The Icarus Project

By Jeffrey Ellis

Mankind had to reach into space, and I wanted to take us there.

It began in high school. My physics teacher's area of expertise was orbital mechanics, so she focused particular attention on that area, having us work out orbital trajectories and giving us a good understanding of the basic requirements of spaceflight.

Actually, it came long before that. I had long been interested in spaceflight, taking a myriad of books from the library on the space shuttle, moon missions, anything I could get. But there, senior year of high school, it coalesced into an ambition.

One particular exercise stood out: calculating the fuel and oxidizer requirements for a Single Stage To Orbit vehicle, or SSTO, to launch a given payload to orbit. I went a bit farther giving a full detailing of the crew quarters and other support mass, but even then, I knew it was only a basic approximation - the equations were were given only gave a basic approximation of atmospheric resistance. But I saw the point. It was an immense requirement - launch weight of the vehicle would be mostly fuel and oxidizer - and yet, it seemed so doable, so simple.

Given the basic numbers, I began to sketch out possible vehicles, with what I already knew about spaceflight. I filled several notebooks with sketches of possible vehicles. I moved on to considering components, particularly engines, control mechanisms, flight parameters. I considered many possibilities, existing designs and more fanciful ones. They were only conjectures; I had much to learn, but I knew it could be done.

In time, of course, other things caught my interests; but the SSTO never left my mind entirely. I always kept a notebook handy, and might start sketching a new thought, or detailing an existing one, or I sought out another book on the subject. And my physics teacher had inspired me to more than just spaceflight; I had an existing fascination with physics, and she only strengthened it.

I chose to go to a small, liberal arts college, for a number of reasons, not least of which was the

impressive presentation of the tour, and beauty of the campus. As a result, I took a breath of courses. Among them was a geography course. Geography is more than just identifying features on the landscape, but understanding how place affects everything else. In one particular class, we looked at the European colonial expansion, beginning in the fifteenth century. We were asked why Europeans came out of the period as the dominant civilization on the planet.

It's not a simple a question as it seems today; European conquest of the world was never a sure thing. The Chinese were more advanced, by far, and had completed circumnavigations of the world. But what was really important was that, for a number of reasons, Europe developed a strong desire to explore and colonize. It was that desire for expansion, more than anything else, that led to the eventual domination of western civilization.

That realization was as important as the physics class had been. I already knew that spaceflight was possible, but I came to believe that it was vital to continued human progress. Western civilization had progressed by growing, it had to continue to expand. It was not only possible that we grow into space, but essential that we do so.

My desire to pursue spaceflight intensified.

I continued an aggressive, broad physics coursework, seeking the technical and mathematical background to better understand spaceflight. Calculus gave me a great deal of trouble, but also the tools to deal with the complexities of orbital mechanics. I continued my designs, considering SSTOs and conventional expendable rockets, and consulted with some of my physics professors, and some of my fellow students.

I also took many liberal arts courses, eventually earning a double major in history. I wanted to understand the social dynamics of spaceflight, why exploration had been so crucial to human expansion, why Europe had developed such a thirst for growth, and what enabled it to do so. I studied many aspects of growth, economics, politics, sociology. Eighteen credit semesters were my norm..

Afterwards, my physics major got me a job at a major defense contractor. The work didn't do much for me, and I quickly realized that this kind of company wouldn't do what was necessary to advance human destiny. But it was a solid, it paid well, and I was was frugal. I contained to work on my designs, and kept in touch with some of my professors. I kept the old truck I'd had since high school, a Ford pickup, three-on-the-tree transmission, and did most of the work on it myself. The one thing I spent money on was information, technical sources, operating manuals for early spacecraft (mostly facsimiles, but enough for my purposes) and other information. Technical information was harder to come by, but I did what I could, and steadily improved my designs.

I quickly began to focus on a single design, trying to create a complete, workable design. I quickly settled on an SSTO, and felt that a lifting body was the only airframe that could carry the needed fuel. I collected all I could on lifting body designs - NASA had done quite a bit of work with them, back in the sixties, but some of that was classified, and the rest was hard to find. But I found what was there to find, and was able to setup aerodynamics simulations on my computer. Of course, a single run, simulating a few seconds of flight would take several hours, but I was quickly able to devise a workable shape.

Working at a large defense contractor made me certain that this wasn't the type of organization to carry out my ideas. I thought a smaller, agile group would be much better suited. That quickly began to color my designs; besides, the more uncertainty I could eliminate, the better. I decided that it would be best to use existing technologies and systems, as much as possible. The engines would need to be custom designed, but everything else, I hoped, could be used off the shelf, or adapted. In particular, I planned to adapt the Space Shuttle's thermal protection system.

But in time, I had carried the design as far as I thought I could. I had continued to ask friends and colleagues for advice, but there as only so much I could get from studying (I have real trouble with electronics) and eventually, things would have to get built.

One evening, I headed over to my Uncle Robert's house, over in Maryland. He's a longtime engineer, and has often been a help with my designs. Not long out of school, he worked on the engines used in the first stage of the Saturn V rocket, which he still considers a high point of his career. Since, he's mostly worked on jet engines with a number of different companies.

Uncle Robert welcomed me to his apartment. "I was just about to make dinner. Want something?"

"Sure." I said, "What have you got?" Uncle Robert is a consummate bachelor, and he offered me a selection of TV dinners. I picked one; and he put it in the microwave with his.

"How's your truck running?" he asked.

"Fine," I said. "Thanks for helping me with the brakes; I wouldn't have been comfortable doing that myself." Uncle Robert often helps me work on my truck.

"Anytime." he said, admitting he had been uneasy the first couple of times he did brake work. "You should still think about installing disc brakes, though."

"I know, but that's expensive. And alot of work." I shrugged. "The drum brakes do stop the truck. Eventually." The weaker performing drum brakes had taught me to think ahead of the vehicle, but an emergency stop could be hairy. I asked how work was going – we both have worked for defense contractors now, and have had some similar experiences. We talked about family, as well. Finally, I brought up what I had come to talk about.

"I'd like to start putting a team together to build my spaceship," I said, "And I'd like your help."

He looked at me, then into the distance for a long moment. Finally, he said, "You've got some nice designs there, alot of good work. But building a real spaceship ... It took half a million engineers and scientists to put men on the moon. It's alot more than you think."

"I know how much it is." I said. "Some of what we need is known, now, but alot of it isn't. I've no fantasies of putting this together with duct tape and bailingwire. But I know it can be done. You've said yourself that what you did on the Saturn rocket was the best work you've ever done. Here's a

chance to do that again, and more."

"And where will you begin?" he asked.

I thought a moment. I knew the big view, what would be needed. Parts and systems would need to be designed, built, tested. Money would need to be raised, millions of dollars, at least. I was sure I would be able to find investors hoping for the large payoff that would come when we finally did reach space. But where would we begin?

"The design needs to be finished." I said. "I'd like to get a few people together, properly design needed components. I don't know enough about electrical engineering, and the engines will have to be designed almost from scratch. I think the right few people can do it."

"And then what?" he asked, adding , "No, don't answer that. You're going to need alot more than that to make something happen. But keep working on your designs, you've got alot of good stuff there."

I needed, knowing that was rejection, and turned the talk to other things, more about work, television. I rarely watch TV, but stayed to watch a couple of shows, before going home.

I took it in stride, and asked other people, friends, coworkers, former professors. But I got much the same response. At best, people were noncommittal; others rejected it outright. As one, a colleague at work, electrical engineer Peter said, "It's a nice idea you've got there, but it's going to take more than a few friends to make it fly."

Perhaps they were right. Spacecraft took billions of dollars and thousands of engineers to develop; this wasn't a small project. But I couldn't think that way; this needed to be done. Humanity had to reach out into space, and we needed to, now. One English professor had told us he hoped to see humans land on Mars in his lifetime; I had replied that "It'll happen in our lifetime, or not in our epoch." We had to keep growing, expanding, or we would collapse without realizing it until it was too late – Holding still is impossible, stagnation turns into decay, decline (Look at the Roman Empire).

And government sponsored space exploration seemed to be in a cul-de-sac; the risks would be too high for a modern, risk adverse corporation. A small, determined group seemed to be the only way it would happen.

I was heartened by the existence of the X prize; I wasn't the only one who thought private enterprise was the way into space. The X-prize was based on the prizes that had fueled much of early aviation, and offered a 10 million dollar award to the first privately funded team to launch a three man spacecraft to a 100km suborbital trajectory, and repeat it within two weeks. But I thought the X-prize's approach of suborbital flight was a dead end. It was far easier than orbital flight because it avoided the main challenges, particularly the enormous quantity of fuel required, and the massive reentry heating. The push needed to be for orbital flight.

People didn't seem to think I was serious enough, or that I understood just what was involved. I needed to show them that I was, that I knew what would be needed, and how I planned to get there. I began work on a formal proposal. I aimed for something small, bu it eventually went over a hundred pages, plus appendices. It explored technical requirements, highlighted existing technology, and summarized my current design. (Complete, or near complete, design diagrams made up one appendices. A summary of aerodynamics simulation, and sample data, made up another).

It needed something else. A focal point. A name. I chose Icarus, after the Greek boy who saw in his fathers wax wings not just a means to escape, but a means to fly, to reach, to go beyond.

My proposal complete, I showed it to Uncle Robert. He was impressed, but still questioning. "It's still alot more than a simple paper." he said.

"It's alot of work," I admitted, "But I know it can be done."

"And the name?" he asked. "Literature was never my favorite, but didn't Icarus fall to his death?"

"Daedalus made wax wings for himself and his son, Icarus." I explained, paraphrasing the legend. "For Daedalus, they were no more than a way to escape the Island of Crete. But Icarus sought to go

higher. That is what we seek to do. Our wings too may melt, the risk must be taken. It's to only way to get anywhere."

"Risk, indeed." he agreed. He raised his eye. "You've given it alot of thought, and have some idea what you're in for; but smarter men than both of us have given these things a great deal of thought. As you say, filling is possible."

"Even so, we must try." I pointed out.

"Of course," he said, still not entirely convinced. "But a hundred page report is still not a spaceship. There's still alot you've got to do."

"And I will, but I need help." I said, knowing the power of saying it like it's already been done. "We must try - and I need your help. I can't guarantee success, but I can't think of anything better to try and do."

"You're best won't be enough." he said. "Grit and determination are never enough. It will take everything you can think of, and more. Still," he said, and looked wistfully at the wall, almost as if he was trying to convince himself. "You may be right. I can't think of anything better. For all the money it took to get us to the moon, we wouldn't have made the first step if it wasn't for the people who said 'it can be done' in the first place. I've spent thirty years working on engines for jets, nifty fighters and pedestrian, but impressive passenger jets - engines which have seen thousands of hours of use. But nothing beats shooting for the moon."

I had him. "We're not shooting for the moon, but we're taking a big step."

"Wherever it leads us," he agreed. "Then, where do we start?"

When I got back to my apartment, my roommate, Troy,w as busy with some paperwork on the kitchen table. He had an MBA, and had a management-track position at the headquarters of a major local retail chain. No doubt, he was finishing some paperwork from there, and didn't look up as he asked me how it went.

"He bought it," I said. "He liked my proposal. It showed how serious I am." I slid the notebook I'd brought back into a bookshelf. Our small apartment has a small common area, and I had filled one wall with bookshelves. Besides space and rocketry books and school textbooks (I didn't sell any back to the bookstore,) I had a broad collection, books of philosophy, history, literature (including a complete works of Shakespeare) and other things. I've had many for a long time, and many I bought in school, but I have a weak spot for books.

Troy still didn't look up. "I'm telling you, Dan, you need to forget this rocketry stuff and go into business. It took you what, a week? to put that proposal together? I've worked with people who would take a month to do that, and say they got it done quickly."

I'd long since given up arguing with Troy. We'd been roommates for two years in college, and had gotten this apartment together after graduation because it worked well for both of us - saving on rent is good when you're going through business school, or saving every penny you can up for a spaceship, but we'd found few common interests. "I just do what's necessary." I relied. Troy didn't look up as I went into my room.

Encouraged by my success, I sent several copies of the proposal to people I knew would be interested; I ran through two inkjet cartridges printing them out. I gave careful consideration as to who was worth sending a copy; who might be receptive. I sat at my desk for some time going over a list of people I had talked with, at various times. Who had been receptive when I proposed this before, who had rejected it outright. And whose talent I needed. I mailed almost a dozen copies. I would give people a few days to read it over, then meet with them, and try to persuade.

I met with Peter first, offering to buy him lunch one day. Peter was an electrical engineer I had met at work; he had recently gotten his professional engineer license. He was in many ways a classical technical college product, focused on his specialty. But he had a childhood fascination with space travel, and had once wanted to be an astronaut.

More than the seriousness of the proposal, I thought that the fact that someone else already had joined would help sway him.

"So what do you think?" I asked.

"Nice ship you've got there." he admitted. "But it's only on paper. It's going to take alot more than that to build it."

"You've read how I plan to do it." I said, "But I need your help."

"It'd take alot more people." he said. "And where do you plan on getting the money?" Pointing to the proposal, he continued, "You admit it'll take tens of millions. I know you don't have that in your bank account."

"I'll raise it." I said. "There are plenty of investors who interested in early stage projects."

"Ambitious." he said, and raised several other objections, which I countered, sometimes pointing out sections of the proposal. He also pointed out sections of the proposal - clearly he had read it - and asked me to clarify, or defend points.

Finally I said, "You took the time to read it. You must think there's something there."

"You talked me into it." he said. "And I don't doubt it's a good idea. But it's a big project, Dan, bigger than you can pull off. This is one thing" he indicated the proposal, "But to build a real spaceship? That's not a small project."

"Not so big it can't be done." I said, deciding I needed to change my approach. "What do you think of the design, anyway?"

"It looks good," he said, "As far as I can see. You've used alot of my suggestions."

"I've never been very good with electronics." I admitted.

"I've noticed." Peter said, "But beyond that, there's not alot I can say. You haven't figured most of the wiring or electronics - I don't know much about the rest, especially engines or aerodynamics, which you seem to focus on."

That was, I knew, a problem with recruiting people like Peter; when I'd asked questions outside his specialty he showed little interest. Everyone would need to think more than their own specialty. But I needed specialists, too, and an electrical engineers especially. I had to convince Peter. "Most of that's simple; I know you took the basics in physics. Have another look at the appendix tables, if you like." I wanted to encourage him to think about that. “But I'm pretty good with the aero, and my Uncle Robert has already agreed to join; he's been designing jet engines for thirty years-"

"And you need a rocket." Peter pointed out.

"And he worked on the Saturn V out of school." I said. "You're right, I can't do this alone. But we can do it. And think, Peter, you've always wanted to be an astronaut. This will be your chance."

"I'm just an electrical engineer," he pointed out, but I could tell by his tone that he was really thinking about it.

"I need an electrical engineer." I said.

He thought a moment. "You're asking me to quit my job, make a commitment, to your idea. Your proposal. It's just to much, for a few sheets of paper.

I thought a moment; it was a big commitment. "You don't need to commit right away." I said, somewhat unsure - I didn't want to loose people after we started, and it would be alot of work once we did start. "It'll take a few weeks to get things moving, refine design points. Decide what systems to work on first. You'll know then how committed we are." I hoped so, at least.

"It's still alot," he said. He was thinking about it. "I'd like to see you get some investors, at least. Then I'd consider it."

"I'm starting with my own money." i said. "It's enough to get us started, summarize designs, begin prototype work." I summarized a part of the proposal - I envisioned beginning by designing, fully, one of the systems; the first round of investment could come to build a system prototype. "Serious design. But you don't have to fully commit at first - it'll take organizing. But Peter, it's a chance to be a part of

something big."

"We'll see." Peter said, and was silent a while. Finally, he said, "Well, I'll see what you have to offer; I'm intrigued by the challenge; even designing the electrical system for a thing like this will be interesting, even if we never get off the ground."

"Then I'll let you know when we'll be meeting." I said. Talk then lapsed to general space exploration, and our common interest in space, before Peter pointed out it was time to get back to work.

A few days later, I had lunch with Susan, who I knew from school. She was a chemistry major, and we had been in the same lab group in general chemistry. We'd kept in touch since then, and I'd often asked her chemistry questions for my designs. I'd sent her a copy of the proposal along with several others.

When I thought she'd had enough time to look over everything, I gave her a call; she sounded excited to hear from me, and suggested meeting at a local deli the following Saturday, to which I agreed.

She was there when I arrived, sitting outside in the patio section. She was wearing a pink dress, and her brown hair back behind her round face. I joined her, motioning to the waiter.

“Good to see you,” she said, and I agreed. “I'm finally getting settled in my new job. It's alot to learn, and different from my last job. And a big change from class.”

“It it, indeed.” I said, then got right to the point. “What did you think about my proposal?”

She looked at me a moment, then said, “Not bad. I knew you'd put alot of thought into it, but that was more than I'd expected. Like I said on the phone, I was a little surprised to get so big a package.”

I shrugged. “I am serious about this, and I know it's a big job. Actually, putting it all down on paper like that – as opposed to diagrams and sketches – helped me to think thorough and organize some things.”

“I'm sure.” she agreed. She asked me some specific questions about the proposal, and made some

comments; she clearly had read it, and was impressed. But she also had her doubts, and reminded me how large a project it was.

“The only way to finish a big project is step by step.” I said. “We've got to start somewhere.”

She also said that she was just getting settled in her job, and that she'd been thinking about graduate school. I said the same thing I had with Peter, that she could wait to give her full commitment; it would delay graduate school, but would be an impressive thing to put on any application. "You'll be prime PhD material after this." I added.

In the end, she was much easier to convince than Peter had been, and gave a surer commitment, although she said she was still going to wait before leaving work. I said that was fine, we would probably start with a few planning meetings.

Afterwards, we talked about work, a bit, and time since we had both left school. She had graduated two years after I had, having taken chemistry as a freshman. "We should get together more often." she said.

"We'll see alot of everybody once we get this thing rolling." I said.

"I'm not talking about work," she said. "We should go see a movie, or something."

I shrugged. "I've been pretty busy." I said. "If I'm not at work, I'm working on this, or hunting down some document. I don't think I've been to the movie theater in a year and a half; they don't make much worth watching, anyway."

"I'm sure we could find time for something." she said.

"We'll see," I said, "But like I said, I'm pretty busy." I changed the subject, bringing up the latest bit of news from school. Susan sighed as she said she hadn't heard it, and we reminisced about school for a bit.

I talked to a few other people, but they remained noncommittal, so the four of us planned our first meeting. One of the local libraries had several small meeting rooms, just a table, about six chairs, and

a whiteboard with markers. It seemed like a good place to get started, so we met there one evening. I introduced everyone – this was the first time they had met - then I got things started.

"Thanks for coming," I said. "You've all seen the design in my proposal, and you know alot of the ideas I've tossed around. And you know what we're trying to do. So, what do you think?"

No one spoke for a moment; there was a bit of fidgeting. Finally, Susan spoke up, saying, "I think you're right to try and use existing equipment as much as possible," there was a nod of assent to this, "But how much are we really going to be able to find?"

"Some we will," I said, echoing my proposal, "More we'll have to adapt from existing equipment. Alot of things well have to custom build, but the basic designs are well established - like fuel cells."

"And some parts will be hard to come by," Uncle Robert pointed out. "You want to use the Shuttles thermal protection system for reentry, but how available are those parts?"

I knew Robert knew this, at least basically, and figured he was giving m an opening to elucidate details. "The reinforced carbon composite material is commercially available, but expensive. The tiles are harder to come by, but they can be found." This was some conjecture on my part; I hadn't yet found references to commercial uses or supplies, though there were similar materials.

We talked for a moment about reentry technology; I took a moment to explain some of the basic principals. "The main source of reentry heating is not friction, but the compression of the air and the formation of a shock wave. With a proper shape, a layer forms between the hottest layer of plasma and the skin of the spacecraft, insulating it. Indeed, researchers in the fifties realized that the kinetic energy of a re-entering nuclear warhead was enough to completely vaporize it. It was only with a complete study of reentry dynamics that the solutions were understood."

"Very nice history lesson," Peter said, "But can you get to the point?"

"Of course," I replied. "The lifting body shape actually has some advantages for reentry over the space shuttles planform, and existing shielding technology should be more than sufficient. Obtaining

the materials will be difficult, and expensive, but should be possible. Any other approach - and there are alot of concepts out there - will take much more time and money to solve."

We agreed that tiles and RCC panels were the way to go, and discussed other components. I had made some exploration of the availability of components and materials; but most would have to be special ordered, at least, and I wasn't in a position to make inquiries. We all agreed on my approach and general layout; we then asked, "What next?"

Peter asked, "Then where do we begin? I hope you've given that some thought?"

"I have," I said. "Design systems, one at a time, build them, test them. Once we've got a better understanding of the actual parameters and limitations of the systems, we can begin to integrate them. The question is, what system do we start with? We can start with something small - working fuel cells, for example, and get them largely working before we solicit outside funding. That will be much easier if we can show a working prototype, I think. Or we can start with one of the big systems - the engines will largely dictate what we can do with the rest of the spacecraft - there's only so much we can do without knowing how much power we'll have, how much weight we can lift."

Susan was in favor of starting small, she pointed out that there was only four of us, and besides, she had fair expertise in that area. But Uncle Robert said that anything we designed before the engines was suspect, because we might not be able to lift it. "We'll only get one shot at an engine - we'll have to develop that from scratch, and it'll take time and money. If we come up with an engine that's to underpowered or overweight, or too much or too little of anything else it needs to be, we probably won't be able to design another. And Dan is right - it pretty much dictates everything else."

And so the discussion went. I thought Uncle Robert was right, the engine needed to be designed first, because it defined everything else. But it was a big thing to start with.

Susan made a good counter-argument - once many of the other systems were developed, we would have a better idea of the weight we would have to lift, and the target we needed to design the engines

to. In other words, we could design the engines, then design the rest of the ship to be lifted by those engines; or we could design the rest of the ship, and build engines that could lift it. Still, the latter posed another risk - we could design a ship, then be unable to build engines powerful enough. We decided to design the engines first.

As we were leaving, I talked to Peter. "You didn't have too much to say." I pointed out.

"I told you before, I'm an electrical engineer, not a rocket scientist." he said. "There's not alot I can offer on engine design."

"We're all going to have to be rocket scientists to make this work." I said. "There aren't enough of us to stick to our specialties."

"Then we need more rocket scientists." he said.

"I think a small group can do this, but we all have to stretch ourselves." I said.

"Is this a real project?" Peter asked, "Or your sociology experiment? I'm interested in designing a rocket, not in being a guinea pig."

"It's no ones sociology experiment," I said, "But we're all going to have to pull our weight to make it work." I didn't want to push harder; he could still leave.

"I'll pull my weight," he said, "Just give me some electronics."

I kept myself from saying anything else, and let him leave. It was going to take work just to keep everyone together.

I got together with Uncle Robert a couple of days later, to begin laying out the engine design - not major work, just breaking it down into manageable parts.

We met again in the library, but we were leaving the engine issue aside for the moment, although I suggested that Susan should review hydrogen-oxygen chemistry, and gave her some material to read. The first issue was planning and organizing. I had made clear at the first meeting that nothing was to be considered sacrosanct; all elements of my proposal were open for discussion. But mostly our talk

revolved around putting things in motion - when we would try and raise money, what resources we had to start with, and how we would go about it. Peter wanted to know when would bring more people on.

