary said, “Just to go over the rules, as you agreed with NASA, we'll accompany you while in the space station; Dr Carpenter will work in the lab with Patricia. I don't think it's a big deal; I say anyone who can build their own rocket can take care of themselves up here, but NASA's pretty insistent. They're afraid you might break something, or something.”

“Of course.” I said; we'd already gone over all of this before launch. After that, we talked and ate for a while, the excitement of space travel, and it's more mundane aspects. Gary and Dmitri had both been up before, and had both spacewalked on the station. And we talked about everything else a group of distant travelers does when they meet in an inn or tavern.

After that, I offered to show them Icarus, so we all floated on back down to the docking module. “Our flight deck is pretty small,” I said in the docking port. “My crew might as well stay up here, if that's alright.”

“That'll be fine.” Gary agreed, but Dmitri cautioned them to stay in the docking port.

“Then lets go.” I said, leading the way down into the airlock and into the flight deck. I took a glance at the instruments and the display screen as I grabbed onto my seat. Turning around, I said, “The galley's back there, and the lavatory's on the other side. Otherwise, it's a bit tight, but adequate.”

Dmitri said, “It looks like ah hacked-together early Soyuz cockpit.” he said, “Like you've taken parts from just about everywhere. And I don't think I've ever seen a spaceship with control yokes.”

“We pretty much did.” I said. “But hey, it all works. But that's pretty much it” They looked around a little, and Gary said he'd heard how tight it was on the long Hubble mission.

After a few minutes, he said, “Well, I guess we ought get back to work. Patricia here can show Dr Carpenter to the lab module; I understand she's god some research she wants to do.”

“Yes,” I said, pushing myself down to one of the storage lockers. “She brought her instrument pallet along, here.” I pulled it out, and Gary helped me maneuver it through the airlock. Dr Carpenter and Patricia went off to the Destiny laboratory module.

The rest of the stay went pretty much routine; as we had agreed with NASA, we slept in Icarus, and were – mostly - accompanied while in the station. Dr Carpenter spent most of the three days in the lab, and told us she was making some real progress, “Although it'll probably take me the next year to analyze the data,” and Ray spent much of his time in the control room, looking over the computer

system – and looking out the window. He wasn't doing alot of real, practical work, but hoped to increase his cachet with his aerospace clients. Susan, Uncle Robert and I toured the ship, spent time with Gary, mostly – Patricia stayed in the lab, and Dmitri mostly ignored us, although he warmed to us after a couple of days – and we also took turns keeping an eye on Icarus, watching for failures.

The morning we were preparing for departure – too soon, I might add – I commented to Uncle Robert, “Icarus seems to be behaving herself – I'm wondering what trouble she's saving for us.”

“Maybe we've finally got things behaving,” he said. “We did replace a lot of components last time.”

“And if it does all work, it makes me wonder if we're right to retire her now.” I said. “Maybe she's got alot of flight left in her.”

“It's a decision you had to make,” he said. “Besides, we've still got a lot to go, and we've never tried a complete propulsion shutdown before.”

“Right.” I said. “How does everything look?” Uncle Robert gave me a full report, and I requested into the radio, “Capcom, this is Icarus. How do we look down there?”

“Weather is clear over northern Virginia, and Dulles control says their ready for you.”Abby reported.

“Copy that.” I said, “I'll start checking with everybody else." That meant checking with NASA, with the Russian controllers, and of course the FAA. All came through, and we finally prepared to depart. As I prepared to close the hatch, I shook hands with Gary and Dmitri; Patricia was already in the control room. “I'm honored to meet all of you.” I said.

“And I you.” Gary added. “With luck, we'll see you all up here again, in your sporty new spaceship.”

“It may be a few years.” I said. “But good luck with the rest of your mission. And happy landings.” I backed feet-first the rest of the way into the airlock – I had already been halfway in – and closed and secured the outer door, informing them over the comm; then through the door into the flight deck, and

ssecured that door. Once in my seat, I got on the comms with them, and they confirmed that the door was closed on that side. “Robert, how do the thrusters look? Have they come up?”

