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Tom Swift's — Kicker

By T. Edward Fox

Sometimes knowing about everything you have going against you can be a little disheartening. Tom Swift is determined to make his mark early in life by being the first private individual to launch a man into orbit. But, with limited funding—his father is equally determined to build and launch his own giant rocket at the same time—he finds that he needs to think small.

It may be too small. Though smaller rockets need less fuel, it now seems that there is just not enough room for enough fuel to get the rocket into orbit.

He needs to come up with a radical idea to super-energize his rocket fuel. The problem? Most of his designs give him less thrust from the start or become less effective he longer they run... usually just when he needs them!

This story is dedicated to individuals who persevere. Practically anyone can build a giant rocket weighing a hundred thousand times the payload it can put into even low Earth orbit. But, it is the men and women who say “No way” to the concept that bigger and more obtuse is better. Here’s to the X-Prize winners and also rans. It is they who will keep us in space long after the politicians ruin things.

A SWIFT ENTERPRISES INVENTION STORY

Kicker

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FOREWORD

When the Germans succeeded in launching the V2, they proved what science fiction (and closet rocketeers) already knew: a cigar-shaped rocket could cut through the air and head for the heavens.

They, like Tom after them, discovered that slipping Mother Earth's bonds of gravity took much, much more than the fuel they could carry. Science wasn't with them like it is with Tom. That, along with everything that made the V2 a despicable weapon, would never have allowed them to succeed in making it capable of rising high enough and fast enough to go into orbit.

Tom carefully studied everything he could find regarding every documented rocket launch and attempt. His sharp mind spotted the one thing that he knew he must overcome: how to get more power out of the meager supplies of fuel a smaller rocket can carry.

But he also ran onto that little thing known as 'physical limits.' Then, he peeked around a corner and saw that—like the sound barrier—there *was* a way around those limits. His fuel kicker was a marvel of its time, and might still be in use today if it weren't for those darned repeltrons of his.

Victor Appleton II

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PART 1**We Need More Power**

TOM SWIFT, blond-haired teenage inventor, was sitting on his favorite stool, leaning on his work bench in the large laboratory he kept in the Administration building at Swift Enterprises, a four-mile square research and development center located in upstate New York.

The previous day he had returned from a test launch of a small rocket a privately-funded industrial consortium hoped would let them place lightweight and compact satellites into orbit for less than half the price of the current rockets available either from NASA or several other international agencies.

As with two of the previous three attempts, it had failed. This time it made it to an altitude about fifteen miles up and five miles out over the Atlantic Ocean. But, as with the others, something failed when it was time for the first and largest stage to separate, falling into the ocean, and allowing the second stage to ignite.

It *had* ignited and right on time. The problem was that the first stage was still firmly attached. It was a problem shared by many smaller rocket makers. The most efficient and reliable mechanisms for separating rocket stages were large assemblies that weighed a hundred pounds or more. Smaller devices had a very high failure rate.

Single stage rockets just couldn't make it high enough and the timers and compact explosive decoupling devices were probably a year or two away from being reliable and

accurate. They were so unreliable that the first of this new series of rockets had exploded only a hundred feet up when the four connections—ironically called 'explosive bolts'—had set themselves off prematurely splitting the rocket in two.

As part of his attempt to fly the first privately-funded orbital rocket, Tom already had designed a beautifully sleek rocket that was currently being forged from aircraft aluminum and other lightweight materials and outfitted with three gimbal-mounted rocket motors, huge tanks for the fuel and its oxidizer, and a cabin that could hold two people. He would, of course, be the number one man and he planned to have Bud Barclay—eighteen like Tom, and the person he most trusted his life to—next to him. Bud had come into his life a couple years earlier and was turning into one of the best test pilots Enterprises had on staff.

Tom understood the negatives of multi-stage separation, so his rocket contained everything in a single stage.

He was looking at the full-color drawing of his little... well, it was going to be his... he hadn't exactly come up with a proper name for her. *Space Javelin* seemed appropriate as did *Sky Splitter*, but nothing really grabbed him.

Even Bud, generally adept at giving nicknames to everything Tom created, had come up empty.

Tom sighed as he set the picture aside and turned to his notes. His biggest problem at present was one of fuel, thrust and load weights. The—he decided to think of it as *The Javelin* or *Sky Spear* for now—stood at slightly under

fifty feet in height and weighed just twelve tons empty, but would swell up to forty-one tons once fully fueled.

His computations regarding the fuel and oxidizer mix showed that the available fuel load along with the two pilots, air, water and food supplies, could reach to just fifty-ones miles... and that wasn't enough to make orbit.

Something had to make a difference.

He tried three different fuels including a very volatile monopropellant—his father had put an end to that when Tom's first motor blew apart along with an expensive test rig and shed.

After extensive tests he had settled on the pair that would give the best power-to-weight/volume ratio, but it was still not enough. And, he did not have the luxury of adding more fuel; his rocket was too far along to change the tanks.

A solid propellant might be something to think about except that it would mean having to replace the entire bottom half after each flight. When Bud asked, "Why don't you just strap on a couple solid boosters to the sides?" Tom explained that such rocket motors would need to be an integral part of the space ship's structure in order to be stable enough. It would also require some re-engineering to account for the excess heat.

The door to his lab opened and an older, heavy-set man—well, to be truthful, he was more than just a bit on the roly-poly side—walked in pushing a stainless steel cart in front of him.