"We've got enough to get things started." I said, saying I thought we had enough to work through designs; I had already done a fair amount of computer modeling for the airframe, and would continue that for the engines.

"I've said before, I'm not an engine designer." he replied.

"We're all going to have to do what we can." I said, reminding them that I had a good deal of reference information already. "But we're talking about organization right now - how we're going to move this forwards." Things descended from there into an argument, mostly Peter reminding us what he wasn't.

I'd been hoping we could get the preliminaries done with a couple of meetings, but we didn't get much done that time , and agreed to meet the next week. Things didn't go much smoother that time; I did my best to keep the engine design, and who would do what, off the discussion. But everything seemed to revolve around that. Once again, we had to agree to get together again the next week.

Susan pulled me aside as we left. "He's really getting to be too much," she said. "If we all stick to our specialties, we're not going to get anywhere."

"I know," I said, "I just don't want to push too hard. I'm hoping to ease him into it, a little bit."

"I'm just getting tired of it," she said. "But that can wait until next week. I was going to see a movie this weekend; you're welcome to come along."

"Thanks," I said, "But I've got work to do."

Uncle Robert was waiting for me outside. "You're going to need to show a little leadership in there," he said. "This isn't a very convincing group."

I tried to chat Peter up about it at work, but he didn't want to talk - and he was busy with several projects. Things seemed to have picked up for him; I wondered if he'd taken on any new projects, and

worried that he might be having second thoughts. Nervously, I asked one of the people who was working with him if Peter had been taking on any new projects. He replied, shaking his head, "No, things have just picked up for him." He paused, then added, "Actually, he seems to be working ahead on a couple of things, like he's hurrying to get them wrapped up."

Wrapping things up? That sounded promising, but either way, Uncle Robert was right; I had to do something.

I decided to push a little more, asking people - especially Peter - specific questions, especially engine related. I had came up with a short list of engine questions, all related to the electronic components of the engine, aiming to relate the electronic component to him. He said he didn't know, said I should ask the engine expert, but I did get him interested in the topic.

There was more argument when I turned talk back towards organization.

Maybe I was trying too hard; we didn't need a real formal organization, just a basic outline plan. Peter was even less interested in that than in the engine, but I reminded him he needed to plan to get the electronic components to work, too.

I also tried not to tolerate the fighting that was already starting to emerge. There was only so much I could do, but I did what I could.

Things didn't settle down, not really, but we were getting somewhere. We settled on a plan of action, at least, and some basic things, after a fourth meeting.

Organization questions finally answered, I began the process of formally chartering the Icarus Project, and we began really thinking about the engine.

Peter still didn't want to work much with it. But I pressed him, and he did start to give useful advice.

We had to decide how many engines to use. More engines gives a greater safety margin in case of failure - but more engines also means there are more that can fail. More engines also means each one

is smaller, and a little easier to design. We decided on a cluster of four engines, and quickly settled on a target thrust and burn duration. We based our basic design on the Space Shuttle Main Engines, and the design parameters would be similar - liquid hydrogen / liquid oxygen, throttleable.

Our overall plan was to sketch out the basic plan and parameters of the engine in several meetings, then decide how to continue. That was the point I hoped to organize as full time work.

Peter continued to resist my efforts to pull him into the discussion, but he also contributed - on his own, he brought an almost complete electronic plan for the engines. Hydrogen engines need a continual ignition charge, and we planned on using solenoids to control the various valves and components of the engine. Among other things, Peter designed an electronic throttle system, complete with chokes (hydrogen engines need to be cutoff in a very specific manner.)

We soon had a basic engine plan. It was very similar to the SSMEs, though somewhat different in shape - long and thin, where the SSMEs were short and fatter. We took some risks designwise, using the most advanced configurations, routing preburned hydrogen into the engine. This had been done in a few engines and greatly increased efficiency - but it presented substantial challenges, and the technical information would be difficult to come by.

Now for the hard part, I thought as we wrapped up the basic sketching. The whiteboard was covered with the engine diagram. "This," I said, "Is just drawings on a board; as you've all said, it's going to take more than a little bit of sketching to make this thing work. I said a while back there would be a little time before we needed a full commitment. That time has come. We need to make the Icarus project real, commit our full efforts towards it." This was a critical moment, I knew. Peter had been getting steadily more involved, but was still on the fence. Susan had already proved invaluable, having applied the fuel calculations for hydrogen rockets to our design; but she seemed oddly uncertain here. Uncle Robert was with me, I knew, but only as long as he thought I could make something happen.

"We can build this." I said. "And we can fly it. We will fly it. I can think of nothing better to do but to make this happen. It won't be easy - I dare say we can do was NASA has not, by building on what they have already done. I may sound sometimes like I think we can do what NASA cannot, that we are better than thousands of the best. I do not mean this. Issac Newton once said, 'If I have seen farther it is by standing on the shoulders of Giants'. We can stand on NASA's shoulders and see the universe. We may stumble, and our wings may melt like Icarus - but we must try. We must fly, and I will not rest until I have traveled among the stars."

A little dramatic, perhaps, but in that moment, I knew I had them. We signed the paperwork right there, chartering the Icarus Project as a partnership, and made our plans. None of us could leave work immediately, but we all could give notice. Peter admitted that he had been trying to wrap up his work in preparation for this. We would continued to meet regularly until then, and I would begin scouting for work locations (we couldn't work in the library, after all)

And so it was done. Peter's departure from work met with a fair amount of surprise; mine less so. Susan said she wouldn't be able to break away immediately; she would need to remain available for some time to finish certain projects. Uncle Robert, being fairly senior in his position, also would have to disentangle himself slowly.

As we continued meeting, we refined a few specific parts of the design, and planned our approach. We did our best to keep things within everyone's knowledge base - Peter would design the electrical components, for example, and Susan would make sure the fuel mixtures were right.

Finding office space was a bigger problem. Besides the question of time (it's hard to rent anything quickly) even a small amount of space would be expensive. But Uncle Robert finally, and a little reluctantly, suggested the only real solution - we could work in his apartment. I told him we could find something else - that wasn't necessary - if we used anyone's apartment, it should be mine, but that could never be worked with my roommate - we both knew his was the only option.

And so, I began bringing many of my rocketry books to his apartment, and one of my computers, which I use for most of my modeling and simulation work. We cleaned the table off, and I got a couple of extra chairs, and some other equipment - drafting supplies, things like that.

Money would be and issue for everyone, for a while - I could live on my savings for a while, as could Uncle Robert, and both of us were going to commit money to the project. Some of that would help Susan and Peter pay for things, but it wouldn't be much of a salary. Raising money would have to come soon. But some of that we would deal with as it came; we'd planned what we could plan. My hope was that we would have a complete engine plan within a few weeks.

We started on a Monday; I took a few minutes to set out a few ground rules - lunchtime, breaks, like any other office. We would work as long as we needed to, though - the sooner we finished, the better.

Uncle Robert seemed a little uneasy with sharing his apartment, though - he made his bedroom off limits, and for a while, kept an eye on anyone who went into the kitchen or bathroom.

"You invited us." I pointed out during a break in our work.

"I still don't like everyone in my space." he said. He shrugged, "But we do what we must." Later, though, as we were having lunch, Peter a negative comment about a picture Uncle Robert had hanging; a Norman Rockwell reproduction, the classic "Triple Self Portrait." Robert got real defensive, reminding Peter that it was his apartment, and didn't say anything to him the rest of the day.

Still, things settled int a routine through th rest of the week. We started off by going over the parts of the engine, discussing approaches, components. Peter brought up electrical again. "What are we going to use as the ultimate power source?" he asked. "Will we draw power from engine turbines?"

"The engines can draw from the ships power supply," I said. We had discussed this before. "Fuel cells and batteries, running a twenty-four volt electrical system."

"It'll need to be stepped up for ignition." Peter said. "A cars induction coil should be adequate, if you want to use existing technology."

"That's a reliability issue," Uncle Robert said, pointing out that engine failure in a car was an annoyance, but a failure of an engine during launch could have catastrophic consequences. "That is one of the costs of using 'off the shelf' components. They're usually not designed for the load - or criticality of function - that we're asking."

It was a fair point, and we talked about it for a few minutes, but I cut it short, saying that we could address each function at a time. Besides, I had a specific point to the component in question. "Car ignition systems are designed to produce a rapid series of high voltage sparks. We need a constant ignition voltage for about eight minutes."

"The same principal should work, though," Peter said. "Just let me know what voltage you need for ignition, and I'll give it to you."

Much of the work was done individually, Peter drawing schematics, Susan working out fuel relationships given the evolving parameters of the engine, and we spread out over Uncle Robert's apartment as we did so - he sometimes cast a sharp on on Peter as they both worked.

That weekend, my sister, Abigail, called. Abby has always been the adventurer of the family - mom says she could "scale a kitchen cabinet at eighteen months," and she's got the scars to prove it. She's two years older than me, and has been a wanderer since she finished school.

"I hear you quit work to work on your rocket ship." she said.

"Yea, a couple of weeks ago." I said, and told her a bit about it. "There's alot to do."

"You know, I never thought you'd actually do it," she sad. "You talked about it enough, of course. But quit work for it? I would have done that long ago, if it were me."

"Yes," I said, "and in another week you would be off on something else. But anyway, how've things been? I haven't heard from you a while." I knew Abby didn't really care much about my SSTO, and she was glad to change the subject, telling me about the latest of her travels - she'd been staying in New Mexico for the last couple of months, with a new boyfriend - she told m I'd love the Grand Canyon. I

said I'd love to see it, and expressed surprise she'd been with the same boyfriend for two months, and asked when she thought she'd be back in town (she didn't know.) Shortly, she said she had to be off, and would call back when she had a chance, and wished me luck. I knew she doubted my spaceship would ever become anything, but she was honest in her congratulations.

Work continued on the rocket motor, but we quickly descended into problems. Everyone was working on their own parts; but there was too much of the engine outside of that. Too many parts that just weren't getting considered. I started to take a more active directing approach, saying we needed to work on this component or that part. But Peter continued to protest that he was "only an electrical engineer", though he was working on other things when pressed, and Uncle Robert was getting irritated with him. Susan began to try and mediate between the two of them, which helped a little.

We made progress, finalizing the exhaust nozzle and combustion chamber design; but work on the turbopumps that would supply fuel and oxygen to the engines just turned into arguments.

"I've said it before, and I'll say it again," Peter protested. We'd been working for three weeks, and it was finally coming to a head. "I'm and electrical engineer, no more. I've done what I can. If you need more than that, you're just going to need more people."

"We've got the people we need," I said, "I'm certain of that. We just need to stretch ourselves. If you want to fly in space, you're going to have to push it."

"Relax, Dan," Susan said. "You know, Peter is right. We've not been trained for this. Peter is an electrician-"

"An electrical engineer," Peter protested.

"And I am a chemist." Susan continued without pause. She shook her head in the negative. "You ask too much - we can only do what we know."

"And is what you know limited by what you're professors have told you in school?" I demanded. "Uncle Robert, was in anything you learned in school that got you your job on the Saturn rocket?"

"My degree," he said, "And alot of hard work."

"But what did you actually learn in school that you used?" I asked. This was true, I knew; I'd sometimes wondered how my degree was supposed to help me.

"I'm an engineer," he said, "I know how things go together." But he continued before I could say more. "But we're only as good as what we've been taught, our experience. If I've used more than school along the way, it's because there were others to show me the way."

"And I've tried to show you all what we'll need," I said, gesturing to the bookshelf I'd brought over. "If there's any bit of knowledge you need, I'll do my best to find it. But we have to stretch ourselves to make this work."

"If you can find it, then you can use it," Peter said, dismissively. "I told you, this wasn't going to work." He hissed. "I'm going home, it"s been fun, guys."

I protested as he left, but to nothing, and he slammed the door.

"Well that was good." Uncle Robert said. "You really know how to run a show."

I shot him a dirty look, but Susan said, "Come on, Dan, you can only ask so much." she looked at Uncle Robert and me, shrugging. "I guess that's it, then. I'm sorry, Dan, we should still get together sometime. If that's it for today..."

I nodded, and she left.

"You need to work on things a bit." Uncle Robert said.

"You saw how it went!" I said, "If people were just willing to stretch out of their little niches."

"But engineers are taught to know what they don't know." Uncle Robert said. "And you need to specialize if you're going to et any depth at all."

"And if you don't know how the parts go together ..." I said. "But no ... I understand. Well, this isn't over, Uncle Robert."

"Maybe not," he said, looking at the door. "But you're not any closer.

I sped my truck around the beltway as I headed back home. At least I was avoiding the traffic, I thought - it's jammed during rush hour.

I couldn't let it stop like this, couldn't afford to. But maybe Uncle Robert was right - there as just too much to do. Was my whole idea wrong?

But the Wright brothers had accomplished so much almost by themselves, and many other inventions had been done in small groups. Granted, this was much more difficult, in many ways - but most of what we were doing was incorporating existing components.

We had to do it. We had to get it done.

I wasn't sure whether Peter intended to come back, or Susan. I decided to officially let things cool for a couple of days, and try and talk to the both of them; I left messages for everyone to that extent.

Peter didn't get back to me for a few days, but Susan did the next day, and I met her for lunch. She said the same thing everyone had been, maybe I was pushing to hard, expecting too much. She understood Peter's problem, and said she didn't know alot of the things I as asking. I asked if she was still with me.

"As much as I can," she said, "But maybe we need more people."

"We will need more people, as time goes on," I said. "But we can't hire experts in every component we'll need. If we were building this from scratch, we might need to do that. But the knowledge is out there, we just have to figure out how to put it together. I think we can manage - we just need to push, to learn the things we don't know."

Susan was doubtful, but said she was trying. But she wasn't in this for nothing - we had to show signs of moving towards our goal.

I still couldn't get in touch with Peter. Finally, he called me back, and we were able to get together. he wasn't sorry for what had happened, and he repeated that he was only an electrical engineer - but I could tell he didn't really want to quit. I said we all had our strengths to bring to the table - and I

needed an electrical engineer more than many other things - but we were all going to have to do alot more than that.

If he had really wanted to quit, I wouldn't have been able to talk him into coming back. But he did com back; early the next week, we were meeting again.

Things didn't go much smoother, not really. But I think we had a better idea where everyone's buttons were, and tried not to push them. Sometimes Susan mediated between the rest of us, sometimes not. I tried to do a better job of leading the efforts, with some success.

A few weeks after that little interruption, we were working on the oxygen turbopump. Even Peter was making some good suggestions. But we had been working on the same pump for almost a week, and I was beginning to think we were stuck. "We could widen the blades," I suggested, "without widening the turbine core. Increased blade overhang should gain efficiency."

"But you're last run of simulations suggested we were already at optimum width." Uncle Robert pointed out. "I still think a two stage design would be better. It would keep things cooler."

"And also add weight," I pointed out. "We've got to keep a check on that."

"What about bypass oxygen for coolant flow?" Susan suggested, pointing out an article she had just been reading a couple of days before. I had made available several aviation engineering magazines I already subscribed to.

"Propellant weight," I said. I had read the same article and been intrigued; but it had an efficiency cost. "We can't afford to throw away fifteen percent of the O2 as coolant."

"What about recycling it into the flow?" she suggested.

"Much more problematic design," I said, "And it hasn't been tried; there are no designs, or design studies, we can work from."

Peter pointed out, "It took hundreds of engineers to come up with any of these designs. We're just not going to be able to match them."

“We don't have to match them,” I replied, “But we've got to use what they've already done. It's all here, we've just got to put it together.”

“Then why didn't they?” Peter asked.

“They were doing something else,” I said. “Even the SSME had slightly different design constraints. But we're working from that model, and putting the best of other engines into it. We're not doing this from scratch.” If we were, if there wasn't so much information on the design and behavior or hydrogen rockets available, I knew we wouldn't even have gotten this far.

“It's still a tall order.” Uncle Robert pointed out, “As I've said from the beginning.”

I could tell everyone was getting fatigued, strained. It was so simple, in principal. But getting it to work wasn't But it was important. “I know it's a tall order; Everest is a tall mountain, and that's why people climb it. We can do this. If we are few, we can react quickly, we can work everything as one team. We can use what others have done. But we can do this, and we must do this. If we don't reach for greater than we are, we will fail, will fall, and will decline. We must do this, and we can do this.”

And so we continued. The final design was largely an adaptation of the SSMEs, synthesized with features from several other engines. It still wasn't - quite - a completed design - we had to "fudge" a number of components in hopes that we would later be able to obtain better information on equivalent parts in real engines. Still, I did a great deal of computer modeling, and we agreed it was as far as we could take it. We had to start building parts, and we needed money for that. It was time to seek funding.

I started by creating a new proposal, this time intended to attract financing. I had considered reworking my previous version, but a complete rewrite was necessary, as this round was dedicated to engine development. The new proposal opened with a brief description of our goals and the design for the Icarus spacecraft, then focused on the engine design. It pointed out that a completed rocket engine alone would be a very marketable product, even if we were unable to go further.

I approached a couple of banks, but was turned down quickly, which I expected. We had little to offer for collateral, and no prospect of beginning repayment for several years. I then turned towards other sources.

I had made a fair study of the various modes of startup financing, and put that to use, identifying several groups who fund early stage and startup companies. I added a brief prospectus to the proposal, and sent it out.

It was, however, late spring 2000, and the dot-com bubble was in the process of bursting. At first, I didn't get any bites at all, and I began to curse my luck and bad timing. But in time, I got a few calls. Most were just requests for more information, but there was some serious interest. Finally, a meeting was arranged.

I reviewed information on the company before I went in. Like most of the firms I had contacted, they specialized in providing startup and early funding to companies several years from profitability. I had some limited information on some of the ventures they had funded, and on the holdings of their principal investors, and other information I had found.

I was very nervous as I went in. I don't do this very well, or often. If there's one thing I'm not, it's a salesman. I hate job interviews for the same reason, and have been known to postpone them, just because I was nervous. (I lost at least one summer job that way, when I was in school.)

But this had to be done, and I was the one to do it. Still, I hesitated before going in the door, and introducing myself.

The receptionist told me to sit down, and paged Damon Santiago, the investor I was to meet. He was out in a moment, and I was up, shaking his hand firmly and remembering all the interview tips mom had told me.

This was, after all, an interview, and I was trying to persuade him to give me a good deal of money.

He welcomed me into his office, which was decorated with several colorful pictures of sailboats,

and bade me sit down, asking why I thought he should give me money.

I launched into a summary of my proposal, focusing on the engine, and the prospect that a functional engine would be a viable product itself. I began to feel more at ease as I spoke, but for a hint of nervousness. He listened intently for several minutes, then motioned for me to stop. "You're pretty much summarizing your proposal, which was impressive. But what I really want to know is, how do you propose to make a real business out of this?"

"Access to space can be enormously profitable," I explained, changing mental gears with slight difficulty, and focusing on the need. "The commercial value of unmanned satellites is already proven, but is dependent of government launchers and equipment - and once a satellite is in orbit, it's on it's own. If it develops a problem, there can be no repair mission. Think what AT&T would pay to repair a failed fifty million dollar satellite, instead of launching a replacement. If you want more prospective profit, Dennis Tito has already offered the Russians $20 million dollars for a trip to the space station. The startup cost would be enormous; but a handful of those tickets would make it up, and a handsome profit."

"Perhaps," he said, "But that requires getting there." He didn't invite debate on that point, but asked several probing questions, which I answered honestly, if optimistically.

Finally, he said, "Well, Daniel, you certainly seem to have a good idea of what you need. I'm not sure you've got enough to pull it off, but I admire determination. I'll look over your material again, and get back to you." He rose, and led me out.

It wasn't an outright rejection, but he didn't sound impressed. Still, I couldn't feel too bad as I left; he at least sounded interested, and I was relieved it was over.

I went to other meetings, and they went about the same, or worse - investors weren't afraid to say they thought their money as best invested somewhere else. But I refined my pitch each time, taking note of what had impressed and what hadn't.

I hadn't restricted interest to only local firms, and I found myself flying much more than I was used to; I had expected to use a fair amount of my startup money flying around to find funding. The fact that I was traveling so far for initial funding was noticed by a few contacts. I said I knew I would need the right kind of investor, one who was willing to take a big risk for a big prize, and was willing to travel to find them.

The small size of the group attracted notice; I pointed out that most of what we needed already existed, we just needed to find new ways to put it together. More concern was raised about our degrees, all four of us had only bachelors degrees. "I would feel better if you had even a single PhD." one investor pointed out.

“The Wright brothers had no degrees at all.” I pointed out

It was beginning to get depressing.

We were continuing to work. There wasn't much more we could do with the engine, although we continued to consider some of the parts we still needed to finish, but we considered some other systems. In particular the power system and fuel cells, since they would be essential to almost everything else.

In principal, fuel cells are quite simple. Susan worked out the equations for our needs, and Peter the electrical layout. We defined our basic power needs, and wanted several cells for redundancy. The biggest problem comes with the materials, some of which are quite expensive, and the need to precisely control the reaction conditions. Like many parts of the Icarus, it was simple in principal, difficult, and expensive, in practice.

Close study of fuel cells led me to something I began including in my sales pitch, however. Much of the material cost - and overall development cost - came because the exotic materials aren't broadly used. However, they would come down significantly once we developed a market for them. I was thus able to demonstrate that we would be able to bring long term costs down, once we succeeded. "It won't

help us getting started," I said, "But once we are able to reach space, we will be able to do it cheaper."

But we had to get there first. We needed money. We weren't burning through savings too fast, rent and living expenses as the biggest part of it - but we were burning through it.

But persistence pays off, and I did find interest. In some ways, the dot-com decline helped us, as investors were looking for other places to invest their money. I began to work this into my pitch, as well, suggesting it as a new field to invest in. Interest eventually turned to offers, and finally negotiated our first venture deals. It wasn't much, not the the eventual sums we would need, but it was enough to get started.

"Well, congratulations, Dan," Uncle Robert said, the day after I closed on our third deal. "We were all beginning to wonder, but you've gotten us started. You've gotten some investments."

"Yea," Peter added, "I didn't think you'd be able to do it, get people to give us money for this."

"Well," I said, "We can't just sit on it. The first thing we should do is to find a real working location." I suggested the couple of things I thought we would need, a fairly large, open workspace, maybe on old warehouse. And an open enough area we would be able to conduct engine tests.

"You don't think you're getting ahead of yourself?" Uncle Robert asked. "We've got to build the engine first; finding somewhere with enough space to do that should be our priority."

"We still need to think ahead," I said. "We will have to test the engine, eventually; having to transport it to a test site is going to be expensive. We won't be able to waste the money."

Peter pointed out we could cross that bridge then; we might only have to transport the engine once, to the test site, then store it there.

Uncle Robert pointed out that we would eventually have to transport the engine, and to wherever we built the spacecraft, unless we built right at a suitable airport now. "And I don't know of any nearby."

Even with those questions unanswered, it was still a tricky question. We needed cheap space, of course, and suitable for creation of some sort of workshop. We would need a fair amount of space,

even without testing. Wherever we did test the engine, and probably for cold tests as well, we would need to be able to store liquid oxygen and hydrogen, an additional hazard. On costs alone, we decided we would probably need to be fairly far out.

This posed another problem; the best area would to be west of Dulles, and outside of Leesburg even better. That would be enough of a drive for Peter, Susan and I, but would be a couple of hours for Uncle Robert, coming from Maryland.