“They came up fine,” Uncle Robert reported. “We're doing final checks now.”

“Capcom, this is Icarus,” said. “We're almost ready to depart.”

“We copy, Icarus.” Abby said. “You look good.”

A few minutes later, Uncle Robert confirmed that everything was ready to go, and with a final call to the station, we undocked, me now giving slight downward thrusts away from the station, then backwards, the station sliding into clear view. “That's really something, isn't it?” I said, and Susan agreed. “Switching to attitude control,” I announced, then pitched Icarus round, yawed a bit with the pedals. “Back to translation, now.” I said, and gave a minute burn with the forward RCS, putting us on a sufficiently divergent orbit with the station that would would be well clear by our deorbit burn the next day. Abby came on and confirmed we looked good, and gave us our entry windows. “One more day,” I said, “And we're back on terra firma. Robert, how does everything look?”

“Everything's running nominally.” he said. “We're right on track.”

“Let's hope it stays that way.” I said.

We had one more dinner, and one more night in space. The following morning, after breakfast, we again contacted Dulles, who confirmed weather was still clear and ready. We began preparing for orbit; I confirmed our approach and landing course with Abby, and made sure it was updated and set in the computer.

Finally, the time came, and I pivoted Icarus around, ready for the deorbit burn, Dark Earth looming large above us.

“Ready APU prestart,” I said. “Now watch them not work.”

“APU prestart.” Uncle Robert reported. “You know you don't have to be so pessimistic.”

“You know me.” I said, but I was worried – we'd been almost problem free, after launch, and I was

just waiting for the other shoe to drop. But there was something else, too. To Susan, I said, “I'm sorry to be leaving orbit – I wonder how long it will be before we can make it back up – if we are able to at all.”

“We got here now, and we'll do it again.” she said. “I'm looking forward to getting back on the ground, but I'll miss it up here, too.”

“So will I.” I said. “Ready for APU start?”

“Starting APUs.” Uncle Robert reported, and the ship rumbled as the three diesels rumbled to life; and I imagined the puff of black smoke dumping into the void as they did so. He ran the units through their test cycle, then reported the pressure was built up.

“Alright,” I said. “Five minutes to deorbit burn. Capcom, Icarus, how do we look for burn?”

There was a moments pause as Abby checked with the other controllers then reported, “You are go for deorbit burn.”

“Copy that, acknowledge.” I said, setting the channel for Dulles tower, and switching to it. This was actually relayed through ground station, since we were still on the other side of the world. “Dulles tower, come in, this is Icarus. Come in.”

“Icarus, this is Dulles approach.” came the controller.

“Icarus requesting permission for deorbit and landing, per special FAA permission 110708.” I said.

“Permission granted,” the controller said. “We're ready for you down here. You are cleared for runway 1 right.”

“Copy that, runway 1 Right.” I repeated. “Icarus out.” The size of the airport – and it's multiple parallel runways – allowed it to continue flight operations until just a few moments before we touched down – essential for such a busy airport. I glanced at the runway diagram velcroed to the panel – 1R would put us coming in over Manassas. “Deorbit in one minute. Authorizing computer for automatic burn. OMS status?”

“OMS pressurized and ready.” Uncle Robert reported.

“Burn in thirty seconds ... twenty ... fifteen ... 10 ... 9 ... 8 ... 7 ... 6 ... 5 ... 4 ... 3 ... 2 ... 1 ... ignition!” and the engines lit up, slowing us down just enough to commit to reentry. And then the burn was off.

“OMS shutdown and safed.” Uncle Robert reported.

“Pitching to reentry attitude.” I said, switching out of stationkeeping mode, and down, so that the Earth passed under us before disappearing below the nose, and I reactivated stationkeeping “Reentry attitude.” Now I was getting a little nervous at flying Icarus through reentry. That would figure, if the craft worked perfectly, only for me to screw this up?

I continued to watch the indicators as we continued along, now descending. “Atmospheric interface,” I announced as the inertial data showed we were below 400,000 feet, and in a few more minutes, it showed that we were beginning to slow appreciably.