"First we invade your apartment," I said, as we were touring one location. "Then we make you work two hours away from it." He just grunted at that.

We did find some promising sites around Leesburg, and spent some time touring several. We would drive separately to the area, then tour three or four locations.

On one stop, while we were touring an auto repair shop that had closed down a while back, Peter said, "We're going to have to hire some mechanics, at least. or are you expecting us to become skilled metalworkers, as well?" Lately, at least, Peter had been trying to gain understanding - and contributions, beyond the electrical systems.

"We'll have to hire a couple of techs, at least." I agreed. "But no more than we need. We should try and gain some basic fabrication skills. I looked around the former garage; most of the equipment was gone, but it was a good space for a workshop. "Something like this would work very well," I suggested. "But it's pretty small. For the engine alone, we'll need three or four times the floor space."

Noting the remnants of the fittings for the lifts, Susan asked, "What kind of specialized equipment are we going to need to bring in here? I mean, how much are we going to have to renovate?"

It was a good question, and brought up another discussion. We had planned on leasing any property we used; it would be cheaper, and commercial leases allow - and include - extensive renovations. But there are always limits, especially for additions that would be harder to sell to the next tenant. We extended our explorations to properties for sale.

It was a fortunate move, for in a fortunate find, we found an old warehouse a few miles west of Leesburg. It was on a fair sized property, but a little overgrown, and the building needed minor work. It had disadvantages; the distance was a little further than we wanted, was on a pretty small road, and was still a bit expensive; but it was still a good deal.

To buy, we needed a commercial mortgage, which would be almost as difficult to get as the business loans I had explored some time before - but no we would at least have collateral. That was the angle I took as I went into the bank. I toned down my pitch from that used for investors, and pointed out that we would renovate the building, making it excellent collateral. The first two banks turned me down almost without thinking.

At a bank down in Springfield, I could tell the banker was intrigued. I was careful with my pitch, but opened it up just a little bit. "I don't pretend this is anything but a risky investment," I said, "But It'll be a chance to get in on the round floor of something real big."

"We try to avoid too risky investments," the banker, a man named Frank Davis, said. Had I read him wrong, was he about to turn us down? "But there's something inviting about your enterprise. I think we may be able to work out a deal."

And so we did. It was a conservative deal, carefully limited in scope, and we had to put up much of the money we had already raised as down payment, but it was a deal. More important, it would prove to be the beginning of a very successful business relationship.

We began listing tools and equipment we would need, and technicians to operate them. A real problem was tolerances; finding the basic equipment we would need would be fairly easy; but finding equipment precise enough to meet our purposes would be much more difficult.

And we needed people; not rocket scientists, but technicians and fabricators of the first class. We started on a lookout for all of them.

First, though, we contracted for the renovation of the building. It had been a small warehouse at one

point, but had been empty for several years. Working with a construction company, I did my best to oversee the work; we kept most of the changes small to avoid extensive approvals, and the need for an architect. It was already laid out well enough, an open space, with a section of offices in one corner. We had some bench space set up on one wall, and a few fixtures. One thing we did do - and Peter signed the engineers papers for this – was to overhaul the electrical supply for the building. The power company raised an eye when he looked at the capacity of line we were putting in.

With work underway, we began sourcing equipment, and seeking techs. Uncle Robert had an idea, and called up one of the people he had worked with, who had extensive experience building jet engines. More than that, however, Uncle Robert said, "He's built two kitplanes in his garage; that should be just the kind of experience we need."

Hank was his name, and he was hesitant to leave a stable job, especially a few years from retirement. But the project intrigued him, and he signed on. He would prove a fortunate find, as well. He had little skill in design, but had worked with almost every tool in the existence, and was a true craftsman. He would prove able to work a took far beyond it's design specs, or rework a tool beyond it's original intent. He could weld, or bolt, or turn metal or wood by lathe; and his kitplane building had given him experience with composites, as well. Better, he was a natural teacher, always ready to show us - or another worker - how to use a tool. We made him shop foreman, and with his help, had soon hired three additional technicians, and began the process of outfitting our workshop.

While that was going on, I was continuing to pursue funding. With one investment, others come a little easier, and I was getting better at selling it. Sometimes, I got advice, instead, which could be even more valuable, or contacts.

I also began making contacts with other companies, possible suppliers, and other rocket builders.. Potential competitors weren't too free with their trade secrets, and some companies laughed off our requests for parts - but some didn't. We were making progress.

By fall, most of the renovations were done (that was another reason we kept them minor) and we moved all operations there. I used my truck to haul most of my books and relevant documents over there, as well as computers. I began carpooling with Peter, often in my truck, because his apartment was only about twenty minutes from mine. We tried not to talk about work too much, but sometimes he complained that he was only an electrical engineer.

The drive quickly got too far for Uncle Robert. He had me haul his couch over to the warehouse, however, and began sleeping there many nights.

We began receiving equipment, installing it, adapting it. The warehouse included large storage closets, and we begin setting them up with supplies.

I began doing the books, with an accounting book for frequent reference. Things started to look not so good.

"We're running out of money." I finally admitted, looking up from the screen one day. "We'll be depleted in a couple of weeks."

"We're still better than we were when we started." Susan pointed out.

"Yea, but then we didn't have expenses, either." I said. "We're putting money out pretty quickly, and suppliers will get cranky if we don't make payments."

It called for another round of investment seeking. But that's not a quick process, even calling on those who have already invested, and might be talked into more. We called suppliers and let them know we had a problem, and they weren't happy. We told employees that they might have to wait for their paychecks, and they were even less happy.

After some discussion, we decided to suspend operations for a week. Our techs were whining as they left, one was saying "First they say, 'don't wait for your paycheck,' then they say 'don't bother coming in.' And I quit my steady job for this?"

I waved to them, motioned them to come over a moment. "We're not getting paid either," I said,

motioning to Uncle Robert, Susan and Peter. “And no, I don't know what's going to happen; I'm working on it as fast as I can. But think to yourselves, can you think of being a part of anything as ambitious as this?"

Walking back towards Uncle Robert, I said, "I hope they come back."

"I think they'll be back," he said, "As long as we don't take too long."

In fact, I got a call the very next week, one of our original investors willing to expand his stake. He gave warning, though, that we couldn't expect infinite money. He - and other investors - understood it would be a while before we showed revenue, but we needed to show something, soon.

Things got back on track, but the break shook everyone. I redoubled efforts to raise money, and we moved things along.

We needed something to show. Thus far, we had been installing equipment, assembling test components. Part of the engine built, at least. I suggested we begin with the nozzle and combustion chamber, if we were ready for materials fabrication.

However, Susan pointed out that the nozzle would be piped with liquid hydrogen for cooling. "We can start fabrication," she said, "But if we're going to test as we go along," which was our plan, "We're going to need at least a small supply of cryogenic fuels as we go along."

She was right, and so we built tanks for both, in limited quantities. The liquid oxygen as simple enough, and easy to buy. The liquid H2 posed severe problems, however. The tank was colder, but not undoable. But we needed permits to keep it on premises and approvals for the tank. And it was much more expensive. I had to call more investors.

We soon questioned the idea of building the nozzle first - we would have to way to test it's heat tolerance or structural integrity without most of the rest of the engine. We decided to begin with the preburner/turbopumps that would supply fuel and oxidizer instead, party because this would give us experience with burning H2/O2. We would still need a supply of both liquids, so it wasn't a total loss.

We reviewed our turbopump design, and started construction. The hydrogen preburners would burn a very H2 rich mixture, producing an H2 steam. This would then drive the turbopumps which would pressurize the hydrogen and oxygen supplies.

We didn't have exactly ideal working conditions, even with the space - turbines can be very sensitive to dust. And with only four designers and as many technicians, it made for alot of work. There was some complaining, but Hank had put together every part of his aircraft; hew knew what to expect, and kept the others in line. I encouraged them, giving them little bits of my sales pitch, trying to gradually build interest in the larger project. they all had some; that was one of the things we had looked for, and I tried to build on it. I also made a point to work with Hank learning to use various tools and equipment. And we all had roles on the floor, supervising the installation of the pumps components; in particular, Peter oversaw the control circuits application. In a matter of weeks, we were ready for our first test.

Hank oversaw the preparation of the test, inspecting the chimney that would route the hydrogen-rich steam outside, and watching as two other techs connected the cryogenic tanks. Peter checked the connections on several instruments that would monitor the tests, and Susan set the data logging system and calibrated the sensors. Uncle Robert and the other tech was checking the fire suppression system, which would automatically swamp the turbopump. The pump was also between two thick brick walls to contain problems.

Hand indicated for us to step back, and we retreated into the office area. Susan activated the automatic test. The electric pumps supplying the liquid fuel activated, and the preburners lit a moment later. The turbine began to spin up, and Susan announced, "The electric pumps have cut out; turbopump is now drawing it's own Hydrogen." I watched her monitor showed the mixture feeding the preburner, and the hydrogen-rich exhaust; I thought for a moment of the cost of the hydrogen that was being vented into the atmosphere. The whine of the turbine was becoming audible through the wall,

and I watched as the turbine hit speed and pressure, and the control unit held it at speed.

After a programmed interval, the turbine slowed down and stopped; the screen showed that the sequence was complete; extra oxygen was being pumped through to vent any remaining exhaust. "Logging test data." Susan reported.

"Very good," I said. "Well, thank you, everybody. This seems like a good start. The test area will be clear in fifteen minutes."

Later review of the test data showed that the pumped had performed exactly as intended. A few adjustments were needed, then the pump was run for a longer test, to verify there were no overheat or durability problems. We then began on the second turbopump complex.

With a part complete, it was a little easier to raise money. We were no longer a "paper project" but had built something, one small part. Existing investors offered a little more, and more investors were found. It was still alot of work, I spent at least a day a week selling us, more if I had to travel out of town, but a few of the investors I talked with were interested. Money as still tight, and I watched it like a hawk, us never far from running out of money. Our costs had actually gone down a little, with the renovation complete, but there were still parts, mortgage payments, and salaries, but we were never comfortable.

Using cryogenic propellants - liquid oxygen and hydrogen - also posed problems. We had taken into account insulation of fuel lines and such, based on known figures, but of course we had to adapt those to our purposes, as we developed our parts.

Susan came to me one day with one of the aerospace magazines I had subscribed, pointing out an article on the use of RP-1 rocket fuel, a highly refined grade of kerosene, for proposed SSTOs. I scanned the article quickly; it noted that the lower efficiency of RP-1 was partly offset by slightly simpler engines, lighter, uninsulated tank, and more compact, if heavier storage volumes.

"You still can't get passed the energy efficiency of Hydrogen," I replied. "It's a very narrow margin

we have to hit to keep our mass fraction high enough; hydrogen's just the best way o hit it."

"But it also adds mass," Susan pointed out, "And it's not very easy to work with. We could at least look at RP-1."

"I've already looked at it," I said, dismissively, "Hydrogen is the way to go."

A few days later, I as at my desk, looking over design specs. We didn't have formal offices; the "office area" had a receptionists desk and waiting area in the front, and a mostly open space behind a wall. There were desks for all of us, some kitchen supplies in one corner, a couch and coffee table; Uncle Robert slept on the couch when he stayed overnight.

I was looking over the results of my latest computer simulation, when Hank and Uncle Robert came in. "We might have a problem, Dan."

I looked up, and Hank explained. "We've been disassembling and inspecting the turbopump assemblies." This was an important - and time consuming, as we were finding out - part of system development. Since we had concluded testing, we were taking the components apart, to make sure there weren't any hidden problems. "There was signs of excessive heat stress on the inside all of the oxygen turbopump." I already knew that had been noted. It could be catastrophic if the pump wall failed; the pumps were double-walled, with channels for liquid hydrogen coolant between the walls. If that penetrated into the high pressure oxygen...

Uncle Robert continued, "Susan just finished chemical tests," she'd complained about that, a bit; metallurgy wasn't her specialty either, "And the wall is definitely heat compromised. She's double checking her tests now, but we can't use the pump wall as is."

I frowned; the metal was of adequate grade and should have held under the conditions; I pointed this out to them. "I'll check the test data again. Has Susan pinpointed the actual peak metal temperatures? Is there any chance the instrument readings were off?"

"She estimated it to be higher than intended." Uncle Robert reported.

I nodded, and told them to continue the inspection of the turbopumps; they were muttering something as they returned to the shop floor.

I put the simulation data aside and called up the turbopump test results. I had spent a fair amount of time right after the test compiling the data and running analysis; I pulled out the printed summary folder, and called up the raw data on the computer. I also called up the data for the hydrogen turbopump system, which was the same basic design as the O2 pump, but with somewhat different flow rates and specs.

I flipped through screens of temperature graphs, heat and pressure levels, RPM curves; indications had shown temperature and pressure to be just above predicted levels.

We sat down to discuss it the next day. Susan had continued her chemical analysis, she said that the level of thermal breakdown indicated that the metal had been at least 150 kelvins above design levels, but she thought other chemical indications indicated "maybe 25-50 kelvins high." She was still trying to work out the discrepancy.

Uncle Robert had been working with the technicians as they continued to break down the turbopumps; he detailed the extent of the damaged area - it extended all around the turbine, so it wasn't a local hot spot - it also wasn't concentrated around a hidden defect. I asked if there as any comparable damage on the hydrogen turbopump. He said there wasn't. "We disassembled the hydrogen pump first," he said, "and didn't see anything. We had another look once we found the problem, but didn't see anything."

"We should run an analysis of the hydrogen pump, for comparison." I said. "The oxygen pump shouldn't be running that much hotter."

"That would require alot of metal to be removed," Susan said, pointing out that she had been able to analyze the other pump because of the charred state of the metal, but removing that much material could compromise the other turbine wall. This isn't science fiction; I can't just put a scanner up to it

and see how hot it got."

"It still needs to be looked at." I said. "Do what you can."

"I'll do what needs to be done." Susan said.

Peter had been reviewing the electrical connections on the turbopump; there were no apparent defects that might explain an incorrect temperature. There also was no sign of overheated or damaged wires, as might be expected with an improperly functioning engine.

I then reviewed my own work, emphasizing my concern over incorrect reading and pointed out that incorrect readings could have led the system to run too hot. "I didn't find any evidence of that, though," I said, noting that such problems tend to leave other discrepancies; everything had appeared to run as expected.

A few ideas were suggested, but nothing satisfactory. We agreed it was crucial; failure of the inner wall would lead to coolant loss and pump overheat; it could also lead to fire.

"The metal was definitely too hot," Susan said. "Metallurgical changes show that clearly. But my expertise in metallurgy is limited; I can't be sure how hot it was."

"What about instrument failures?" I asked, telling Peter to double check a couple of the relevant sensors.

"I said I checked the wiring," Peter said, "I'm following everything out as the evidence dictates. Unless you think you can do better?"

"No, of course," I said, "I just want to be sure it's not a sensor problem." Peter assured me he would let me know if he found anything.

We didn't come up with anything else of use, and we went to continue our investigations. Susan waited a moment for Peter and Uncle Robert to leave, then said, "We all know what we need to do," she said, "You don't need to tell us."

"I just need to be sure everything's covered." I said. "We're not going to be able to afford too much

backtracking."

"But we may have to backtrack," Susan said, reminding me of a couple of dead ends Uncle Robert had told us about, from the Saturn V. She shrugged. "I'm going to see Blair Witch 2 this weekend. Want to come?"

"No." I said. "We need to get to the bottom of this."

"We will," she said. "I'm not into usually into horror, but the first one was so ridiculous, I figure this will be worth seeing."

I shrugged and suggested we get back to work.

I looked over the test data back and forth, an reran several of the analyses. If the turbine was running hot, the sensors had to be misreading. Peter finally did check the sensors, and found nothing. "If the gas flow was as hot as Susan said," he added, "the sensors should have shown signs of damage as well. They don't."

I thought about that. Indications were that the temperature as normal, yet the metal had been damaged. A sensor error was possible, but there were no other discrepancies.

I setup some simulations for higher turbine temperature, to see what other readings would be off. Nothing matched. All the sensors could have been off, or a systemwide bias could have been present, but the increased temperature curve wasn't linear, and predicted flow discrepancies also weren't present.

So if the temperature wasn't too high, then what was the problem? There was no question the temperatures had been above the metals rated temperature.

There were a couple of small back rooms; Susan had set one up as a simple lab - no hoods, nor any needed, a large exhaust vent was adequate for the couple of solvents she had. Mostly just a bench, a couple of microscopes, and some other test equipment.

We discussed it again the next day without coming up with anything. We usually met for an hour or so each morning, revising plans, working out problems. Now we were meeting for a couple of hours,

going over the problem.

The next day we met again; I explained the results of my latests rounds of simulations and analysis; I was confident it wasn't a sensor problem or overheat, there were just too many secondary indications the temperature was normal. "I checked the turbine exhaust in particular; it couldn't have been hot enough to cause this damage, and give the exhaust readings shown."

Uncle Robert backed me up. "We've been closely examining some of the other parts around the turbine, mounting brackets and hardware - and a couple of wires, as Peter pointed out to me. The hydrogen coolant would have picked up some of the extra temperature, but some would have escaped. There's no indication of that. In particular, a couple of wires run very close there," he pointed to a sketch of the turbine on the whiteboard, "their conductivity would have changed with temperature. There's no sign it did."

"If it wasn't too hot, then, what caused the damage?" I asked, rhetorically. "Susan, what's the temperature tolerance of the turbine walls?"

She told me; it was well above the operating temperature of the turbine.

"If it wasn't hot enough to damage the metal, but the metal still gt damaged, maybe we should check the metal," I suggested.

After the meeting, I continued checking numbers. Maybe there was something I'd missed.

Susan came out of the lab later in the afternoon. "I've been checking the extra metal supply," she said. The alloy composition had been correct, and we had no way to test under heat; but she'd thought of something else. "I had Hank spray a piece with liquid oxygen. Steel of this grade shouldn't be this brittle." She showed me the party shattered piece.

"So the steel's bad," I said. Susan said we'd need proper testing - which we weren't setup for - to be sure, but that's what it looked like.

I immediately called everyone together. Everyone thought it was a reasonable explanation; we'd

send some of the metal out to be sure. The bigger problem was, what to do about it. Uncle Robert pointed out that the material had been rated to the required grade; substandard material would always be a risk. We could test material as it came in, but Susan said we didn't have the facilities; and contracting out testing would be expensive.

"We'll have to be careful," I said, "And double-check material sources. Let's keep this in mind, from here on." I also said I would contact the supplier.

Further investigation revealed that that company had been selling poor quality steel to several clients; we changed our supplier, and I began very thoroughly checking future sources.

We also had to completely rebuild the turbopump. Fortunately, most of the steel had been adequate; but we still conducted additional tests on the hydrogen turbopump. It's a tricky process, because there are several types and grades of metal needed, but we continued. By the end of the year we were back on track.

The engines were beginning to take shape; they were impressive in size. The Icarus would not be as big as a space shuttle - it was a prototype, after all, and was to have only limited payload capacity, and be primarily a passenger spacecraft. Nonetheless, the need to have well over 90% of takeoff mass be fuel and oxidizer places a lower limit on the size of any SSTO. The engines would take a significant portion of the warehouse when they were complete.

The turbopumps complete, we began working on the rest of the engine. We continued working on one component at a time, then building lines to connect. Valves were needed for several points in he engine, controlling fuel and oxidizer flow, handling cold liquid hydrogen and oxygen, gaseous propellants, and the hydrogen-rich steam that would come out of the turbines. There were also split valves, regulating deliver of oxygen to the two preburners, or dividing off hydrogen to serve and coolants. More difficult was rejoining the coolant lines, now at higher pressures, to the main hydrogen flow. And particularly difficult was injecting the hot hydrogen-steam into the combustion chamber.

This had been a problem which had vexed many other rocket designs, and only a few engines had been able to implement it effectively.

We studied closely all that had.

We ran into problems, none quite as severe as the pumps, but plentiful. Sometimes we danced around a solution before we found it; sometimes it was clear. Testing was a problem, and I didn't like the degree to which we had to rely on simulations. I worked late many evenings, setting up and verifying a simulation and leaving it to run overnight, only to find it failed, or simply in error the next morning. As e worked, we modified the design as needed, always watching the weight, and the effect on thrust.

And I continued to make the rounds, raising money, attracting funds. I sold the glamour of spaceflight, the promise of profit when it was achieved, what ever was necessary. When I met doubt - and there was plenty of doubt - that we would achieve manned spaceflight, I pointed out how far we were on a rocket engine that would itself be remarkable in it's low cost and high power.

"Maybe you should concentrate on building unmanned rockets," suggested one prospective investor, pointing out that there was money in that. I replied that our goal was an SSTO, but that we were working on the engine right now, and it could be used for many things.

It was not without setbacks. A hydrogen valve blew one day during a cold test dumping hydrogen about the room; the powerful ventilation system we had installed quickly cleared the dangerous gas, but I quickly reemphasized safety, and considered whether we should move outside for all tests. Peter questioned the use of hydrogen, and Susan reminded me of that article of several months before; I said we had to be more careful. It was also a total loss on the valve, which had to be redesigned and rebuilt.

Other times, parts simply didn't work. Or didn't fit. Weeks of work went into the trash on more than one occasion. Tempers flared; things got thrown, and people threatened to walk out. I pointed out that we learned from failed components as well as successful ones. And sometimes I was the one

throwing things.

For all that, the engine was coming together. We began work on the nozzle, using a double-walled system like the turbopumps, essentially engraving the hydrogen channels inside the outer wall.

The gimbals which would allow the nozzle to be redirected for spacecraft control posed another problem, because they were meant to be driven hydraulically off Auxiliary Power Units - but the APUs hadn't been designed yet. We decided to consider that separate from the engines themselves, and leave it for later. We designed the nozzle to swivel, testing it manually. I commented to Uncle Robert that this could cause a problem later.

Finally, we were left with the last part of the engine, and its heart. The combustion chamber. It had to withstand the combustion of hydrogen/oxygen, and direct it out the nozzle. Two ports injected hydrogen-rich steam from the preburners, and a single injector supplied oxygen. Ensuring efficient mixing was essential, as was Combustion chamber shape. And the wields had to be of perfect quality.

I also was working on another crucial part of the project: programming the control systems for the engine, as well as the data collection systems for testing. I've programmed in various forms since I was ten, beginning with interpreted basic, and I was putting the brains of the ship together, as well.

Finally, the engine was coming together, and it was every bit as massive as expected. We ran every cold test possible, to verify the integrity of the engine, but knew we would eventually need to test fire it. We sat around the conference table to discuss our next move.

“Couldn't we do a single, short test?” Peter suggested. “And go with that, if it matches your simulations?”

“We could,” I admitted, “But that wouldn't save us as much as it seems. Fuel and oxidizer, certainly, but many of the costs here are one-time costs involved in setting up the tests. Construction of a test facility, moving and testing engine for the test program, and of course, the necessary permitting. Once we've done that, we might as well run a full sequence of testing. But the bigger question is where? We

certainly can't just roll the engine out the front door, and fire it into the street. That seems to be the first question we need to answer."

"We'll need a lot of space," Uncle Robert said, briefly describing the test facility used for the Saturn V engines. "Someplace isolated, both for noise and safety reasons. And pretty much an empty parcel."

"Well, we found this place," I said. "Though this will be somewhat harder. We'll have to keep our eyes out."

A few days later, I spotted a newspaper article about a recently abandoned quarry down in southwestern Virginia, and how the county was trying to figure out what to do with the site. From the article, it sounded like a fairly large open quarry, and it occurred to me that such a site could be an excellent site to test a rocket engine – using a large, open pit would reduce the sound impact, and protect the surrounding areas in the event of an explosion. I did some research on the site, and confirmed that it would be eminently suitable. Everyone else agreed it would be perfect, so I began preparing an inquiry to the town.

The the inquiry posed a bit of a problem – requests for large rocket engine tests don't come in every day, and I knew I was apt to be laughed out of the room - or that they would reject it as silly without looking closely at it. In the end, I prepared a brief, vague request, offering discussions about an unusual, short term business opportunity, for the quarry site.

I made the trip down myself, battling tractor trailers on the way down I-81, before meeting with two of the county supervisors in a tiny, one stop light town.

"Now, I indicated when I made my inquiry, that my proposal is unconventional." I said, "So please hear me out fully before you respond – I want you to know I'm serious. Put simply, have built a large rocket engine, and I need a site to test it; I believe your quarry would be the perfect site. It is sufficiently isolated to protect the surrounding area from noise, and any safety hazard; and of course, it sits empty right now."

“That is indeed an unusual request,” replied Billy Lee. “But aren't there more traditional sites for such a test?”

“We are a rather small operation,” I replied, “And most such testing is done at large, company owned – or government – test sites. We don't have access to them. But your quarry will be as suitable as any of them.” I gave both of them brief summaries of the projects, including pictures and spec sheets of the engines. “And there would be benefit to your communities. We'll need to bring contractors down to assemble the testing equipment, and most of our team for the test program. Even for a few days at a time, that would be a significant boost to the town – and of course we'll pay fair rent for use of the quarry. Not to mention, it would raise your counties profile substantially – it wouldn't be a bad thing for you if we weren't the last aerospace company to operate in your area.”

Kellon, the other supervisor, nodded, looking intently at the engine. “It certainly looks like your serious,” he admitted. “This is no small machine you've built. How would you get it down here, and what facilities would you need in the quarry?”

“It will fit – barely – on a long tractor trailer.” I explained. “As far as facilities, we'll need some kind of test scaffolding, to support the engine, and a shelter – probably some kind of trailer – to use as a control base. That will be pretty much it – besides the motel rooms will occupy, and restaurants we'll stop at, of course.”

“Well, it certainly sounds like it's mostly upside, for us.” Mr Lee said. “It would certainly bring needed money into the county, and it would be nice for western Virginia to be known for something other than tobacco farms.”

“If thats the case,” I said, “Then where do we begin?” This was a little harder – there aren't permit applications for 'rocket engine testing.' We discussed some of the specifics – hazmat storage, noise regulations, but eventually agreed to consult with lawyers as we proceeded, and both of them promised to do everything they could to move us along.

I met with several lawyers – and a couple of them laughed me out of their office. We worked quietly, at first; we didn't want to draw too much public notice yet.

I prepared a lengthy summary for the county supervisors, detailing what we meant to do and how we meant to do it. Safety was our primary concern, as it should be. Explosion of the hydrogen supply would create a massive fireball which could to a good deal of damage. I pointed out, however, a number of precautions we were taking. "To begin with," my report explained, "Liquid hydrogen is not as dangerous as people think – it has to vaporize, mix with oxygen, in order to burn. While a fuel explosion cannot be ruled out, it is one of the less likely scenarios." in short, the form of a fuel is as important a safety consideration. An apt example is diesel fuel – you can extinguish a cigar in it. I thought about offering to demonstrate that, but thought I would look too reckless to be trusted with a diesel engine. "The liquid oxygen can actually be more dangerous," my summary continued, "Because of how readily anything will burn in high oxygen concentrations. Both tanks will have dual redundant check valves between them and the engines, and automatic shutoffs." I also pointed out that we would be relatively close to the engine, to monitor the tests, and that we wouldn't proceed unless "WE felt it was safe.

Other concerns I tried to deflect as best as I could. Noise – it would be loud, but brief. The exhaust would be very hot steam – quite clean. And the tests would be conducted during the day – there would be no unexplained lights from our direction. I did my best to anticipate the hoops we would need to jump through.

I also highlighted our basic test plan. "Two to four tests, depending on the results of the initial firings. Most will be short, no more than two minutes in duration. The final test will be a flight duration test, ten minutes, moving throttles to various fight settings. All tests will be shutdown immediately if any problems are detected."

They weren't convinced, of course, but were definitely interested. "We'll have to have at least one

public hearing.” Mr Lee told me. “And of course, you'll have to fully publicize your tests.” But all of the supervisors seemed interested, and things seemed to be on track for approval.

One day, about a week before the hearing, several of us were working in the conference room. We had the TV on, but nobody was paying much attention to it, until something caught my eye, about a protest down south in Virgina. I just keyed onto it for a moment, when i saw what county it was.

"Rockets produce perchlorate pollution and massive amounts of noise, and what do they get us?" a young, middle-eastern looking woman was saying; the title bar on the bottom of the screen identified her as Jessica Hunt. "This two-minute planned test will create a huge source of perchlorate pollution, scare animals for miles around. We want the county government to put a stop to this, and reject Icarus Project's bid to open a rocket testing facility."

Peter moved to shut it off, but I stopped him. "Damn environmentalists," he said, "Always meddling when real work needs to be done."

I raised an eyebrow. "If we destroy the environment, there will be no 'real work' to be done."

"You're not saying you agree with those greenies?" Peter asked.

"Only in part," I said, "We mast take care of he environment. But suppressing technological - or economic - advance isn't the way to do that."

I found out more later that evening, watching the news. I don't usually pay much attention to the TV news, preferring to get information from other, more reliable sources - but I wanted to find out more about this protest. Troy, my roommate, usually does watch the news, when he's home in time, so I watched it as he did.

The protest was small, a dozen people or so, and all from the local area. Jessica Hunt had come from Massachusetts, however, after apparently seeing a blurb about us in her local paper.

"I don't think that's the kind of attention you wanted," Troy pointed out. "Probably voted for Nader last election. Give her credit for that, at least. Put Bush in the White House."

"Bad ballot design put Bush in the White House," I said, "But don't jump to conclusions."

He protested he wasn't, she just looked like a socialist. "And she is from Massachusetts."

"In any event, I still have to figure out what to do about it." I said, pointing out that the county wouldn't want the controversy.

I looked online later, but didn't find any information on this Jessica Hunt. And I thought about strategy. I wasn't going to let her get in the way of human destiny.

We met to discuss our response. Someone suggested that we could call a press conference, to rebut some of her accusations, but I pointed out that would just draw attention to her protest. "Better to ignore her for now," I said, "And focus on the board of supervisors and the hearing. We need to convince them that we're right and she's wrong. But I think I should take a ride down there first, meet with them, and introduce myself to some of the neighbors."

I did so, a couple of days later, and found the supervisors significantly less enthusiastic than they had been. "This protest isn't the kind of attention we wanted to bring here."

I assured them that this wasn't the kind of attention Icarus would bring them, but I could tell that they now had reservations. I did my best to assure them that we would do things right, and make them look good.

"Privately," Mr Lee admitted to me. "I still like your idea. But we've all got to be careful right now. We all have to get reelected, you know."

"I understand." I said. "I intend to show you, and everyone here, that this is the right thing for your county, at the hearing.

"We look forward to it." he said. "We'll do what we can; you'll be able to speak first."

"Actually, I think I'd rather speak after this Jessica Hunt." I said. "I assume she's requested permission to speak?"

"She has." he said. "With the support of several residents. I'll tell the truth, she has me worried.

Her kind is always making trouble."

"Well, I'd like the opportunity to directly answer her concerns, and show you and the county that this is a safe operation we're planning."

"I'll see what I can do." he said.

This Jessica continued to raise publicity, across the county, appearing on local TV, pointing out all the harm my rocket test would cause, and how it would gain the county nothing. She also highlighted the fact that I had so far said nothing in response to her accusations, that meant, she said, that it was true.

She said much the same things at the hearing, when it came. She said my rocket would put enormous amounts of perchlorate into the air around, and since it as a ground test, not an actual rocket launch, much more would be at ground level. She said it would produce an immense amount of noise. And she asked what the county would get from it, making clear her disdain for all things spaceflight; why spend huge amounts of money reaching for the stars, she asked, with as many problems as we had here. "Actually," she said, "In the time I've been in town, I'd say your town is doing pretty well. But there's still a homeless man across the street from my hotel, and even those working can't always afford to feed their families. This project offers little in extra revenue, and nothing for anybody else. Reject it with a vote for the people of your county."

Then it was my turn, and I got up to speak. "Yes, I am reaching for the stars," I admitted, diverging for a moment to diverge from my carefully-prepared comments. I had to answer this question first of all. "For how else can we we reach our full potential but to do so? What more can we ask but a chance to be a part of something great, of the continued train of human progress? That is what I ask of you. That is what I invite your county to be a part of." I worked in just a little bit of the more farsighted aspect of my pitch.

"But, I grant that some very valid issued have been raised," I continued, "and I would like to take a

moment to reassure the citizens of this county. Our rocket test will make a great deal of noise, but not at the level Jessica Hunt is suggesting. Ms Hunt points out the noise produced by the Space Shuttle at launch; but this is one engine, that's three markedly larger engines, plus two very noisy solid rockets. Ms Hunt also points out the hazards of liquid hydrogen; and in that she is also correct - if the entire supply of fuel for even a short test were to explode, it would be catastrophic, let alone its form. But consider a candle: the wax is quite flammable, but in solid form, it still needs to be heated and melted before it burns. So with hydrogen; I can't say with certainty that a tank will explode, but it's not so real a threat as has been made out."

"This engine will not cause any perchlorate contamination," I said. "Ms Hunt is right that some type of rocket engines are significant perchlorate sources, including the solid rocket boosters used on the Space Shuttle. Hydrogen rockets use oxygen as an oxidizer; perchlorate or any chlorine compounds are not used in any part of the fuel mixture. Don't let this fallacy sway your vote."

I closed with another grand, sweeping promise of human glory, then thanked the supervisors for their time. A few other residents spoke afterwards, some opposed, some - including one of our neighbors - in favor. But my words swayed the Supervisors, and they voted heavily in favor. We were given express permission to conduct rocket motor tests on "up to four separate days" before the end of the year. Jessica left shortly after the vote; watching her, I had a feeling she would be back. She looked like someone who believed in what she was doing.

Some of the supervisors caught me as we were laving, saying they were impressed by my words. I told them it was only the truth, and I thanked them for their confidence.

There were still hoops to jump through, of course. A final agreement had to be rendered and approved, the fire marshal and other local authorities had to be satisfied. And of course, we had to prepare for the tests themselves.

“Foremost,” I said, “We need a test stand for the rocket. The stand needs to hold the thrust of the

engine on full firing, holding it stably. And it needs to shut down quickly if any failure develops."

"Could we fire the engine upwards?" Susan asked. "That would put the thrust directly onto the ground."

I frowned. "I think the engine would be too tall for that. Any lateral swaying, such as from wind, could tip in, and it could tear itself apart. We could brace it against the side of the quarry, however. That would have the same effect." People nodded. We had a picture of the quarry on one wall, to help visualize our designs. I started pointing to it. "If we have the engine nozzle over this pond here, at the bottom of the quarry, the water will absorb some of the noise. I think this vertical face here looks to be the best anchoring point, and it should put the distance about right. We'll have a scaffold across the top and front of the engine, with covering to keep the engine dry between engine tests. And we could put a water reservoir over top, to deluge the engine in the event of an emergency." The cost of water alone frightened me, but I knew we needed a way to rapidly extinguish everything.

Everyone agreed the basic concept was sound, and we proceeded to design, then contracted construction. Besides the test scaffolding, we constructed two large cryogenic tanks, and placed a construction office trailer on the far side of the quarry, to use as a monitoring station. The side nearest the engine we covered with a cinder block wall, and a narrow viewing window.

It was midsummer by the time everything was ready. We had run every cold test on the engine we could.

Getting the engine out to the test stand was its a challenge;. It fit on a flatbed trailer, but barely, and we were all tense during the trip down.

Locking the engine in place took several hours; we had to be certain it wouldn't move out of place. The lines were hooked up, flow tested, cutoff valves tested. And the truck was moved back out of the way.

Inside the trailer, we had several computers along one wall; and we crowded around the window.

"Is everything set?" I said, initiating the checklist; each person confirmed, we were ready. I had the main control panel for the engine; on one side as the large throttle control. "Setting throttle to 75% and arming system." I announced as I set the controls.

"Logging data." Susan announced from the data computer.

"Electrical system hot, indicators green." Peter said.

"Engine systems show ready." Uncle Robert confirmed.

"Initiating startup sequence ... now." I said, pushing the big "ignition" button.

Nothing appeared to happen, but the ignition sequence would take several seconds. "Preburning ignition," Uncle Robert announced, "turbopumps active." The turbopumps were now pressurizing the engine, filling the combustion chamber with fuel and oxygen; wafts of vapor started coming out the nozzle. When the pressure was high enough, the engine would ignite.

And it did with a flash, white hot and quickly turning blue, an burning with a roar. "Engine reading 75%" I announced.

"All readings nominal." Uncle Robert said.

"Throttling up to 100%" I said, slowly moving he throttle up. The roar intensified; I kept an eye on the fuel flow indicators. "We have full power."

I held it there for thirty seconds or so, then said, "Throttling back to 55%" The engine quited slightly, the thin blue flame receded. it was really two flames, a broad, almost invisible blue spreading out from the nozzle, and a sharply defined blue cone, pointing away from the engine, in the middle. As the thrust lessened, the cone moved visibly towards the nozzle. "55% power." This was the minimum setting for the engine; less and the turbines would begin to stall. I held it there for a few seconds, then pushed it back, slowly, to full power. "Full power." I was now watching the timer, which had begun cycling at ignition; at 1:50, I announced, "reducing power for cutoff." The power came down just a s the red SHUTOFF light came on, and the engine shut-off sequence began. In a moment, everything

was quiet.

Susan confirmed that all data was logged; Uncle Robert activated the power down sequence, pumping additional liquid hydrogen through the engine to cool it down. We waited an hour before we went outside; the engine was checked and protective panelings were enclosed around the test scaffold.

I spend the next several days running analyses on the engine data, internal temperatures, flow rates. The engine thrust and fuel consumption was very close to what we had predicted. there were some discrepancies, and possible problems. In particular, the hydrogen turbopump seemed to be running a little hot. The engine was also partly disassembled and inspected.

We discussed the changes that had to be made – nothing major, but there were some minor modifications.. The bigger question was continued testing – were the changes enough that we needed to perform another short firing, or could we proceed immediately to the full length firing? The changes were minor, but important; on the other hand, I didn't want to use the additional fuel. We decided we were ready for a full firing.

The second firing occurred almost two months after the first – two months of twelve hour days, six day weeks. Once again, the engine was trailered out and affixed on the firing mount; everything was secured and checked. And then, ignition!

Once more, i was at the controls. Ignition at 75%, then pushing power up to full. I had projected an approximate launch procedure based on the Space shuttle; at 1:30 I pulled the throttle back to 55%, simulating reduction for max-q, reducing thrust as the spacecraft hit maximum atmospheric pressure. After a minute, I increased it again to 100%.

The windows began to vibrate from the noise; I could see birds jumping from trees over in the distance. But I kept my eye on the engine itself; everything was going smoothly. At time approached full, I reduced the power back to 55%, and activated the cutoff sequence. The silence settled upon us.

Once more, I analyzed all the run data, the engine was disassembled and inspected. There were a

few minor deviations from projected parameters, but everything was in range, and had operated successfully.

We had our engine.

It was Saturday morning, and I was under my truck, working on the front suspension. Lately, the steering seemed to be pulling a little, but mostly I was just tightening things up, and inspecting. Since I've had the truck, I've learned to do most of the work on it myself – with Uncle Robert's help – and it has saved me quite a bit of money.

I didn't notice a pair of feet walking up the drivers side of the truck, until I heard Uncle Robert's voice. "Dan?" he was asking.

"Yea," I said, "Just a moment." Now, where was that bolt – this? I tapped with the ratchet, no, This. I tightened it, then nodded as I looked over the rest of the front end, then slid out. "I'm going to have to replace that left shock, sooner or later. Both springs, too, I think. But not too soon." I said, sitting on the ground.

"Let me know," Uncle Robert said. "It'll be a big job."

"Oh, I will." I said. "I'll be in in a moment; I've just got a couple of things to finish up here."

Uncle Robert nodded, and in a moment I was alone again. I was parked in my parents driveway – car maintenance is forbidden in the parking lot of my apartment complex, and anyway there's more space here. I slid back under the car, then finished my work, and put my tools away, then washed up when I went inside.

My parents and Uncle Robert were sitting and chatting in the living room, and I joined them. "You've come along way with your rocket," mom commented. "An engine is a big something."

"But there's a lot more to do." I said. "It's only an engine."

"Even so," she said, "It is a great deal. Robert tells us the test firing was most impressive."

"A rocket engine is." I admitted. "And it is one of the biggest pieces. In some ways, one of the most difficult. Many of the other components, we'll be able to buy off the shelf, or adapt. We've almost got the fuel cell design complete, for example; Susan has been working on prototype units – but

it's existing technology, and principally a matter of implementing existing designs."

"From what reporters say about electric cars," my dad said, skeptically – he's usually skeptical about environmental ideas - "Fuel cells have a long way to go."

"Cheap, mass produced fuel cells are still a long way off." I explained. "But the basic technology has been used – for spaceflight – for more than thirty years. We don't need a design that can be economically produced by the thousands, but custom built for use in space – it's mostly a matter of adapting NASA designs to our specific power and weight requirements."

Changing the subject slightly, mom said, "It sounds like you're headed out of town again."

"Yes, to Cincinnati." I said. "The search for money never ends. I've made contact with a major investor up there, and am going to drive up there next week."

"Well, good luck." mom said.

A few days later I was preparing for the trip to Cincinnati. Once again, I had revised my proposal, now reflecting the successful design and test of the engine. It included the performance specs and thrust capability of the engine. I had also prepared a short video clip of the engine in operation.

I also spent some time reviewing information on James Tucker, the potential investor I was going to meet. His company had a number of interests, particularly in the aviation and transportation industries, and was worth over a billion dollars. He wasn't normally an early stage investor, but had been particularly interested by my proposal.

I was in my office, going over some final papers, when Susan came in. "All ready for your trip?" she asked.

"Getting there." I said, not looking away from the computer screen.

"I'd like to come with you." she said. "See you work your fundraising magic."

Now I looked at her. "There's really nothing too it. I just show them what I've got, what we've done, and the money that could be made. Besides, there's other work to do. You've got to get those

fuel cells done."

She shrugged. "I've got the design specs done – there's not much to do before they're fabricated, and Hank and Ryan can do that better than I can." Ryan was another technician we'd brought on, community college graduate. Not so great with the theoretical work, but a quiz at assembly. "Besides, then we could take my car."

The last didn't interest me at all – I was rather looking forward to getting my truck on the highway for a while. "It's really not necessary, Susan."

"Yes, it is." she replied.

"No, it isn't." I said.

"Why do you have to be so stubborn, Dan?" she said. "Besides, I'm coming."

"I'm not being stubborn, and you're needed here." I said. It continued, for a moment, Susan repeating that she was stopped as it was, and making clear that she was coming.

Finally, I said, "Alright, you can come. But we're taking my truck." I thought that would dissuade her, but it didn't.

"Alright." she said.

"And I'm leaving early in the morning." I said. "It's an eight hour trip, minimum, and I want to get out of the area before traffic picks up. I was going to stay here tomorrow night."

"Makes sense." she agreed.

It was still dark when we set out, two days later. Susan had slept on the couch, and I on the floor in my office. We climbed in, buckled our seat belts, and the truck roared to life. I backed out of my parking space, pushed the transmission into first, and pulled out onto the road; the engine roared before I popped it into second, then third. "Can you drive standard?" I asked, realizing suddenly I didn't know if she could.

"No, I don't." she admitted. "Do you think we'll be able to get money this time?"

“I hope so.” I said. “This guy seems pretty interested – and now we have something to show. But I can never be sure. I'm not much of a salesman, and I'm never sure how things are going to come out until I hear.”

“You've done pretty well so far.” she said.

“Yes, well ...” I trailed off. “But how is the fuel cell work going? You never did give me a full update.” So she did, detailing the small problems she had solved, and the parameters she hoped the prototype would achieve. After that we continued into other parts of the design, and discussed and debated other components. “Now that we've got the engine designed, we can work from that.” She – and everyone else – already knew that, of course, but I detailed my calculations. Exactly how much payload we could lift – payload referring to the entire crew compartment – and what weight we could afford for the airframe and other system components.

It was a long drive – we were on the road most of the day – but we got into Cincinnati in plenty of time, and checked into the hotel. I was nervous that evening, as I always was when preparing for the sale. I was also trying to figure out how best to make use of Susan – I decided to leave that for the technical questions, if it got into that, and I told her that. “It doesn't usually get very technical,” I told her, “The biggest thing is to show them that we know what we're doing. Don't let them think you have any doubts we can do this.”

The next morning we went to meet with Mr Tucker. Somehow, with Susan there, I didn't feel as nervous as usual while waiting. Once I threw myself into my pitch, of course, it didn't matter. I'm no salesman, but I had to make this work. And I did. I promoted Susan a few times for some technical “color” - which we had arranged, it would look bad to have her sitting there, silent.

When we were finished, Mr Tucker said, “Very impressive,” but I felt a moment's dread – too many prospective investors had said that, right before they said they just didn't think it was the right investment for them. But he said somewhat else “Very impressive.” He stood up, looked at one of my

visuals for a moment. “Once, I thought I might go into aeronautical engineering. I still remember the feeling when we walked on the moon, that that was one of the greatest things we had done, that it was a great thing to be a part of. But my math – or engineering – was never up to it, and I found better talents in another direction.” He sighed. “But it still fascinates me; I've long thought about it, if the right opportunity came around. And I think you might be it.” He sat back down, and looked directly at us for a moment. “I'd like to back your venture. Not without conditions, or progress, of course, but heavily.”

“Well, thank you, Mr Tucker.” I said.

“Call me James.” he said. After that, it was a matter of working out details; final paperwork would be sent to us once his lawyers had reviewed it.

It was more than I had hoped for. Not full backing, of course, still only a portion of what we would need in the end. And not all at once, steady investments as we made progress – but enough to make things a great deal easier.

As we drove back to the hotel, I said, “That went well.”

“That went very well,” Susan said. “Did you ever hope to get that kind of support?”

“It'll be a big help. I won't have to spend half my time fundraising.” I said. After a moment, I said, “I'm glad you came, Susan. It's nice to have company.” She suggested that we should stop somewhere for dinner, and I demurred; I wanted to continue to work out some of the designs. The next day, we returned to northern Virginia; I kept the conversation focused on the continuing design.

Work proceeded smoothly with more secure funding. I still had to do some fundraising; James Tucker's investments would only amount to a third of what I projected it would cost – but it gave us much more secure footing, and I was able to spend more time working on the designs. We were progressing system by system, in part, designing, prototyping various pieces of equipment. We were also finalizing the basic design of the spacecraft, it's shape, and airframe. I spent a fair portion of my

time running aerodynamics simulations – but in time, things were mostly set – and with the exact airframe configured, we could design each component knowing exactly how much it could weigh, and in what space it would have to fit.