Communications blackout came on as we were still over the Pacific, and I began to adjust our attitude so that as we sunk into thicker atmosphere, it would push us further north, onto track for Dulles, and a red glow began to rise up from the windows. I had left the stationkeeping on, but I switched to manual as Susan began switching over the control axis, and I could feel the slight nudges of the control surfaces as we sped through the hot plasma and over the United States, crossing the big western states in a matter of minutes. Watching speed, I announced, “Beginning first S-turn.” and rolled Icarus left, not as quickly or steeply as Abby had, but feeling the lifting body bite into the atmosphere and dump additional speed; as the heading came around I rolled the other way, carefully watching pitch; but I had to make a couple of adjustments to get on course. A couple of minutes later I rolled into the next one, not quite as steep this time, still not quite on course as I came out. I focused on the computer screen as I guided us down, feeling the spacecraft respond to my inputs, and try and pitch to weathervane into the wind. We were now in the thicker part of the atmosphere, with heating at a maximum, surrounded by a thick ball of plasma.

And then the static of blackout faded, and I head Abby, “Icarus, come in Icarus.”

“Capcom, Icarus. We're back.” I pulled us through the third S-turn, this time to the right, then eased the pitch down as we were flying over West Virginia, still at more than twice the speed of sound. I watched the GPS now, correcting our track, as we rapidly descended – a quick glance out the side windows and I saw the mountains of West Virginia, Maryland, and Pennsylvania distantly below – we were still well higher than airliners fly.

“Dulles tower, Icarus. Come in.” I requested.

“Dulles tower here,” the controller said. “We've got you, hot and high.”

“Requesting final landing clearance.” I said.

“We're all set,” the tower reporting. “Holding traffic now. Runway 1R is all yours.”

“Approach runway 1 Right, copy.” I said as we passed over into Virgina, still distantly below. I was watching out the window more now, and had dropped the nose enough to see the horizon ahead.

“Radar altimeter on.” Susan reported, and I glanced down at it's indicator.

“Thank you,” I said, keeping the aircraft in line. Feel the aircraft, Dan, feel the wind flying around it. “I have visual on the airport. I have Dulles.” I said, seeing it off to the left, and we were passing well south of Leesburg, almost, and Manassas straight ahead, and it was coming up at us, and the ground was coming up at us so quickly, we sere still going almost a thousand miles per hour.

“Icarus, you're a little high,” Abby reported.

I looked at the gauge and verified, “I'll correct on the turn,” I said, and Manassas slipped out of view under the windscreen; I watched the GPS screen and began to cut into the turn, slipping Icarus just a little to dump altitude, and watching as our airspeed went below the speed of sound. I glanced out the window and Manassas pivoting below us, then began to roll us out – this time, watching the GPS almost right in line with the runway.

“Icarus,” Abby reported, “Now you're a little low. Watch it.”

“I see that,” I acknowledged, adjusting the pitch to preserve attitude while I fine-tuned our heading, seeing the runway ahead. “I've got the localizer.” I said as interstate 66 passed below us and we continued to descend – we were high but coming down steep. “Hold airbrake,” I said, seeing visually now that we were low, still fine tuning pitch. “We're drifting, too.” I said, there was ab it of crosswind, and I rolled us into it, a little opposite rudder, fine tuning, watching the localizer beam as I requested, “Gear down.”

“Gear down,” Susan reported, “And locked.” as we came over route fifty and over airport property, as I watched the runway, - would I make it? - “Flaring, airbrake ... now!” and puled Icarus up as we came over the runway threshold and I felt the stall, then bump – bump as one gear touched down, then the other, then the nose gear a second later, brakes came on hard, full airbrake and we continued to speed down the runway; I looked out the side window as the terminal buildings with all the busy Jetliners waiting, and then we came to a stop.

“Confirm, full stop.” I said. “We're down.” and I breathed a sigh of relief. I had done it. We had done it; I couldn't wait to do it again.

And we were home.