I was in the conference room a couple of months later, reviewing the latest set of designs, when Uncle Robert came in with his lunch. I looked up at the clock; it was about that time.

"At some point, we're going to have to think about moving." he said. "We're not going to be able to build the ship here."

I sat back and nodded. "I know." It wasn't just a matter of space – though the ship would be too large – but we would have no way to launch. Eventually, we would need to move to an airport – a big one, and build the ship in a hangar. "We've known that from the beginning – but as long as we're working on individual systems, we've got this place set up for it."

"But we can't do that for much longer." he said. "We've got to start looking."

"I know." I said, after a pause. "We'll talk about it tomorrow, all of us. I've got some ideas, and I'm sure everyone else does."

We did so first thing the next morning, the four of us, and a few others, Hank, for one. Most of the technicians – we now had eighteen people, total – were in the workshop.

I laid out what we needed. "Since there will be no way of moving the completed craft, we have to find our test site now, before we begin airframe construction. What we need is simple, but not so easy to find. Given the weight – and the high takeoff speed required by the lifting body design – we need a long runway. International airport standards will be enough, I think, at least ten or twelve thousand feet. Dulles airport could handle our flight requirements, for example. But we also need somewhere that isn't very busy – somewhere that could lease us a hangar for several years, and handle our flight and safety requirements."

"The best possibility for that would be a former airbase, of which there are a few around." I

continued. “Many of them have large enough airfields, and often limited flight traffic. Bangor International Airport in Maine is one such example. But we also need somewhere closer to the equator, to get a boost from the Earth's rotation.” I had discussed this casually, before, now I went into detail. A spacecraft on the earth surface was already moving eastward; launching east, a spacecraft would get a significant speed boost. However, the boost was greater the closer to the equator – this is why NASA launches shuttles from Florida.

“It sounds like you've already got it figured out.” Peter said.

“Somewhat,” I said, “I know what we need. But I don't know where.”

And so we discussed it. Airports and locations were tossed out; ways to get around the problem were suggested. Even if we could find a way to transport the ship, it would be too much – several test flights would be needed before a space attempt.

In the end we had little more than I had started with, except the suggestion that we look into candidate sites, in hopes of finding a suitable one. There was nothing else, I supposed, but to look up such airports, closed air force bases, and the like. I did so over the next few evenings – it wasn't as easy as it could have been, several places I had to look, but in the end I found several good candidates.

And we continued work of the Icarus. With the engine designed, we now could determine the other major design constraints – loaded weight, fuel, dry weight. While we were working on several systems – Susan on the Fuel cells, Peter with the electrical systems, we were designing the general airframe. Not just the basic sketches I'd done before, but a complete design. A lifting body, as clumsy as they look, with an internal airframe that would be largely fuel tank, but also provide structural strength with empty tanks. The weight numbers didn't look good – we didn't have a lot to play with – but it was shaping up.

Such it was on a Tuesday in September – we had the basic airframe structure, but were still struggling with the weight (I had a feeling we would be struggling with the weight until the moment we

finally took off) – and I pulled into work, ready for another long day of design. I was the last of the four of us to get in, and we all sat down for a quick status meeting, before moving on to airframe design. We would work together for much of the morning weighing airframe considerations, then work separately on our own projects in the afternoon. I described the latest set of aerodynamic calculations I had run during the night, and Susan was in the middle of of a fuel cell status report, when Brian, one of the technicians, suddenly came in. "Quick," he said, "Turn on the TV!"

"What's wrong?" I said, as I reached over to the TV. "What is it?"

"Just turn it on. One of the news channels." Brian said, with a look of horror on his face.

We usually keep the TV tuned to one of the major networks, so I didn't touch the channel switch. As the picture came in, it showed smoke pouring out of one of the towers of the World Trade Center, with the tag line on the bottom saying, "AIRLINER CRASHES INTO TOWER". We all gasped in shock, and listened as the reporter explained that little detail was known yet, but that damage was extensive, and firefighters were already on the scene.

Suddenly the picture changed to another shot, from a different direction, with the announcer saying "Something else now ..." and another airliner plowed into the second tower. The reporter scrambled for a coherent thought.

"My god ..." was all I could say. One airplane could have been an accident – indeed, the Empire State Building had been hit by an aircraft in the late forties, lost in heavy fog – but two ... two was simply unexplainable.

We continued to watch, transfixed by the horror. Horror mounted further when another aircraft crashed into the Pentagon, and it was confirmed: the attacks were believed to be terrorism. American airspace was closed down, controllers bringing aircraft to the ground.

And then the first tower fell, and then the second. The fourth plane crash landed in a Pennsylvania – more dead. The newscasters were trying to make sense of it all, and they couldn't, no one could. No

one spoke, no one left. Susan began to cry, quietly. The rest of the team had quickly filtered into the conference room, and we all just watched in horror.

How could anybody do this? Who could kill, destroy, so callously? And is there anything we humans can do better than to destroy?

Finally, I had to say something. We were all here, trying to make something better for mankind, and mankind could only seem to bring such horror. I couldn't escape the thought of what the Icarus could do, if used in such an attack. “My god.” I said again, still staring at the TV. Now though, everyone was looking at me, as well they should: I had brought us all together, here. “I really don't know what to say here,” I said, slowly, standing up. “We've all seen these events, now. What some people ... are capable of. I really don't know how we'll deal with it, or what effect it will have on us.” I closed my eyes, still gathering my thoughts. I told myself, if it our power to destroy, it was also our power to create, and that was what I was trying to do. What we were trying to do here. I've long believed that the only alternative to continued expansion was self destruction. But now, watching these images, I couldn't help but wonder if it really was all a waste, with so many others destroyed. It disgusted me, what humans were capable of; we could do so much; why did we always have to use our best talents to kill? I spoke again. Telling myself silently that it was true. “But we cannot divorce ourselves from this, we cannot think we have nothing to do with it. We can offer humanity something else than self destruction. Great efforts, great hope, I think, is the only alternative.” Saying it helped me believe it, a little, and I thought as I looked over everyone, it helped them, as well. It was all I could say. I added, “I'm sure a lot of us have family who may have been affected by this, so everyone, go ahead and call who you need to call. Make sure everyone is alright – and if anyone isn't,” I froze again – how could I say I was sorry, that I understood, in such a circumstance? But, looking at everyone, I had to. I had to say something. “If any of you ... if any of us has lost anyone, I can only say I'm sorry, and we'll all support you. After that ... You're all free to go home, as you like. I'll be here, if anyone wants to stay.

Maybe thinking about something else will help, maybe talking about it will ... I really don't know. We'll just meet back here tomorrow morning. Is that alright with everyone?"

Most everyone nodded, then broke off to make calls, some on cellphones, some waiting to use the building line. Afterwards a few people left. But most of the team stayed. Some went to work in there own corners; Susan went back in the lab and kept herself quiet; only later did she tell me she tried to lose herself in the work, and mostly succeeded, for a while.

I tried to do the same, looking over the data numbers from last nights calculations. But all I could see was the smoke pouring from the towers; all I could think of was the death and destruction, the lives lost. Finally I just sat back and tried not to think. I turned the news back on, periodically, but they had little new to report, mere speculation; and I couldn't bear to hear the casualty counts.

Finally, later in the afternoon, I checked in with Susan, then with Uncle Robert, who was planning to stay the night at the building. I told him I was going to take off for the afternoon. "It's hard even to think about, isn't it?" I asked.

"Yes, it is," he said. "But you spoke well. I think it helped everyone."

"Words, just words." I said. "Thats all we've done yet, isn't it. Just words."

"Perhaps." he admitted. "But what can be accomplished, without words?"

I just nodded. "Not much, I suppose. Well, I'll see you tomorrow."

I climbed into my truck and started it up, pulling out onto the main road. But instead of heading back home, I headed westwards, winding up the straight-six engine, and pushing the three speed transmission. I still drove carefully, always thinking about weight and stopping distance, but I opened it up around the country road bends, and major roads as I hit them. I stopped for fuel in Winchester, then continued westwards, into West Virginia, powering up mountain grades in first gear, pounding the clutch as I hit the shifts, now at least I had the road ahead to think about, yet still I couldn't erase the images of the day. I knew I wouldn't be able to erase them for a while. For a long while. I bore

southwards, finally coming back up to Northern Virginia after making a wide loop, and having burned the better part of a tank as I pulled back into my apartment.

We resumed the next day, and things slowly got back to normal, somewhat. Everyone seemed to have a kind of apathy, still pained by recent events. Myself, I was distracted, at best. After a few weeks, I finally gathered everyone together. "I know it's been a hard few weeks," I said. "Two thousand dead, and now, we're preparing to invade, to retaliate; more dead. That may be necessary; I don't know. I'd like to think there are better solutions than 'an eye for an eye,' but when someone is determined to attack you, is there anything else but force? I don't know. Diplomacy only works when both sides are genuinely interested in a peaceful resolution. Defense – how can you defend against civilian airliners? I don't know what the answer is, I only hope that the present course of action proves the correct one."

"But that," I continued, "is not what brings us here. Force – whether right or wrong – is not our role. But if there is an answer beyond force, we must look for it beyond the here and now. Humanity can do so much – but it can also turn that to its own destruction. Without great goals, we tend to serve ourselves, we tend to think only of ourselves. Without great goals, we have nothing to unite us. This project isn't just about building a spaceship. Those who know me well, and you all know me well by now, know this is my passion. Not simply because I want to fly in space, although that is true – but without great goals, we are nothing. Not as individuals, and certainly not as a species – our tendency to destruction will override every good thing we've done, if we let it. We need great goals, we need to reach, to be more than ourselves. That is what I am trying to do here – what we are trying to do. We can't stop those who would kill us, but we can offer an alternative to violence, to destruction. We must reach, or we are nothing."

"I'm not saying I can stop this" I said, "That we can stop this. I don't think that highly of myself. But when we accomplish something great, we do it as a people, we do it as a species, we do it together.

We must do it together, and we can't do that without something to strive for. What we do here cannot change the world, but striving can, getting us to pull together, can and that is what we must do, or we are nothing."

Everyone nodded and expressed agreement, and soon, they were back to work. I felt like I had helped some of them, the feeling was more positive than it had been for a while.

I held Susan back, a moment. "How was that?" I asked. I had come to value her opinion, and she had been so important in the early stages, keeping us together.

"I think it helped," she said, "It certainly helped me. It's been hard to focus the past few weeks, wondering what this has to do with everything."

"Ah, but it does," I said, though I still had my doubts – but my speech had helped me, as well.

"I know," she said, "and you say it so well. I just wonder how it will prove, in the end."

"We cannot find out without trying." I said.

Susan nodded, "Anyway, you do such a good job presenting it. I am always impressed."

"Thank you," I said, and it seemed like there was something more she wanted to say, but didn't. After a moment, I continued, "Now I've got to call James Tucker back, and see what he wants."

"Our backer?" she said, "You said he called."

"And it sounded urgent." I said. "It may be bad. We've already had a couple of other venture capitalists pulling back, and that's only going to get worse. Nobody knows what the economy is going to do after this, especially the aerospace sector."

"We'll manage," she said. "Anyway, he seemed pretty determined to back us; I doubt he's changing his mind."

"Perhaps not, but things can change in an instant." I said. "And he he may have no choice but pull out, which might hurt us as much."

"Well, you'll do your best." she said. "Good luck."

I headed into a cubicle and made the call, reaching his secretary; but she put me through immediately.

“Thanks for getting back to me so quickly,” he said.

“Of course, Mr Tucker.” I replied.

“I told you, call me James,” he said. “Anyway, Daniel, we have to talk.”

“I understand.” I said, bracing myself. Here is comes. “Significant realignment is necessary in the current environment.”

“Yes, it is.” he said. “What is your current status – your other investors?”

“A couple are pulling back, more are freezing their investments.” I said. “We're stable at the moment, though; we've got enough cushion. It's continued fundraising I'm more worried about.”

“Understandable.” he said. “Well, I'm realigning some of my investments as well.” Here it comes, I thought. “But not my Icarus project investments. I wanted to rest any concerns you might have about that. In fact, I may increase my stake slightly.”

I gasped with relief. “Thank you, James. That will be a big help.”

“I didn't want you to have to start retrenching.” he said. “But I do want you to understand why. I knew this was a long-term investment when I signed on in the first place; it'll last well beyond the current difficulties, and I wanted to know you still had my full confidence.”

“Thank you,.sir.” I replied. We spoke a few more minutes about project status and direction, and he promised to contact me shortly with some additional investments.

That, at least, had gone well. A couple of weeks later, there was more good news: the prototype Fuel Cell had been completed, and initial testing showed it performance to be well above expected. We reviewed the numbers after the first series of testing, and I congratulated Susan on her good work.

Afterwards, Hank brought up the latest supply orders; I looked them over and signed off on them. “About how much will it run?” I asked, and I whistled when he gave me the figure. It's the little things

that kill you. “Well, be careful with them.” And Hank was resourceful about things; I had already seen him “bend” the designs of things to meet our needs, to save wasting parts, or having to custom order them.

I frowned as I looked at the books, though. Even with James's additional investments, things were getting tight. Other investors had reduced their stakes, or ceased fresh investments (the most common pullout – our investment terms precluded simple liquidation) and we were only beginning to feel the tightening regulations resulting from September 11. I didn't even want to think about the next time we had to order liquid Hydrogen.

Still, the fuel cell results were promising, and I was in a good mood when I got home.

But Troy, my roommate, wasn't in such a good mood. “They've canceled almost all the seasonal hires,” he said. “They're expecting most of the junior management and trainees to take over on the floor.”

“I didn't think sales were that off?” I said. He hadn't been too worried thus far – sales weren't much down since September, although they had been off before that.

“They're not,” he said. “That's what's worrying me. There's something else going on they haven't told us about.”

“Well, you'll just deal with it as it comes up.” I said, “We had a good day today. The fuel cell tests came out very successfully. Things are moving along.”

Several weeks later, I was in the conference room, going over the latest structural analysis data. With each revision of the airframe I ran more analysis, determining the weak points and stress points of the structure; then we would revise the design again.

Susan came in. “There you are,” she said.

“Yes, here I are.” I smiled. “have you pinned those fuel cell discrepancies?” Although the first test runs had gone well, Susan had noted a few problems when the cells were run for longer.

“Close, I think.” she said. “I still think we need to perform a couple of endurance tests, at least twenty-four to forty-eight hours.”

“Can't afford the hydrogen.” I said. “Liquid H2 has almost doubled in price since they tightened the regulations. In any event, we can't get any until we get the new license approved. I think that will be at least three more months.”

“I believe we have enough for a full days test.” she pointed out.

“Which would deplete us completely.” I said. “We'll do full testing once we have the Icarus built.”

Susan nodded. “Well, I've found a couple of discrepancies back to the original data. Not to power output itself, but the parameters of the plates. Like I said initially, the calculated efficiency of the first runs was very high. At first I though it might be the reaction plates themselves, if they were too far out of parameter, but they're not. However, there's some excessive reaction residue on the plates. Something is a little out of calibration, causing the reaction to proceed at the wrong balance. That's one of the reasons I want to do a longer test run, and see how quickly the power curve drops off.”

“I see,” I replied, “But the hydrogen problem still stands. You can't do chemical tests?”

“I'm having them run right now.” she said. “I'm sending a couple off to an outside labs; we need the high-detail analysis.” I nodded, I had seen the test invoices in the morning; but the results would take time to come back. “We could try and make a fresh set of plates. I know we were going to wait on making additional cells, but we will need them. I could then use the comparative data to pin down the problem.”

I nodded. “Makes sense. Get Hank, if he's not in the middle of something.”

Susan stepped out, and returned with our shop foreman. “Yes, boss?” he asked.

“How quickly would you be able to make another set of fuel cell plates?” I asked.

He frowned a moment. “As I recall,” he said, “we only ordered enough panels for the one set. I think we have a couple of spare plates, but not a full set.”

“I'm sure you can come up with something.” I said. “Not identical plates, but something workable?”

“They'll change the returns,” Susan pointed out.

“Calculable.” I said, “But it might still be enough for the contrast data you need. Maybe better.”

She nodded. Hank said, “I can come up with something, if it's test plates you're after.” he said. “We've got enough scrap pieces around.”

'Talk to Susan.” I said.

A couple of days later he brought in the first plate. I just took a glance at it. Hank said, “As soon as Susan verifies it, I can finish the rest of the set.”

“Nice work.” I said. “It's good to have someone who can rig things up in a pinch.”

“I've had to do worse on some of my airplanes.” he replied.

I nodded. “You probably don't have much time for that, these days,” I said, thinking about how many late nights he tended to put in.

“This is even better,” he said, “Especially when we get of the ground.”

A week later, I anxiously watched as Susan powered up the fuel cell with the test plates. Electrical current from each plate was measured, voltage output, as well as water produced. “Remarkable devices, aren't they?” I asked. “They provide both power and drinking water, without the hazards of normal combustion.”

Susan nodded without looking up. “And a lot of work, too. We're at full output.”

Peter poked in. “Here you are, Dan.” he said. “I was looking for you; Robert was, as well. Do you have to observe every system test, anyway?”

“I haven't observed every one.” I said. “But I do like to keep apprised of everything.”

“There's only so much you can,” he said. “Besides, you've got other work don't you.”

“Always.” I said. “So, what's your problem?”

“Just some issues with the main twelve volt system.” he said. We had decided to use a twelve-volt system for power, allowing the use of standard – especially automotive and light aircraft – equipment. But, as Peter pointed out, there were reliability issues. “But the bigger concern I'm beginning to see,” he said, “Is the size of the spacecraft. Most twelve volt systems – like cars - are markedly smaller. Some of the power lines are getting long enough that their resistance is becoming something of a concern.”

“Suggestions?” I asked.

“A higher voltage on the main electrical bus – say, 24 volts – should ameliorate the resistance problems” he said, “then be stepped down for local buses.”

“Too complicated,” he said, “I thought we didn't want to use separate power buses. Besides, DC is harder to step down, isn't it?”

“A little.” he said. “The other option would be to use heavier wires for the pain power bus. But that will add weight, and raises a couple of other issues – I've increased main bus size already.”

I nodded, thinking for a moment; I've always had trouble with the finer points of electrical engineering. “Well, sketch the dual voltage system; see what the weight is going to be. But I still think the 12 volt system will be lighter, and simpler.”

“We could also switch to a pure 16 or 24 volt system,” he said, “But then most off-shelf equipment won't work.”

I shook my head. “We can't afford that. Just see what you can do.” He nodded and left, and I turned back to Susan.

“Almost done,” she said. “Powering down ... now.” After a couple more minutes, she said, “Test complete.” At her direction, I helped empty the water output, getting an exact measure of the water produced in the reaction. “I'll compile the test data and have it by the end of the day.”

She brought the readouts and the data disk to me before she left. “Power output is down from the

original plates, but consistent with the plate quality."

"Any leads on the original problem?" I asked.

"Maybe," she said, "I'll look at it more tomorrow. This data will prove quite useful."

"Very good." I said.

Indeed, the data did help Susan on the cells, but the problem continued to evade; with each thing she tried, the problem seemed bigger and bigger. What had initially been only a minor problem began to seem a major concern. Peter's problem proved less – it would be persistent, but manageable.

December slid by, holidays providing only a minor distraction, as one solution invariably presented more problems.

One day in early January, when I got home, Troy was sitting despondent on the couch. "The store is being bought out by a national chain." he said. "Apparently they've been talking about it for some time; they closed it at the end of the year. They'll be closing down out headquarters and merging it with their own administration, and as the first step, they've laid off almost all of the junior managers and management trainees. Myself included."

"I'm sorry to hear that." I said. "I'm sure you'll be able to find something else."

"I hope so," he said. "I've already started looking. But with the economy right now, no one's looking for outside management. Hiring is down across the board."

"Well, good luck." I said. I looked at him a long moment. Being laid off – especially to a business decision – must sit on him hard, though not doubt he understood it better than most. He was ambitious in a way I have trouble understanding, seeking power and money for the sake of the pursuit; and being ambitious, failure must hit him hard. "Maybe you'd be interested in working with us?" I finally asked.

"On your rocket?" he asked dubiously, and slightly scornfully: I knew he considered my project a pipe dream. "I'm no scientist. Or engineer."

"No, but we'll need businessmen, as well." I said. "And managers."

He laughed. “Are you saying it's too much for you?”

“Not at all,” I said. “But a project of this magnitude requires a wide range of skills, and I'm not afraid to find people that are better than me at certain things.”

“Wise.” he said. “One of the first things I learned in business was the importance of putting the right people in the right place. In other words, you're looking to bring on a leader.”

“Not a leader,” I said, now laughing slightly. “My project; I'm in charge. But I could use a business manager.”

That seemed to darken his interest a little bit, and he made a snide comment about working for a dreamer. “I'm sure I could find something better than working for you,” he added after a moment.

“Maybe,” I said, now deep in thought. The idea had come to me rather suddenly, but now that it had, it seemed like an exceptionally good idea. In fact, the management, and especially the books, was getting a little ahead of me. Nothing I couldn't mange – not for this – but the right people in the right spots. I began to turn my energy onto the task of convincing. “And maybe it's too much of a pipe dream for you. But everything has to start somewhere, with discipline and good management to help bring it along – and profit to those who succeed. And believe me – you've seen bits and pieces of my proposal – this will bring profit and status.”

I could tell he was thinking about it, but he said he'd rather be in charge. “No offense, Dan,” he said, “But you're not exactly what I'd call management material.”

“I've done well enough so far.” I replied.

“And now you're asking for my help.” he said. “Besides, if I go in on something small, I want to go in on top.”

“Only starting small.” I said, “And it's my project - and everyone whose involved – I'm not moving aside. And I may be asking for you're help, but I don't need it.”

“If it's not on your terms, you mean you don't need it.” he said. “You might find that differently as

your project starts to get bigger."

"I'll grow with the challenge; we all will." I said. "But this is your chance to get on something big."

"A big pipe dream." he said. He chuckled, though, and I thought I might have him. I wasn't interested in giving up control, though. "I don't really mean taking your job, of course – a CEO defers to his best subordinates when it's appropriate. Especially with research and development."

"Oh, I'll be the CEO," I said. "If your not interested in less than that ... but I could use a business manager, and like you said, a CEO defers to their best subordinates when appropriate."

He chuckled again. "I'll have to think about it, top spot ... or otherwise." Sitting back in the couch, though, he added, "But truthfully, I like the idea. And you drive a surprisingly hard bargain, for an engineer. I begin to see how you've been able to raise money so far."

"All for the project." I said. "I will have to talk to everyone else, of course, and see what they think. It may be my project, my inspiration, but we've all given a lot already."

"Well, talk to them," he said. "I'm open to it, if we can get all the arrangements ironed out. And if I don't find something better before that." He smiled at the latter, but I could tell he was intrigued.

I talked to Peter, Susan and Uncle Robert the next day, and they were all receptive. Especially Peter, who pointed out that a real manager was one thing we didn't have. "You got an electrical engineer because that was one of your weaknesses," he said, "But not a manager."

Susan added, "Maybe you'll have a little more time, this way."

"More time for the project, that's for sure." I said. "Then the next thing to do would be to bring him in for an interview?" and everyone agreed with that.

Troy was agreeable, as well, although we now dodged the question of his exact role. I think the challenge of managing such a monumental, almost quixotic enterprise appealed to him; it was one of the things I had tried to emphasize to him. So, the following weekend, we went to meet the others.

"I'm not used to job interviews on Saturdays." he said as we left the apartment.

“We're pretty informal.” I said. That itself seemed to make Troy a little uncomfortable; I'd had to warn him not to wear a suit and tie. “Any of us is apt to get down on the floor and work on things, operate equipment, move supplies. Whatever is necessary.”

“We can take my car,” he suggested.

“My truck will be fine.” I said, climbing in and turning it on. Almost reluctantly, Troy climbed in, and I continued as I pulled out. “It's the only way to operate with such a small team. Everyone has to be willing to do what's necessary, not stick to their own little job. And it works pretty well. It makes for a pretty dynamic work environment, and has helped us all get better insight into the problems we face. And believe me, they're not small.”

“Oh, I believe you,” he said. “Considering the number of people who built the Space Shuttle. Or the Concorde.” He cited a couple of specific examples, impressing me with the references.

“You've done your research.” I said.

“Of course.” he replied.

“You'll need to do more, of course.” I said. “Alot more. But that can come soon enough. First, you'll have to convince everyone else that you can add to the project.”

“You seem convinced.” he said. “And I thought you were the boss. And still wanted to be the boss.”

“We pretty much work together.” I said. “I am in charge, of course, but in a 'first among equals' sort of way. At least that's what I try for. Beyond that, we don't really keep much status. Everyone has their specialties. It's mostly the same way even among the technicians and fabricators. We've got a shop foreman, and everyone has their primary jobs, but we all work together on everything. I'm open to suggestions from everyone, and they do come from everywhere. Not at all like a retail environment, I'm sure.”

“Not at all.” Troy agreed. “Then if it's so democratic, why are you so adverse to letting someone

else be the 'first among equals'?"

"For one, because leading, truly leading such an organization requires an intimate knowledge with the technical details, and a close familiarity with everyone else. We can't just bring someone in from outside to lead us. It wouldn't work." I explained. "Secondly, it's my project. I'm not giving it over to someone else." Troy nodded in understanding.

We arrived a few minutes later. Not at the warehouse, much to far away just for a meeting, but at a local library with small closed-off meeting rooms. We went in one, and talked to Troy about the project. I went first, giving a brief overview, mindful of the things I'd already told him in the past. Then, we all asked questions, what he could do for us, and why he was qualified.

I pointed out that he had been dismissive of my designs since the first time I'd shown him one of my sketches asking "What makes you so interested in participating now?"

"Oh, I still think it's a pipe dream," he said. "But then, when George Westinghouse first proposed his air brake system for trains, railroad executives told him 'you can't stop a train with wind.' Pipe dreams can be made to work, and when they do, they can be very profitable. And to make them work – and to make them sell – you need a businessman."

There were other questions, many other questions, but we all agreed we could use his help. Then the discussion came to that of money – he asked how much we were offering.

"None of us draws a fixed salary." I explained. "The technicians do, more or less, and they have priority over use, come to it. After that, the four of us draw an equal 'living allotment' depending partly on our current financial situation. That is also one of the reasons all four of us – ultimately – have an equal say in bringing someone else into the project – new faces means all of us get a little less."

"Inefficient," he said, "And not very appealing. However, I see it's usefulness for what you're trying to do. We're trying to do. How much, then, does it tend to come to." I told him, and he whistled. "I see why you've cut your spending down so much."

“Money doesn't matter.” I said. “The project does. That, by the way, is when things are going well. We've drawn less – or nothing – at times, when fundraising comes up short.” Troy reminded me how much we paid for the apartment, rent and other expenses. “Of course. We know what we each need to manage. And there is help other than money. It hasn't been easy, and we all know it's going to get a lot harder. But it's worth it – and that's what we can offer.”

Troy nodded. “Getting in on the ground floor of something big is one of the great goals of businessmen, and I think this is a chance to do that. When do you want me to start?”

Troy spent most of the next month reading materials, my proposal, articles, textbooks, to familiarize himself with the project. The finer points of the engineering he wasn't concerned with; but I was impressed by his desire to see the “big picture” of the project.

We were both sitting in the conference room one day, Troy cross-referencing some textbook material with points in my proposal, me reviewing the latest airframe/weight designs, when Susan came in. “How is it going with the fuel cells?” I asked.

She shook her head. “I still haven't been able to pin down the problem,” she explained. “There are certainly discrepancies with the reaction plates, and the test plates gave me a lot of useful data. But I still can't pin down the problem.”

These fuel cells were becoming a real running problem; what had at first seemed to be minor discrepancies were turning into something much larger. I offered a couple of suggestions, additional analysis to be run cross-referencing the data sets. “It might pop something up.”

“It might,” she admitted, “But I've looked over it several ways, and eliminated several possibilities already. I think it has something to do with the rate of reaction, but I'm not sure. Cross analysis might show something, but I'm more concerned with long term effect – if there are side reactions going on, they could lead to rapid cell degradation.” We'd been over most of this before, and I turned it over in my head. We can't eliminate all side reactions, and there were indications the same unknown effect

was occurring on the test panels – with no contrast, cross analysis wouldn't show much more that what Susan had already found.

Troy cut in without looking up, “You know, it can be a little hard to work in here, with everyone else coming through. Sometimes, I don't see how you do it.”

I shrugged. “I find the interplay informative,” I said. “and helpful to know all of what's going on. I don't like to work in isolation – keeping abreast of what is going on, I can work things right into the design. Besides, there isn't space for all of us to have private offices. You'll get used to it.”

“Perhaps.” he said, pausing. “You've been working on these fuel cells for a while now – a few months, I believe, right?”

“More than that, since we started the design,” I said, “But a few months dealing with these particular problems.”

“Well, sometimes it can be helpful to leave something aside for a while, and come back to it later.” he suggested. “Other possibilities may present themselves. The basic cell works, right?” Susan nodded confirmation. “So take what you've got, and come back to it when you've got some fresh ideas.”

“The problem,” I said, knowing the validity of his argument – a break can be very helpful – but not in this case, “is that the fuel cells drive so much else. We need the fuel cell designs finalized so we know what we'll have to play with for electrical power. If we wait, and cell redesign cuts power from what we expect, it could throw everything else off. Better to get everything set now, so we know what we're dealing with.”

“The main concern I have,” Susan added, “it that we'll see an abrupt power dropoff. We might have to redesign the whole unit, and that would really throw things off.”

Now Troy shrugged. “Perhaps. And perhaps your engine will prove to have more problems than you think. And perhaps a hundred other systems will take more time than you think to make work.

But you pointed out yourself the multidisciplinary effort this will require, " as he said this there was just a hint of contempt in his voice – I knew his attitude towards that idea, "and this seems like just such an example. Redesigning it later may cause other problems, but so will continuing to struggle with it now. If you can come back later with a fresh approach, it would be worth it."

"No." I said. "We also need to do this one piece at a time. One step at a time. If we leave everything in the middle before going to the next, then we'll never get anything done."

"You don't have enough people to work one thing at a time. You said it yourself." he countered. "Besides, don't you work on several things at a time?"

He was right – I was working on most of the ship at a time. The fuel cells, the engines, the airframe and aerodynamics, everything. And that multidisciplinary approach was the essence of what I was trying to do, and how I was trying to do it. And the only way to get it done with what I had. But still, we couldn't leave the pieces be, we had to finish things.

Besides, he'd only been with us for a month – in truth, I was still slightly wary as to his commitment, and I was in charge. The decision was mine.

"Dan," Susan said. "Troy may be right. I've been looking at the same stuff for more than two months now. I've got ideas, concerns, but not enough. And there are other pieces I need to work on, as well."

I grunted, and I didn't want to be seen to be giving up authority. Still, we couldn't be to focused on one piece of the puzzle either. "Alright." I said, "Troy may be right. And it's up to you, by and large – if you think it's the best way to deal with it, do it. Just don't let it slip. And make sure Peter's got good numbers for power availability."

She nodded and left; Troy said, "Just making a management suggestion."

I shook my head and went back to my own data, but couldn't shake it the feeling I had lost a battle here. I've always mistrusted MBAs – I think it runs in my family – and now I've let one into my

project, and humankind's destiny., and worried about what would come out of it.

The next day, I asked Troy if he thought he was up to speed on everything. “More or less.” he said. “Something like this, I'm not sure you're ever really 'up to speed' on. But I'm getting a handle on it.”

“Good.” I said. “Then I think the next thing we need, is for you to look over our finances. They're in order – more or less – but I haven't had as much time as I need to keep them up, and it's not my best thing, anyway.” Besides, I said to myself, it ought get him away from the management.

“Sounds good.” he said. “You did say that was one of the things you wanted me to work on. Where do I start?”

But a few days later he came back to me with several things. Already he had questioned a number of expenses – simply confirming their need, he understood the high cost of the project – and I had answered those. But he said my accounting was sloppy. “I've been able to clear things up,” he said, “But it's been some work.”

“Is it correct?” I asked.

“Yes,” he replied. “Just sloppy.”

“Correct is good enough.” I said. “And I'm sure you'll keep it from being sloppy. But I think you've got something else to say.”

“On a per item basis, you've been right. We need all these parts, and R&D always leads to a fair amount of material wastage.” he explained. “But things have been pretty inefficient on some things. We do need to be a little more careful.”

“I'll keep that in mind.” I said.

“Do.” he said.

Things only seemed to get worse over the next couple of weeks, and Troy seemed to be challenging every decision I made, and I wondered if I had been right to bring him in. We needed more management experience, but he seemed to be trying to run everything. I already stayed pretty late, but

I took to staying later, making sure I always left after he did.

One evening, my sister Abby called, just as I got in. "You finally called at a good time," I said, "I was still at work last week." I hadn't bothered to call back because it was usually useless to call her – she's usually impossible to reach.

"You've been working pretty late." she commented. "Still working on your rocket ship?"

"Of course." I said. "We're making a lot of progress ... and running into a lot of problems. But I never expected an easy ride of it. We finally got some solid backing; we've got a major investor, a big supported, now, and that's also helping bring in more cash. It's a funny thing about raising money – people are more willing to invest when they know others have already invested."

"People can be like sheep." she said. "Even those who claim to be smart about things."

"Well, it makes it easier – I don't have to spend half my time chasing money anymore." I said.

"I wouldn't slack off on that to much," she said. "From what I hear, you've still got a long way to go."

"Of course," I agreed. "But there's more to it than money, too. So many systems to design, and it's all got to be under weight. We know what the engines can lift – getting everything, including the airframe itself – to fit under that is an ongoing process."

"That's your problem," she said, "If you've bitten off more than you can chew, then you've got to find a way to swallow it." That was very much her style; jump into the pool, then figure out how to swim. I supposed I've done the same here, and sometimes I feel like I'm doing more floundering than swimming.

"Oh, I'm managing." I said. "But you're right, I've bitten off a lot. I invited my roommate, Troy, into the project, for his management experience – he lost his job at the department store a while back, and I thought I could use some help with administrative skills. But now he's trying to run everything, challenging my decisions, my authority."

“Is he trying to run everything,” Abby asked, “Or do you simply think he is?”

“Oh, he's definitely challenging my authority.” I replied.

“Is he?” she asked. “You've said yourself you're not the best administrator, and I know you well enough to know that's true. And I know you well enough to know that, besides your obsession with this project, you like to run everything, and tell everyone exactly what to do. Maybe that's what you're doing here?” I protested, but she cut me off, and continued, “Besides, you said you brought him in for his management expertise – you may be the one picking the fight, not him.”

“Anyway,” I said, changing the subject. “How are things going with you? Are you still in California – that was the last I heard.”

“Don't change the subject, Daniel.” she said. “who is really challenging for authority?”

I grumbled a moment, then said, “I'll think about it.”

“Do.” she said, “For the sake of your rocket ship.” She then said she had left California the previous month, and was up in Oregon, but “just passing through,” and told me about her latest travels. She was still wit the same boyfriend she had been traveling with for most of the past year, which still surprised me. “We're both wanderers,” she explained, “and about the same time, we usually start to feel like it's time to move on.”

We talked about a few other things – I really didn't have much to say, except about Icarus, and I knew she didn't really want to hear more about that. But after we hung up, I thought about what she'd had to say. I hated it, but she was often right, about me. Was I the one picking fights? Icarus was my idea, after all, and I was the one leading it – but I knew I didn't know everything I needed, and couldn't do everything there was to be done with it.

Perhaps I had been a little pushy.

When Troy came in a little later, I asked him what he'd thought of working on Icarus.

“When you started it,” he said, “I thought you were nuts. Actually, I thought you were nuts when

you always talked about it, even back in the dorm. You are obsessed, you know."

"Thank you." I replied.

"Hmmm." he continued. "But you've already taken it far beyond what I thought you'd be able to do. And now, I start to see why. It's an obsession, a passion, and you've managed to convey that to the people you've got working on it. You've even got me starting to see it – or at least to think you might be able to do it. But you're a lousy manager – I've only now gotten the financial books in order – and I'm trying to get, and keep, things running smoothly. It does get hard., though, when you insist on questioning all of my suggestions."

"It's my project," I said, "And you're right, it is my passion. I don't want someone else – especially an MBA – coming in and walking all over it. I told you before, I'm in change."

"Yes, you are." he agreed, "I agreed to that, didn't I? I don't want to displace your passion, or 'ruin' it – now I better understand why you do it this way, why it works, and I don't want to disrupt that. And I already know what you think of MBAs. But like you said when you invited me on, you need management skill as well – now you've got to let me do that. Let me be your bookkeeper and glorified assistant, if that's what it takes – but let me bring what I have to offer to the project. Tell me what you need done and I'll see that it gets done, but let me do my job like you let everyone else do theirs."

Things went smoother after that – I still felt like Troy was challenging my position sometimes, but I reminded myself that he was good at what he did, and things were running a lot more smoothly. And the books were definitely in better order; and costs had actually dropped slightly, even as our pace continued to pick up. I continued to work on the aerodynamic design, zeroing in on the exact shape the Icarus would have. Finally, I presented it to the group.

Troy, who had seen some of my earlier sketches, but little of my refined designs, commented that it didn't look very aerodynamic. "Fat and round," he described it, and said the lack of wings was disconcerting.

“Lifting bodies always looked very strange,” I explained, “And they are essentially the opposite of the flying wing, depending entirely on the shape of the fuselage to deliver lift. For our purposes, the lifting body is ideal – more than anything, Icarus will be a giant fuel tank, and this shape supports that.”

“As far as aerodynamics,” I continued, “while the lifting body doesn't look very sleek, it's at it's best aerodynamically in the high supersonic and hypersonic range – exactly where we need it. Historically, lifting bodies were researched for exactly this purpose, and NASA conducted trials with a number of test vehicles. I've used available results from those trials for this design.”

“I didn't think NASA had released all of those results.” Uncle Robert commented.

“I've found what I can, which is quite a lot,” I said, “and computer skills can come in handy.”

“Still,” Susan said, “Computer modeling is one thing, but as you've said, there's no replacement for real data.”

“No,” I said. “A model in a wind tunnel would do a great deal to verify my numbers. And we've got a very small margin to work with; much out of it in weight, drag, or anything else, and we'll never make orbit.”

“I thought you wanted to avoid expensive model testing,” Troy pointed out, “'Taking advantage of the best of modern computers' I believe you said.”

“As much as possible,” I said, “But models are only as good as the numbers that go into them. In a way, it wouldn't be as bad as it seems – the wright brothers built one of the first wind tunnels right in the bicycle shop. But a hypersonic wind tunnel is a much more complicated proposition.”

Uncle Robert squinted in thought. “Would a low-speed wind tunnel be sufficient?” he asked, “It might provide enough practical data to compare with and validate the modeling. If the low speed profile fits, we might not need to do higher airspeed testing.”

I shook my head. “There could be problems at higher speed that wouldn't show in a subsonic tunnel. Supersonic airflow can behave very strangely, after all. I don't know, really, but the numbers

can only say so much, and we can't change the design once we build it."

"A wind tunnel is basically a do or don't do proposition." Peter pointed out. "If we build it, haven't we lost most of the savings of so much computer modeling?"

"Hopefully not." I said. "Validating the computer data would only take a few runs, and then we'd be set. Without the computer, wind tunnel airframe design can take hundreds, or thousands, of runs. Of course, if there are discrepancies, it could take a lot longer."

"Is this something we might be able to contract out?" Troy asked, "I mean, I'm not as well versed in this aerodynamic stuff as Dan here, but it seems like the ought be able to find a hypersonic wind tunnel we could use. It would be less expensive than building our own."

I suppressed the urge to say something to contradict him, and we agreed to explore the possibility. I did point out that hypersonic wind tunnels were few and far between, and most likely to be in the hands of defense contractors, but he was right – it would be cheaper than building our own.

We did find a supersonic tunnel willing to run a few runs for us – I felt that would be sufficient; true hypersonic flight would occur principally as a part of reentry where Icarus would behave more like a capsule anyway. A short set of runs, at the tail end of the tunnels normal operations, validated most of the data, and suggested only handful of minor changes. A second set of runs with a second model I felt sufficient, and incorporated in the computer model. The aircraft design was – finally – finalized.

And work continued. With the aerodynamics complete, I could now turn my attention to other components, including the inner structure of the aircraft, the airframe, and the placement of all the various components. Over the next few months, we made considerable progress, both in systems design and prototype fabrication.

I got up early most Saturday mornings, to continue design work. When necessary, I would make the trip out to the building; more often I would meet with Uncle Robert, Peter, or Susan, or whomever, depending on the current topic of design. I worked on, and thought about, Icarus, all the time, and we

all put many more than forty hours into it, but much of the design work didn't need to be done out at the shop.

One such Saturday – the first of February – I was going over the latest weight balance figures, when Troy suddenly pounded on the door and called for me to come out. He was, as usual for him, watching the news, economic programs, and the like, and spurned by his tone of urgency, I came out.

On the screen were images of the Space Shuttle Columbia, breaking up as she passed over California. "My god," was all I could say, as the newscaster quickly described what little was known. It wasn't much, yet: mission control had lost contact with the orbiter a few minutes prior, and multiple people had seen, and videoed, the craft pass overhead. "My god."

Suddenly weak-kneed, I sat down on the couch and watched the coverage. I already knew most of the details of the shuttle mission, a science flight which had been repeatedly postponed in favor of space station construction flights, and the details of the crew, including Ilan Ramon, first Israeli astronaut, facts which were repeated throughout the broadcast. More than anything, it was endless speculation, with very little information; only the sheer wight of what had happened.

"Is this what we're building towards?" Troy asked, after a while. "If something like this can happen to NASA, how can we keep it from happening to Icarus?" I knew he was thinking of the financial consequences.

I thought; seven people had tragically lost their lives here, horrible. That was part of the risk, and certainly, they knew those risks; and yet, was it worth the cost? "It is a dangerous thing we're attempting. So many things that could go wrong... So many things we could do wrong. But still, we must try. I fear more what will come if we don't"

"Still, NASA will no doubt recover from this," he said. "Probably ask for more money in the next budget. But if something like this should happen to the Icarus, everything we've done will end. And I'm sure investors will want their money back." The last wasn't completely serious, Troy knew as well

as I did the nature of most of our financing, our investors were risking their money as we were. But I saw his point, too, lives, money and more would be lost.

“I never said it was without a great deal of risk. After all, isn't that where the best profit is?” I said, “Still ... still.” Troy nodded; I couldn't say more. Seven deaths. And I was seeking to build, and climb in and fly, a craft much less engineered and tested than this. I shook my head. “Let me know if they have any more details.” and I went back into my room.

A few minutes later, the phone began to ring, everyone in the project calling as they heard the news. Most expressed disbelief, but only a hint of doubt; I did my best to put a brave face on it, that I never said it was without risk, and that I would address in in detail on Monday morning.

Then, I gave it a great deal of thought. I still remembered the Challenger disaster of seventeen years before, though I had only been a child. I had already had a fascination with spaceflight, and I saw that with a child's eyes, a child's simple horror. Now it was so much more, and I wondered if it was worthwhile. I spent the weekend searching for words, and to reassure myself that this was important, that this was worth the risk.

And on Monday, I spoke. Not exactly a prepared speech, but I had brainstormed it a good bit. There were more than thirty of us, now, crowded around the table in our little cafeteria. “In the history of spaceflight, rockets have crashed. Craft have been lost. People have died. And while we must never forget their sacrifice, we cannot let it become a vain one. We know the risks. I know the risks. You know the risks. But in exploration, in growth, there is always risk. But what is worse than trying and failing, is not to try at all. If we don't try and reach to far, we will never learn just how far we can reach. If we never try and be more than we are, we can never grow, as individuals, as a people, as humanity. It is human nature to try and be more than we are, and that is what we are doing here, and I fear what will happen to us if we cease trying.”

“And, yet, and yet.” I continued. “Seven people died on Saturday, in the skies over Texas. And

seven people died on January 28, 1986, when the Challenger exploded after liftoff. On January 27, 1967, three people were killed when the Apollo 1 spacecraft caught fire during a prelaunch test. April 23 of the same year, one person was killed when the first Soviet Soyuz spacecraft crashed on landing, after a problem-plagued flight. June 30, 1971, three people died in another Soyuz spacecraft, again on landing. That is a grave human toll that spaceflight has exacted, and if we continue, it will exact many more. I speak of risk as if it is a car maker who misjudges the market for their next model year and winds up with hundreds of unsold cars on their dealers lots, but it's life and death. One small failure of the Icarus could easily kill three of us. We know the risks – as did all those who I previously mentioned. And it is easy to say they knew and accepted the risks, as indeed they did, and yet, humans are unable to truly contemplate our own deaths; can we truly understand the risk? No matter what, the cost is still death; Seven families with loved ones lost, seven lives, extinguished."

"Is it worth the risk?" I said. "I think it is – to do less, to stop out of fear, is to dishonor those who have paid the price for advancement. To grow is risk. To try is risk. To live, indeed, is to risk death. We must not forget those who have gone before, those who have died before – but we cannot let that stop us from building on what they have done. This is the gravest of risks; we must never forget what the cost has been and will continue to be. But we cannot let fear of that risk dictate us, control us. Our choice is not between risk and no risk, but between risk and fear – and while proceeding brings risk of failure, fear assures it."

"That said, and this is important," I finished, "We must learn from failures, our own and others. We will follow closely the investigation that has already begun, ready to use whatever findings NASA comes up with in our own craft. We're using shuttle derived technologies as much as is applicable and available, and in particular a thermal protection system very similar to that on the shuttle. We will take risks, we must take the big risks – we must take the necessary and inevitable risks – but we must also reduce those that can be foreseen. What NASA learns, we will use; we will learn from this as they

will. We will learn from what we do, what has been done, and we will succeed."

People nodded, agreed, and began to filter out, back to their work. I answered a few questions, chatted with a few people, then sat down. It felt good to have said it. Now, if I could completely believe it.

Susan pulled up another chair and sat down. "Good job." she said. "Troy tells me, though, he thinks this bothered you more than you let on."

I sighed, then forced a shrug. "This is a risky business, and in truth, we really can't afford to fail. As he pointed out, NASA will fly again, but if something happens to us – if we screw up, or just get it wrong, it could set private spaceflight back a generation."

"Is that all?" she said. "As you said, it is a risk we must accept – but far worse is to let fear prevent us from trying."

I closed my eyes, opened them, and glanced around to see if anyone else was around. They weren't. "The truth," I said, finally, "is that I'm not a risk taker. I don't like to take chances, especially with my life. Hell, my sister would be far likelier than me to hop right in to something like this."

"Yes, but you're not a salesman, either," she said. "And yet, I've seen you sell Icarus, get people to raise millions even as they admit it's a 'speculative adventure.' You will do this."

"Besides," I continued, "Seven people have died. A death, any death, is a tragedy, even if they are doing something worth doing. Worth risking. I wonder, sometimes, if we are tempting fate, just a little too much?"

"That, I can't answer." she said. "Although I think you did well enough before. But, maybe, you need a little space from it by now. You've been going all out – we all have – for more than two years now. I think we should do lunch this weekend, the two of us. You could do to get away from this for a day." She forestalled my protest, that there was still too much work to do, saying "A little break won't hurt. You'll come back with a fresh eye, and ready to go. But I think you need it; I don't think you take

any breaks at all, and that, too, comes with a cost."

I looked at here more closely, for a moment. "Why are you always trying to get me away for a bit?" I asked.

She gave me a sly look for a moment, then said, "I just think you need it. We can even take your truck."

"Hell," I shrugged, "Maybe you're right. I guess it would be good to get away for a couple of hours. Why not?" and in a moment, we had worked out the details – we would go see a movie and catch lunch on Saturday.

The week went by slowly; we were all still preoccupied with the recent disaster. I went back over aspects of the design, questioning whether they would be adequate the task, whether the airframe would be strong enough to withstand the enormous stresses, whether the systems would be sufficiently robust and reliable. And the news coverage regurgitated all the latest speculation, for that's all they had yet; no useful information had been released.

On Saturday, I picked up Susan, and we went off to the local multiplex. She surprised me a little, coming out in a fine blue dress. She always wore dresses, even in the lab, but this was still a cut above what I had expected. The movie wasn't bad, if not exactly my type; but she was right, it was good to get out. We went to a nearby deli afterwards and got sandwiches. We chatted about the movie for a bit, laughing about a couple of the funnier parts, and then some of the other things that were going on; I had the feeling she was trying not to talk about Icarus, and for the moment I was content not to – that felt remarkably good.

After a while, however, the loss of Columbia came up; Susan wondered if it was giving me some doubts about the project.

"No, not doubts." I said, after a moment. "Fears. Worries. But not not doubts."

"Fear of failure?" she asked, "Or fear of death?"

“Both.” I admitted. “Like I said, I'm not a risk-taker. In a way, I suppose that confirms my certainly of the necessity of this effort. Sometimes we seem to be a society ruled by fear. We're so afraid of risks, dangers, we let it control us.”

“Like the snipers last year.” she said. “They didn't seem to bother you.”

“Exactly,” I said, thinking about that terrible time. The snipers themselves hadn't worried me – I knew the actual odds of being their next target were comparable to being struck by lightning, and said so to Susan. But the intense fear that had gripped the region had started to wear on me. “I understand why people were afraid, but we've come to expect to be able to eliminate the risk entirely from life, and that's just not possible, and to expect it is dangerous by itself. You overreact to everything. Even if we fall, we need to try. But still, we also can't afford to fail.”

“Then we do everything we can to get it right.” she said. “I've seen your passion for this project from the beginning – you're so different when your pushing this; you can do things you otherwise couldn't, or wouldn't.”

“Is that why you signed on,” I asked, “You saw my passion. Everyone else called it simply obsession, and thought I was nuts.”

“It is obsession, too,” she said, pointing out the fine balance between genius and insanity. “And yes, that was one of the reasons.”

“And the others?” I asked.

Susan was silent a long moment. Finally, almost reluctantly, she said, “Because I like you, Dan. Your passion, your personality. You've never seemed to see it, even now, as we've been working together almost all the time. But I like you, and I wanted to be with you.”

“I've always considered you a friend Susan,” I said, now the doubt in my voice, the hesitancy in my speech. “Or is it more you wanted?”

“That depends,” she said, “on how much you're willing to give.” She paused, another mote of

hesitation. “But I would like you to be mine, if you would like me to be yours.”

The weight of realization was intense; how had I missed it? I though back over all the time I had knows Susan, how many times she asked me to go to lunch, or a movie, or the like. Inexperienced I may be in such things, and a Physics major as well, yet I had read my Shakespeare, too. How had I not seen it – was she simply waiting for me to ask? And had she really waited so long?

And when I looked at her, I realized I liked her too – had I never let myself see that? Or had I been blinded by what I sought to do? Or was that – never acknowledged – why we got along so well?

But there was a fear there, too. For all of that, for all that I suddenly felt – a new understanding of so many of those poems and stories was blossoming in my head – what would it mean for Icarus. My passion, my obsession, whichever it was, was not just about myself, but what needed to be done, what I needed to do. I could let nothing, not even this, jeopardize Icarus. What effect would it have? And what effect if we went bad?

But I heard poems in my head as I had never heard them before, and I understood one of the things that I had always known, that we were people, first, and had to ensure our own happiness, as well.

“I would like that very much, Susan.” I said. “But, as you said, Icarus is my passion – I won't let anything get in it's way.”

“I understand that,” she said. “In fact, at times I thought that might weaken my ... interest. But that passion is one of the things I most admire about you. Besides, you've made it all of our dream, as well – I'm not going to get in the way of that.”

“Then this,” I said, trying to come up with something poetic to say, and failing, “is a beginning.” I took her hand and gripped it warmly, and her mine. “May it last a long time.” We looked into each others eyes for a long moment, savoring the moment. After a while, I asked, “Then, do we tell everyone?”

“I don't see why not.” she replied. “Besides, they'll know soon enough. I don't think we'll be able to

hide it." She was right about that, I thought.

We sat and talked, after that, long after we finished out food, about many things. Reminiscing about school, talking about the Icarus project, and so many other things. We also talked about riding in to work together. All of us had discussed that, earlier on, for practical reasons – but all of us lived too far apart to make it work, and were never quite on the same schedule. But now, things were different, and I said I would pick Susan up on Monday morning.

I was nervous, coming into work that morning, what people were going to think. But riding together, just talking casually, enjoying each other's company, and realizing we had always enjoyed each other's company, we knew we were right. How could I have taken so long to see it?

We didn't make a production out of it, mentioned it casually, and let the word spread. People were far less surprised than I thought they'd be, and none seemed bothered by it.

Later in the morning, Uncle Robert came by, and said, "So you two finally got together, huh?"

"What do you mean, 'finally'?" I replied without looking up.

"We've all seen Susan's been interested in you for a while." he replied. "Well, most of us have, anyway."

"You should talk," I replied. "The consummate bachelor."

"Oh, I've been around." he said. "Just because it's what I've decided doesn't mean it's right for everyone."

"Anyway, yea, we're together." I said. "And I'm very happy about it." I paused, then changed the subject. "I think I'm going to have to replace my alternator. I changed the battery last month, and it's still barely getting a charge." Uncle Robert made a couple of suggestions, things I could try, and I told him I'd already done that. "I'm pretty sure it's the alternator," I said "I was wondering if you could help me replace it, next weekend if I can get it in time."

"Sure, I don't see why not." he agreed.

So the next weekend we were in front of my parents house, under the hood of my truck. “Fine simple engine I've got here.” I said as I slid the new one in place. “Not like those newer things. Some of them, it's hard to tell what's engine, and what isn't.”

“It does make doing you're own maintenance easier.” Uncle Robert agreed.

“Ughhh,” I said as I couldn't get the thing into place. “I can't quite make it fit.”

Uncle Robert took a pull, then a closer look. “Oh, you nincompoop,” he said. You've got it on upside down.” and he quickly adjusted it, and showed me where I had missed a piece.

“Damn.” I said, “I was wondering what that was for.” Uncle Robert let me slip back into place and let me finish tightening it, reminding me to double check to be sure everything was tight. “I gotcha.” I said.

“Perhaps,” he said, “But simple engines can still make big messes if things aren't done properly. Like missing pieces.”

Susan gave me a bit of a hard time about my truck, jokingly, of course. She pointed out that we could ride in in her car any time I wanted. “Save the miles on your car.” I said. “This thing will run forever.” I patted the dash. “You still don't know how to drive a stick shift, do you?” When she nodded no, I said, “I'll have to show you. Be handy if you can drive this to. It's really not bad.”

She agreed, as much as anything to spend the time together. So the next weekend we pulled over to a nearby, empty parking lot. “Adjust the seat to clutch; make sure you've got a good reach through the length of it's motion.” I said, then showed her where the gears were on the old, three-on-the-tree shifter. “You'll be keeping it in first for now, but if you're going to let up the clutch when not moving, push it up into neutral.” We buckled our seatbelt, and I said, now, give it a try. Push the clutch, drop it into first,” and she did so as I continued, “then give it some gas, and let out the clutch as you do so. She did so, and the truck bucked forward twice, and stalled.

“Sorry,” she said, try again. She did, with the same result. A couple more times; I told her to turn

the wheel, keep in the lot, release the clutch a little slower, try and feel it grab.

Jolt. Jolt. Stall.

More suggestions. For a moment, it felt like she had it, then stall. “This can't be good for it.” she said.

“It can take it.” I said. I was, in fact, a little worried about the clutch – learning to handle one is terrible for them – but I wanted her to know how to do it. I gave her a couple more suggestions.

She got it moving with a jolt, but she was in gear. “Alright, now turn.” I said “let up the gas as you go around.” She did so, too much, and I said “more gas as it began to lug, then stalled as she hit the brake. “Always hit the clutch if you come to a stop, or you'll stall the engine.”

“I didn't want to have to get it back in gear.” she said.

“It's easier when you're moving.” I said. “And harder to get it going on the turn. Try again.” This time she got it going smoothly; but she stalled the next three times. “Thing is,” I explained, “the engine can only go so slow before it stalls, so you've got to let the clutch slip just enough to get moving, and give it just enough gas to balance it. Once you get moving, release the clutch completely.” She tried again. And again. And again. She was getting nervous, strained with difficulty. I suggested we relax a few minutes, and talk a bout something else; we did so. After a bit, I suggested, “Let's try it again. Keep calm, you'll get it. This clutch can take a lot of abuse, but it is just a bit tricky.”

And so we tried again, and again. And she was getting it. “Try and keep it smooth. You want to let it slip as little as necessary.” Once she got smoother, I told her to just keep going around the curve without stopping, getting a feel for how slow she could go before she had to clutch, or give it more gas; and I had her clutch and declutch while moving, to get a feel for that, too. “Are you ready to take it out on the road and get up to second?” I asked.

“I'm not sure,” she said. “This is tough enough as it is.”

“Higher gears are easier.” I said. “Take it out this entry and go right; I believe theres a turnaround a

little ways down. Hold here; don't go out yet." It was just a small road through the park, and it was very quiet in February. "The biggest thing is not to let the engine go too fast; when you reach about twenty, clutch, and put it into second – remember up into neutral, forward, and up again." I had her show me a couple of times – I didn't want her pushing it into reverse by accident – then told her to go ahead.

She pulled smoothly out onto the road then gave it some gas as she sped up. "Ready ... now." I said, listening to the sound of the engine. The truck jerked slightly as she released the clutch, and she was going. "Keep it to about 25." I said. "The throttle feels a little different from most automatics; very abrupt response sometimes. Alright, here's the turn. Leave it in second as you slow down ... now clutch as you turn. Just stop it here." We were turned slightly into the side road. You have to be very careful downshifting into first. A couple of basic rules to follow: First, never downshift into first – only put it in first if you're stopped. Second, don't downshift until you're at the bottom of the speed for that gear. You'll see me do both, and sometimes you need to in this truck, but until you've got a very good feel for it, it's very bad for the engine. Alright, now start ... smoothly, very good ... and come around, keeping and eye for traffic." She got it going, and rose the engine to a roar. "Shift!" I said, and she did so, more abruptly than before. "Never push the engine too high; it will blow in first. Don't go above about twenty before shifting."

We went back and forth, several times, getting smoother, mostly. Finally, she seemed to be having enough, and I suggested we stop for lunch; she agreed readily. "Do you think you're ready to take it out on the main road?"

"I'd rather not." she said. "I think I'd like a little more practice. Next time."

"Alright." I said. "You're doing well," though she had actually stalled and jolted a lot; I was slightly nervous about how the clutch would feel. But she was getting it. Stop it here, and shut off the engine. Now, put it back in first and release the clutch. You always leave a standard shift car in gear –

that's the equivalent of park."

"Thanks." she said, before patting the dash apologetically. "I'm sorry, truck" she said, before we switched places, and I pulled us out and we got lunch.

We did the same thing the next couple of weekends; the next time she did get out onto the main road; I told her to shift into third about 45. "Watch your speeds," I explained, "After a while, you'll get used to the sounds you'll shift by. And in a couple of weeks, she was doing it – mostly – smoothly, and I told her to focus on keeping it smooth. As she got better, I let her drive the truck out to the building. She stalled – more than a few times – but I patiently gave her suggestions, and she was getting better.

And work on the Icarus continued smoothly. If I was now spending weekends, usually Saturdays, with Susan, I felt like I was working better for it, more focused.

With the airframe and aerodynamics set, and several major systems progressing, finding an airfield – and hangar – became more important. I had collected information on several viable sites. Now, I sent out inquiries to the most promising sites. Several were met with silence; but with some help from James Tucker, I was finally able to make contact with two. One really wasn't suitable – there were some heavily populated areas just to the south, partly in line with the main runway, and most of the unused hangars had since been demolished and sold, so there would be no place for us to work. But another field – a former airbase like most of the sites I had identified, now used as a public - and heavily underutilized airport. It wasn't quite ideal – in central Texas, it was well away from the gulf coast, requiring an overland launch – but it had two twelve thousand foot runways, and with only thirty daily flights, several unused hangars. And they were eager to hear more from us – they were very interested in better marketing their highly underutilized airport. So, I planned a trip down there to check things out in person. Susan wanted to come; I was worried it might seem slightly unseemly, considering; besides, there was still a lot of work to do. But everyone agreed that two sets of eyes would be better than one.

At first, we were going to fly down, but the paucity of services in the area meant finding a rental car would be difficult – if we did that, the best thing would be to fly into San Antonio or Houston, and rent a car there. But since we would eventually (if we decided it was a good site) be making the trip many times, and hauling our stuff, we decided to check out the drive. Susan suggested taking her car, but I said "If we're driving, we're taking my truck." I also pointed out it would be a chance for her to get some highway experience with the standard shift. So, we took my truck.

Splitting driving time – and Susan was still a little rough – it was a two day trip. We met with the airport director, Clyde Parker, the morning after we got in town.

"Well," he said, standing in front of the small, spanish-style airport terminal, "This is Domingo Airport. Would you like to come inside?" He was a tall, black man with a heavy beard and a lanky build, and a shirt and tie he didn't look accustomed to wearing. We followed him in, and he talked as he waived us through airport security (we had had to send security check information beforehand, of course) and showed us around the small terminal. "It is a former Air Force Base, as you know," he explained, "but the town pretty much dried up when the base closed, and we're too close to San Antonio and their airport anyway. With only about thirty flights a day, we run most things on a shoestring. We've done things up pretty good, though, as you can see."

I nodded. Most of that I already knew, of course. The airport had four gates, none with jetways, and only a pair of small CRJ jets outside.

"We didn't know what to think when we got your first inquiry," he said. "It's hard to know what to take seriously sometimes. Once we knew you were, though, we knew it could be a big thing for Domingo Texas. So you want to launch spacecraft from here – that would be very big. Put us on par with those boys up in New Mexico."

"Yes, well, we've still got a long way to go." I said. "We're still early in our designs, although we have a working rocket engine. We've got the airframe designed, now, but transport issues dictate we

have our launch site selected before we start construction." I looked around the terminal a moment, "This is a very nice terminal, but what we'd really like to see are the airport facilities and hangars themselves. The first thing we'll be interested in will be hangar space so we can begin assembling the spacecraft."

"Of course," he said. "I've arranged to take you up through our ops center, then up the control tower to get a view of our operation. Then we'll take you around and show you some of the hangars and other facilities. Most of the facilities from the old airbase are still in place, but not all are in very good condition. You'll have your choice of hangar and fabrication spaces. It really would be a boon to this airport to have you here.

He showed us through all the operation facilities, and we got a tour of the control tower – a very rare thing, especially in these days. After that, another manager, part of the ground crews, took us around several of the hangars, and showed us some of the other facilities. He, too, gushed about how the airport needed something like this here. The hangar space was very impressive – much bigger - and a much higher room that we were used to working in. Ample space to assemble the Icarus in.

Afterwards, we met up with Mr Parker, back in his office, and spoke at length. He continued to gush about how much he wanted Icarus to come here. "In truth," he said, "We really need something like this here. We're not in danger of shutting down or anything – we've carefully invested the subsidy we received when they closed the base down – but we're not in a position to expand, either. In a lot of ways, we're too big an airport for our purpose – too far away from anything to be of use, too close to San Antonio to provide real service to the region. But it sounds like, almost ideal for your purposes."

"In many ways." I agreed. "Your runways and facilities look more than adequate for our needs, and the isolation of your location, which has been such a liability for your airport operation, is an advantage for us – safety dictates that we operate well away from populated areas. But that brings us to the next point – we'd like to get safety and FAA approvals for all of our operations before we get started."

“I'm sure we'll be able to help with all of that,” he said, “Though of course you're probably more familiar with FAA procedures regarding spaceflight.”

“Well, that's just the thing,” I said, “There really aren't any procedures. They're only now approaching the question of private suborbital spaceflight. From the FAA perspective, orbital flight really shouldn't be much different, but, well, you know bureaucracy. It'll be a matter of working with them to get things straight, and whatever help you can give us will be useful. Especially contacts.”

“Of course.” he said, and we discussed a few generalities, followed by proposed terms. Again, mostly in generalities, particularly with regards to actual spacecraft operation, but I felt we had the outline of an agreement.

That night, Susan and I discussed things over dinner. “He seemed very enthusiastic.” she commented.

“I don't blame him.” I said. “This is much to big an airport for the operations they've got coming through here – a common problem with converted airbases. Hosting orbital spaceflights – especially if it becomes a regular launch site, instead of a few test flights, could give the airport a real reason for existence. Not to mention a solid revenue stream.”

“Still,” she said, “there seemed to be something ... overeager about him. Like he'll jump at any opportunity to boost his airport. But I wonder how much support he'll really give, when he comes to it.”

I shrugged. “We'll see. The truth is, we really don't have a lot of choices, even if we wind up hearing back from a couple more sites. There just aren't that many out there, and the further south, the better. An equatorial site would be even better, but that poses other issues.” We had been through all that, of course. We discussed the facilities, all very good, more than adequate for out needs. “Tomorrow we'll check out town, and get a better idea what there is around.

Town wasn't much more than I expected it to be, which wasn't much. Apparently, it had been a

classic military base town, and when the airbase shut down, the town pretty much lost it's reason for existence. Only a little bit was hanging on.

We spent the third day down in San Antonio – especially since there was so little in Domingo, Texas, it seemed worthwhile to find out about the nearest large city. The contrast was remarkable; after two days in Domingo, San Antonio seemed a truly happening place.

After that, Susan and I returned to Virginia and gave our report. While everyone else seemed even less enthusiastic about the town itself (some of them have an interest in nightlife,) we agreed the airport was our best option.

"Well, if that's that," Troy said, "Then next question is, how do we get there? Are we going to move everything from this building, or do we keep two sites? And when do we begin?"

"First, we need to work with the FAA," I said, "And make sure that they will consider the site suitable for the purpose. Mr Clyde Parker, ops manager there at Domingo Airport, was going to give us some contacts with the government. We'll start from there, and find out what they think of spaceflight from this site."

Initially, the FAA was as skeptical about our request as airports had been; after that, they seemingly didn't know how to handle it. "You want to do what?" one official said over the phone, "Uh, that's not exactly my department. Maybe you need to try the experimental aircraft division?" But the experimental division had said their rules prohibited supersonic aircraft, and directed us elsewhere. The worst were the ones who simply told us we couldn't do it, essentially, the rules had no provision for it. But I was persuasive, giving some an adaptation of my sales pitch, others I flattered (which I'm no good at,) and others I fenced regulations with.

After one exchange, I commented to Susan, "It's sad when I know the regulations better than the bureaucrats."

"Isn't knowing the regulations their job?" she asked.

"That's what makes it sad." I replied. "But I've been able to out-cite them more than once – the guy I was just talking too couldn't even give me US Code numbers."

"Then you should be able to argue your way right to where we need to be." she said.

In time, I was able to arrange several in-person meetings, making sure they were with officials of sufficient position to say more than "no" to me.

The first was with several senior officials, including Pat Moxman, who dealt with high-tech experimental aircraft regulations.

"We're not asking for orbital flight permission at this point," I explained, "We're not even talking about test flights yet. All we're looking for is approval that, if later applications for orbital flight are approved, that this site will be appropriate for launch and recovery operations."

"However with no regulations for the type of craft you are describing," Pat said, "We have no basis for giving such advice, let alone any form of approval. If it's advice you are looking for, you'd be better off talking to NASA."

"NASA is not the regulatory body we need approval from." I said. "And they don't have the expertise with either the air traffic implications of such flights, or the ground safety issues – they can simply setup a several mile exclusion zone."

"As far as air traffic control issues," he said, "Test flights are usually prohibited from airports with any commercial aviation activities, but exceptions can be granted. As for ground safety, Domingo airport has a wide safety perimeter, but we have no basis to evaluate your purposes."

"But the FAA's mandate is broad enough to consider factors and operations not explicitly enunciated by enabling regulations." I said. Pat was interested in our efforts, and I felt my best hope was to offer him a way to do what we were asking. "Especially in the area of experimental aviation. When we do request flight permission, it will be routed to your office."

"And if that was what you were asking," he said, "We would refer to NASA for any technical

questions, and consider on the merits – but there is no protocol for such flights. NASA operates, as you point out – under completely separate regulatory conditions."

"And your office can recommend approval, even without specific precedent," I said, "If it is shown that the flight is within safe operations."

"We could offer an advisory opinion, in such a case," Pat corrected, "If we were so satisfied. But it would still have to be reviewed at the highest levels of the administration."

And so it went. He mentioned advisory opinions, which was the best he would be able to do in any scenario we proposed, but never anything firm, and he always evaded even that. But we did meet with him several times, and each seemed a little more productive – at least he was getting a better idea what our needs were, and we were building contacts.

By the third meeting, he seemed willing to consider an advisory opinion on the "suitability of Domingo Airport and the surrounding area for Future Experimental Spaceflight Operations," and additional meetings were planned to offer any information his office might require.

But then we got a call from Clyde Parker that a Jessica Hunt was protesting the airport having any involvement with the Icarus project. "She's been going around town telling people that this will be a huge hazard to the entire community, and a threat to everyone's health, that sort of thing."

Later that day, we were informed by the FAA that this same person had filed a protest of our request for an Advisory Opinion, raising several pertinent issues.

Jessica Hunt – the name seemed familiar, but it took me a few moments until I remembered that she was the one who had protested our initial engine tests. She really seemed to have a grudge against us, but still, I couldn't find any significant information on her.

Pat over at the FAA was helpful. He admitted that she had raised some important points, but was still giving it a careful review – he was willing to give us a chance to answer them all, and told me that he personally believed we would be able to. "However," he cautioned, "This makes it much more

likely that the advisory opinion would require public hearings." It was certain that this Jessica would be there.

I was having trouble getting in touch with Mr Parker, however. When I finally did, he said that she was raising some significant problems in town, and was saying this was something his airport shouldn't even consider. "Privately, we still need something like this," he said, "But this airport can't afford the negative publicity."

"I'll come down there as soon as I can," I said, once I had gotten a few more details about her activities, "Within the next few days. Do you know how long she's going to be in town?" He told protests seemed to be expected for about the next week.

I spoke with everyone, the Icarus project leaders. "I told you she was trouble the first time you encountered her." Troy said. "You can never trust those greenies, always trying to interfere with progress."

"I wouldn't say that," I said, "But she does seem to have something against us. I would have thought she would have gone elsewhere by now, and forgotten about us."

"Apparently not." Troy said.

"In any event," I said, "We have to figure out how we're going to deal with it. From what Clyde has told me, she's raising a lot of concerns in town. I want to make a trip down there and try and answer some of her charges – if she convinces the town that this isn't safe, we don't have many other test sites. We've also got a meeting again with the FAA this week, and we've got to be quick to make sure they have accurate information. I want to setup another meeting when I get back, but since I can't meet with him and travel to Texas at the same time, I want you, Susan, and Robert to meet with him now; you both are as versed as I am in the details on these issues; then we'll setup another meeting after that. Hank, you may be helpful there too; you've got a good practical knowledge of experimental aircraft."

"When I get to Texas I'll do what I can to size up the situation," I said, "And figure out the best

response. I want to make some kind of presentation or presentations; but whether I'll challenge her directly or not, I won't know until I get down there. Everyone else, we need to keep the design work going, whatever happens. Alright?"

The next day, after scheduling the additional meeting with the FAA, I flew down to Texas. I caught an early morning flight, then a connection to San Antonio, where I rented a car, and drove to Domingo and the airport.

This time, Mr Parker delayed some time before meeting, and shuffled me quickly into his office.

"She's getting people pretty riled up," he said, saying this airport will grasp for any straw to aggrandize itself. And she's criticized airport management specifically."

"I'm going to look into all of it." I said. "Has she gotten any response from the town council, or the county government?"

"Not that I've heard of," he said "But I'm sure she's drawn their notice."

"I'll want to meet with them, if possible, and assure them that we're not going to do anything to endanger the town or the state." I said. "If you could set up a meeting with the town council while I'm in town, it would be very helpful."

"Daniel, I don't know," he said, "They are my bosses, you see. And with all this going on in town, if I'm seen as promoting this too much, it could be a real problem for the air port. And myself."

"I see." I said. Before, he had offered any help he could, but it was now apparent he wasn't going to risk much for it. So be it; I knew apathy could be the most dangerous of foes, but I had other things to worry about.

"Don't get me wrong," he said, "This airport really needs something like this, and I really do want your project here. But I've got to take care of the airport, whatever happens."

"I understand." I said; I had been hoping to have at least one ally. "Well, any contacts you can give me would be helpful, anyway. I'm not going to let her charges go unanswered."

After that, I went to one of her protests, and stood in the background. It wasn't much more than her standing on a platform in the towns one significant park, with a big poster showing the calamities she claimed would befall the town, and taking questions, sometimes shouting to passers-by; she didn't have a large crowd, but several people did stop and chat.

I had decided on the flight down that the first thing would be to contact the town council, but I had hoped to have Clyde as a go-between. No matter, there's always the phone book, and this is a small town. All of the council members were businessmen or otherwise prominent individuals in town, their town governance a second responsibility.

First I targeted Wes Carpenter. He had owned a department store in town since before the airbase closed; he had struggled with it for several years before selling to a larger chain, and stayed on as manager.

I scouted out the store, first, then asked one of the clerks if I could speak with him. He came up promptly, asking me what the problem was.

"Actually," I said, "I'd like to speak with you as a member of the town council."

"I usually handle town business in my office," he said, "But of course I'm accessible. What's on your mind."

"Have you heard of the Icarus project that this Jessica Hunt has been talking about?" I asked

"Yea, I did hear something about it," I said, "But I haven't heard the details. When I called Clyde down at the airport he said it was some discussions he'd had a while back, a way to raise the airports profile and business."

I noted that Clyde had made it sound like 'only a few discussions' and continued, "Well, I'm Dan Enoch, head of the Icarus project, and I wanted to make certain you had the full and accurate details of what we were proposing. I want to assure you it is in the best interest of Domingo, Texas."

"Ah." he said, his look only slightly colder, and he thought for a moment. "Please, come into the

back."

I followed him through a door marked "Employees only" and up a half-flight of stairs into a small, cluttered office. "Please, sit down." he said, and I did so. "As I said, I haven't heard much detail, but what I have heard does give me some concern. We're not Cape Canaveral , you know. Our facilities are limited, and we're ill-equipped to deal with that kind of operation."

"Of course," I said. "What I'm trying to do will be on a much smaller scale than NASA - at least as far as ground operations. Minimum personnel, as efficient as possible. Any services or equipment we require, besides that normally provided by an airport, we'll supply."

"That's actually the lesser of my concerns." he said, "I see safety as a much greater issue."

"I do understand that," I said, "Especially since I do intend to fly Icarus when it is complete. So I would like to assure you that we are going to take every safety precaution available, and won't fly until we are confident in our own safety, as well as those on the ground. We'll take full responsibility for range safety. However, since I do want you to be confident this is the right thing for your town, I do want to give you a brief summary of what we propose. I've prepared short written description, as well." I handed this to him, and launched into a very short description of the project, focusing on our safety plans and our flight profile.

"Hold it," he said, interrupting the latter. "So you intend to fly due east, over all the communities and ranches out that way. Doesn't that put them all at risk?"

"As I said, we won't fly if we aren't completely comfortable with the operation of the aircraft," I said, using the last word to emphasize similarity to existing operations. I also didn't mention of the sparse population of the areas we would be flying over; one life lost on the ground would be one to many. Technically speaking, the biggest danger would be near the airport; after takeoff, we would climb to near vertical, to get clear of the thickest part of the atmosphere, then pitch down towards our orbital trajectory. A problem near takeoff would lead to a crash near the airport; after that, we would

quickly gain momentum towards the gulf. But that wasn't the ... personal connection I needed to make. “However, as I said, I intend to be aboard Icarus when she makes her maiden flight. I ain't flying if she ain't working.” He nodded slowly. “But I also want to be sure you see the upside of this as well. Think about it: Domingo Texas, space capital of the world.”

“I do see that.” he said. “And in truth, the future of our airport gives me grave concern; without something dramatic, it may not have one. But I must also consider the safety of my constituents and neighbors.” He pushed back from his desk. “So I would like to discuss this at greater length; right now, I have a store to run. Are you going to be in town for long?” When I confirmed it, he suggested that we meet at his town office the following evening.

“I'd like to speak to some of the other members of the council, as well.” I said.

“Of course,” he said. “I can give you all of their numbers; this concerns the town greatly. Whichever way we decide. I'll let them all know to expect to hear from you. But don't expect too much; I haven't made up my mind, and it'll take more than this to convince a couple of them.”

“Thank you.” I said, and followed him out of his office.

Indeed, they were as bad as he had suggested. I was nervous when I called them; and one hung up on me almost immediately, which only made me more nervous. There was nothing to do by try again. And again. And again and again and again. Stubbornness can beat stubbornness (and these Texans can be stubborn) and finally he listened, commenting that he might as well give me a minute when I said I would just keep calling until he listened. I gave him a very short version of my spiel; he didn't sound to interested but did agree to give it “careful consideration.” There were five members of the town council in all, and while none of them sounded sold on the project, he was the only one who seemed dead-set against; I soon had meetings scheduled with the other three.

As important as the town council were the residents of the town themselves; the council would, ultimately, do what the residents demanded. So, after checking with the police chief, I picked up a

table at Mr Carpenter's department store (as it was the only one in town) made up a couple of posters, very neatly done with some graphics I had the office send down by fax, and set it up in the park a short distance from Jessica's table. The title of my poster said “Space: The Future of Domingo Texas.”

Only a few people were coming through the park in the morning, but it got busier. I watched Jessica – and could see she was watching me. She was actively calling for people to come over to her table and listen to her, and she was able to keep a fair crowd gathered around her table. Other times, she stood up on her chair, telling everyone in hearing distance how bad an idea Icarus was.

I watched passively for a while, answering people's questions as they came up, and a fair number did – my sign made it clear I was trying to answer her charges. I didn't deny the safety hazards, but showed that thew were less than she made out, then pointed out many of the safety precautions we meant to take. But I also painted a picture of how much this could do for the city. “A handful of experimental flights will put Domingo on the map – it'll be in the news around the world, and journalists will descend on this city where we have our base of operation.” Some asked me why we weren't considering a larger city for our operations. I got the impression Jessica had pushed this line of reasoning, and some said this proved our operations were unsafe. While I admitted that experimental aircraft of all types, including new jetliners, were generally tested in relatively isolated areas, I focused instead on the traffic volume at the airport. “A large, underutilized airport will be best able to serve our needs. For the brief periods when we'll actually be conducting flight operations, we will disrupt other airport operations – a busy, heavily trafficked airport wouldn't be able to handle that. But we'll offer the launch site much more than an ordinary flight.” And I tried to share with them my vision of spaceflights place in human destiny, telling them their town could be part of something big.

I also tried to get a sense of Jessica's specific points, and refuted most of them. Some I couldn't counter directly – she had pointed out that shuttle launches use a three mile radius for safety, which wouldn't be available here. I admitted that was true, but pointed out that the quantity of fuel would be

less as well, and we would keep little reserve around besides that used for a single flight. I also pointed out that liquid hydrogen, while an exotic fuel, really wasn't that much more dangerous than the jet fuel the airport kept in quantity – the low temperature of liquid hydrogen reduces the chance of explosion, and extensive cryogenic tanks and careful handling would prevent mixing with oxygen.

They seemed to respond well to it, and many people seemed satisfied with my answers. But I was nervous about adopting some of Jessica's more aggressive tactics, hawking her point to all her voice could reach. I tried, some, but began to focus on getting the attention of those leaving her table, telling them I wanted to make sure they understood the truth of what I wanted to do here.

Then, later in the afternoon, when things had quieted for a few moments, Jessica yelled at me, "WHY DO YOU HAVE TO BRING YOUR DANGEROUS FLIGHT OF FANCY HERE?"

Not wanted to get into a shouting match, I took a step towards her and said in a reasonable, though still loud, voice, "I'm trying to advance humanity. Would you have told the Wright Brothers they shouldn't try and build an airplane, that it was too dangerous?"

"The Wright Brothers aircraft wasn't laden with enough explosives to level a small city," she shouted.

"Neither is the Icarus," I said, unwilling to let such an exaggeration stand, "And the Wright Flyer led directly to giant Jumbo Jets with enough fuel to do as much damage. But you don't need to shout; if you want to debate Icarus on the facts, I'm more than willing. I'll do it here and now, or we can set something up in front of the town council. It's up to you."

She looked across the park a moment, as if deciding; I suspected she was assessing whether there was enough of a crowd here to make it worthwhile. I was a little nervous about getting into a spontaneous debate and preferred a more formal setting. But I did want to win over the crowd. And a surprise debate might give me an advantage.

She turned and said, "If you want a debate, then here is as good as anywhere. Come on over."

“Come over here.” I said, not wanting to give the impression of conceding the start to her. “This is my project.” She protested, and we argued for a moment, then pulled both of our tables closer.

As she pulled her table, she said, “You know this is an enormous hazard to any town – you want to bring enough explosives here to level the town, then send it flying across the eastern sky? Wasn't it hydrogen that blew up the Hindenburg?”

“The Hindenburg used hydrogen gas,” I said, “And even it burned, not exploded. Even in the quantities we'll be using, hydrogen isn't that much more dangerous, properly handled, than jet fuel.”

“And whose to say you'll handle it properly?” she said, “Doesn't your FAA request indicate that you'll be responsible for handling it, not the airport ground crew, who is experienced in handling fuel? And you're so impatient to get into space, who's to say you're not going to cut a few corners?”

“Handling cryogenic fuel is an entirely different game than kerosene,” I pointed out, “And we're training proper procedures for it, along with everything else. We've already got some experience with it.”

“And then you want to send this flying fuel tank over people heads above town and across the eastern part of the state?” she said. “At least NASA is considerate enough to launch over water.”

“Our flight path won't take us over town,” I said, “But due east, and in a matter of minutes, we'll be over the gulf.” She continued to offer safety concerns, and in fact I was impressed with her knowledge – she clearly had read most of our publicly available documents – including the draft flight profile we had submitted to the FAA. She also seemed familiar with other parts of the project, some that seemed gleaned from my early proposals, and pitches to investors. But I addressed them, detail for detail. I couldn't argue that test spaceflights would be as safe as air travel, and I didn't try; but I demonstrated that the risk, especially to those on the ground, wouldn't be so large as she made out. And I emphasized that safety was our foremost concern. Importantly, I had all the facts and numbers ready to cite.

Unable to outargue me on risk, she turned to the implications for town. “You say this will be such a boon for the town, yet you speak of disrupting airport operations, and say that's OK because you'll only be making a handful of launches – how will a few rocket launches do anything for the town. What, really, are going going to bring to us? Jobs – aren't you going to bring your own people down here? What?”

“The profile of the flights alone will turn the worlds attention to Domingo, Texas.” I said, now addressing the growing audience that was gathering, the real residents of the town. She was trying to call herself one of them, and cast me as the outsider, but I would deal with that in a moment; I knew Texans didn't like being told what to do by a 'northerner.' “Even if we do only end up flying a handful of flights out of here, you'll be able to count your town among those few that have launched mankind into space. Longer term, I don't expect to limit Icarus to these few test flights. If things go well - and I expect things to go well, especially in such a fine town as this – these test flights will only be a beginning. A beginning for Icarus, and a beginning for Domingo.”

“But I find it strange to hear you talking about 'your' town.” I said, now addressing her directly. “I make no pretense of being anything but a boy from Virginia. Yet you come here from Massachusetts, and yet lay claim to this town. I knew northerners could be arrogant, but that's just too much.”

That took her aback, and I could tell a few of the crowd was surprised. Not that many, though – they knew she didn't come around here, though her accent wasn't exactly 'New England'. But she came back after a moment, saying, “I wouldn't call yourself a southerner – Northern Virginia could be transplanted to New York without much notice.”

“It's still Virginia,” I said, but she was sharp with that; I ignored it and continued about her own background. “Why not go out and say it's the same as Boston? Or would that be so much better? And yes, I do come from suburbia. Maybe that's one of the reasons I find this town such a pleasant change. Am I a southerner? That's for these people to decide – I'm not a Texan, but I've made no pretenses as to

my origins."

She continued that exchange, but I felt like I had her on it, especially looking out at the crowd. It was true that northern VA is more North than South, but I think few places can turn the ire of true southerners like Massachusetts. She soon turned the topic. "Well, I suppose such distinctions don't really matter to a scientist such as yourself," and she said scientist with a note of disdain, "And yes, I am from the North. But I care about people, not things, knowledge with little practical value. If I describe myself as one of you, it's as a fellow human being, and if I count myself among you, it's because your town isn't really all that different from my own hometown, no matter how many miles apart they may be. So it is with that in mind that I ask again, what exactly is it that you think this will bring to our town, launching us so much further away?"

Nice. I thought. Clearly she'd had some training in rhetoric. But if she thought I was some narrow-minded scientist, too concerned with my own esoteric pursuits too notice the people around me, then I had something to show her.

"This isn't about a little 'science project,'" I said, "But precisely, as Jessica here says, about people. Showing what people can do, trying to do more than we think we can do. I mentioned the Wright Brothers earlier: some might have said similar things about them. Now, look how they've changed the world – and look what it's done to Kitty Hawk. I can't say the same will happen here – I don't know how this will come out. And it's not without risk. I know what could happen when I climb into the cockpit of Icarus, when it's complete. But it's a risk I am willing to take, because I think so much good can come from it, for all of us. What will this bring Domingo, Texas – fame and fortune, at least, and maybe more: if we can succeed, and a believe we can, it will only be to your benefit."

The debate continued, touching on possible economic benefits and other effects. When I emphasized that these were only potentials, Jessica jumped on that, reminding the crowd that I wasn't promising anything except tremendous risk – but I pointed out that Christopher Columbus hadn't

promised the Spanish any more. “I can promise nothing but possibility.” I said. “But I also want to remind you of the pioneer spirit which brought the first settlers to Texas – the urge to plunge into the unknown, fresh open spaces that had drawn people here for hundreds of years. That is what I'm looking to continue.”

I put no great credit in my debating ability, except the certainly of my convictions – but Jessica clearly didn't expect me to outmaneuver her. I asked her what she would tell the sailors who first set off in search of unknown lands, the pioneers who set off on dusty trails to new frontiers. And I emphasized that this was about people. I showed greater awareness of Texas history than she did (I had reviewed some on the flight down) and I emphasized that it was showing, and strengthening people, that I was really thinking about.

Eventually, things began to peter out, as she realized that I had largely out talked her, and I seemed to be carrying the attention of the crowd. And of course, the crowd had begun to thin, and the debate ended as suddenly as it had begun..

I met with councilor Carpenter and one other council member the next morning. Wess admitted that he had heard the debate yesterday and was impressed – he still had concerns over the safety implications, particularly for those living downrange of the launch site; but felt it was worth the risk. He told me the council was going to call a special session to discuss it, and invited me to address them.

I also spoke with several other locals, many of whom had seen me speak and now recognized me, and now gushed with enthusiasm. They said they looked forward to bringing this to their town, and showing the word the pioneer spirit still lived.

Jessica continued to protest, but seemed to see it was a lost cause, at least for the moment. We were both staying in the only motel in town, and passing me in the lobby the next morning, she told me it wasn't over, and she would be keeping her eye on us. “The world need more practical efforts.” she said. “Not dreamers like you.”

“What's practical?” I asked her. “The pilot of the plane you flew down here has a practical job – because of passionate dreamers and their efforts.”

“Is your project going to put food on people's tables?” she asked, “Or roofs over the heads of the homeless?”

“In time, who can say?” I replied. “I only know that it must be done”

“And money diverted from those who really need it?” she said with scorn, and walked away before I had a chance to respond.

In the end, I didn't even see her at the council meeting – the tone, the excitement around town was apparent, and I had to say very little before the council voted, 5-0, to officially invite the Icarus Project to Domingo Airport, extend a lease to us for “such airport and hangar facilities as we require,” and officially support our request to the FAA. Afterwards, I thanked them for their support, and returned home the next day.

I was still worried about meeting with the FAA: I knew Jessica had been objecting to that process as well, and thought she might try and block us there – we didn't need the advisory approval for this stage, but it would be a major practical problem later if they didn't let us fly.

But when we met with Pat and the rest of the experimental aviation office, things sounded clearer than ever. “The letters from the Domingo Town Council and the local airport authority are quite compelling. Additionally, I got some information back from NASA, regarding some general consideration for a space launch site. All of which leave me include to recommend issuance of the advisory opinion, without a formal hearing

“Thank you.” I replied.

“Now, don't forget that this is only an advisory opinion,” he added, “And does not constitute actual approval of any type of operation. If and when you are ready for flight operations, you'll have to go through that process. And that will require formal, public hearings.”

“Of course.” I said, and thanked him for his help. After that, it was just a matter of implementing the details. We signed a lease about a month later, after negotiating with the airport for the facilities we needed, and then began the complex process of planning our move.

The big question was how much of the operation would we move? Sitting around the conference table, we debated the question.

Susan pointed out, “It's a two day drive at best, or an expensive pair of flights. And a long way to transport equipment. It would be easier to just move everything down, in the end.”

“It is a long way,” Hank agreed. As shop foreman, he had increasingly taken a role in the planning process, giving us the 'voice from the floor.' And he had lots of homebuilt aircraft experience. “But a lot of our people have families, connections here. It won't be so easy to leave. They're all committed to Icarus – but some of them won't be able to make the move. Also, we've got a lot of equipment in place here; replicating the setup won't be easy.”

“What would we do with the building if we left?” Troy asked. “I might point out that, having bought the building, we can't just vacate and leave it to a landlord. And the very reasons you got a good deal on it would limit sale price, or renting it out.”

“But running a two-point operation would be difficult.” Peter said. “Who goes, who stays – when do people go back and forth? You were trying to keep this a simple, small project, Dan, and splitting sites is going to work against that.”

The discussion continued; good points were offered on both sides. Ideally, working out of one site would be far better; coordinating two locations would pose inefficiencies I wasn't sure we could afford. But moving lock, stock and barrel would present other difficulties, we would lose people, and we had contacts here, including business contacts. And we did have a lot in place here, now that wouldn't be so easy to reestablish.

I stayed back and listened, a tendency I had increasingly followed. I wanted to hear what everyone

said, first of all, and I had a tendency to dominate the discussion if I spoke up. I always let people know what I did think, then let them talk. Eventually, though, I cut in, and said "The consensus seems to be that we keep working here as well, at least for the moment. Moving completely just isn't feasible yet. We can keep engine development and some other systems development here; we'll do assembly down in Texas. It won't be ideal, but we may be able to transition more stuff down there over time." When everyone agreed, we began the long job of moving things down there.

I was one of the first to go down, so I could begin planning or operation down there. Susan came down with me, and we spent the first couple of weeks putting things in place. We had two large, adjacent hangars, a fair amount of open space around, and some office space. The terminals had originally accommodated C130 transport aircraft, so they were plenty large for our purposes. We had originally discussed occupying one of the old barracks buildings which still stood on the base, but none of them were in serviceable condition; we sought offside housing instead.

Looking around the hangar, Susan commented, "It may be just as well to leave small-scale work in Virginia. It'll be hard to setup any kind of lab space in here."

"True." I agreed, "Although we'll have time, and we can modify the facilities as we need. We'll need fabrication facilities, at least, metal testing, and storage lockers. I was thinking we could use this one for main assembly, leave it pretty much as is, and set up fabrication in the other hangar. It's a touch closer to the terminal, and the access road."

"Fair enough." she agreed. "Completed and working systems we ought bring down here – we've got a lot more storage space."

We made our plans, figured our arrangements. We rented a block of apartments around town, and got contacts for others – we still weren't sure exactly how many we would be bringing down for the moment. I began running trips in my truck, hauling anything I could fit in it's bed and weight capacity; we contracted semis for heaver, or bulkier systems. For the moment, Peter would remain based in

Virginia, supervising the operation there, the rest of the management team, and about half of the crew came down to Texas. Hank would come down once we had things set up; we needed his expertise in airframe construction. Troy and I vacated our apartment, as did; Susan vacated hers and, after some discussion, moved in with Troy and I. We were leery of sharing a room, but it would save money – and I was all for that.

There were other considerations – so many small things to be worked out. Background checks and getting access badges for the airport and facility grounds, particularly important in todays environment. Finding places to eat, finding things to do around town. So much to do, so little time.

Still, practical work, systems development, and the like, slowed to a halt as everybody was focused on moving and transitioning, and in Texas, we were mostly busy just getting things in place and up and rolling. But in time, things got going well enough, even if we were making many trips – by car, truck and airplane – back and forth.

Things were, at least, getting on track, and one day, looking out at the landing and departing aircraft one dawn, I felt a big step was finally near completion, a great big step closer.