"Grub time, Tom," he practically bellowed. "Got ya a big ole ham sandwich an' some red tater salad an' a great big

glass o' iced tea. Now, don't ya make no fuss, Son. That brainy brain o' yers needs fuel!" He began setting up Tom's desk with the food and utensils. When he was finished he turned and looked at the young inventor. In a much softer voice, he asked, "What cha workin' on now, Tom?"

"Huh? Oh, well, Chow, you know about the rocket I hope to take up and circle the world in pretty soon?" The one-time Texas ranch cook nodded. "It's kind of like me. You mentioned how my brain needs fuel, and so does the rocket."

Chow had removed his ever-present ten-gallon hat and was fanning himself as he listened. "Sure. I seen some o' them Army rockets bein' fired at some target thing on television a few months back. They was goin' on about how some o' them could barely go any farther than somethin' ya could shoot out o' a big gun."

"Right. I remember than program. The problem is that you can only pack just so much fuel into any given size. My problem is that I can't put enough of the fuels available today into my rocket to make it fly high enough."

"Why's that?"

"Well, my dad is over at Fearing Island building his giant *CosmoSoar* rocket that he hopes will revolutionize getting into space with huge loads. Big enough loads to build a space station some day. Anyway, with all the money Swift Enterprises is spending on that project I really had to scale my rocket down. Now it looks like I went to far." He shrugged resignedly.

Chow came over and placed a friendly hand on Tom's

shoulder. ‘You lissen here, Tom Swift. I’ve been around you and your daddy and all these fine folk at Enterprises for more’n two years. In all that time I never seen you give up. No matter what. Ya always find a way ta do whatever it is ya want or need ta do. Just stick with it, I say. Now come on over an’ have yer lunch.’

Reluctantly, Tom rose and walked to the desk. He took a small sip of the tea as he sat down. “Pretty good tea today,” he complimented the chef. “New blend?”

“Nope. Same bags as usual. Made that all this mornin’,” Chow said proudly. “That’s sun tea. Ya take a bunch o’ tea bags an’ put em in a big glass jar with water and just set it in the sun. Some sort o’ magic happens an even without the water boilin’ or nothin’, it turns into dee-licious tea in a couple hours. Eat up. I’ll be back in half an hour ta pickup the *empty* dishes.”

Tom had to smile in spite of himself at the cook’s emphasis on the word ‘empty.’ He sat there eating and continuing to think about the fuel issues.

The door opened and he turned expecting to see Chow again. Instead, Bud Barclay was standing there with a big grin on his face. “Hey, skipper,” he greeted his seated friend. “What’s growing down on the brain farm?”

Indicating that Bud should take a seat, Tom set the last of his sandwich back on the plate and told the dark-haired flyer about his problems with getting enough power from a limited amount of fuel.

“You’ll come up with something. You always do.”

“That’s just what Chow said,” Tom replied. He could see that Bud was looking at his mostly untouched glass of tea

and had a glint in his eyes. “Thirsty?”

“You bet. I had to park the little *Kangaroo Kub* over at hangar three and walk here. That’s more than a mile over the hot asphalt. I’m parched.”

Tom pushed the glass over to him, and Bud gulped down more than half of it. “Hey. That’s really good. Chow find some new brand?”

Tom explained about the brewing of the tea using just the sun.

“Oh, yeah. My folks told me that they do that out in California now. Good old sunshine. Makes plants grow and brews up a fine glass of tea.” He smacked his lips then downed the rest of the glass. “Have you made any progress on the fuel problem?”

Giving his friend a rueful grin, Tom answered, “No. I’ve tried different mixtures, pre-heating the fuel or the oxidizer or both, and using higher and lower pressure pumps and nozzles. Nothing works better enough than just plain old liquid oxygen and kerosene to give us escape velocity. The only thing I know would definitely work is to remove the cabin and all the life support equipment. That would save better than three tons of weight and that would be just enough—”

“Enough to keep our feet on the ground and make the whole project a bust!” Bud declared.

Tom nodded. “I’m not finished trying yet,” he said. “There has to be some way to jazz up the fuel and to squeeze more out of it. Something that’s either so obvious or so obtuse that I need a lot more time to think about it.”

“So, take the time. You’ve got other projects like the

robotic attendant you said you want to build for your dad's atomic research plant. Right?"

"Yes. I'm going to take a few more days before I give up on the fuel issue. I might need to beg dad for enough funding to build a booster stage. You know... something powerful enough to lift the main body up a mile or so and get enough momentum going that the fuel onboard will be sufficient. I hate to do that, though." He looked at his friend and tried to smile.

It didn't really work.

Tom was about to say something when the door opened and Chow returned for the lunch dishes. "Wahl, hey thar, Buddy boy," he greeted the second teen. "If'n I'd known you'd be here I'd a brought another plate. You hungry?"

Bus shook his head. "Not really. I had a huge breakfast. I am thirsty. That tea of yours was swell. I don't suppose I could get another glass."

"Sorry, Buddy. I only made a gallon this mornin' and Tom got the last o' it. I'll put out another jug and get you some later this afternoon. Okay?"

"Name the time and the place and I'll come to you!"

They walked out together discussing the logistics of Bud's next glass of sun tea leaving Tom still sitting and pondering his rocket problems.

As he sat there, a thought occurred to him. Closing his eyes in concentration, he tried to dredge up an old story he remembered reading. Something regarding an older technology. What was it? Then, it hit him.

Years earlier a team of engineers had developed the

ultimate science fiction accessory, a jet pack. Using a relatively small amount of a chemical fuel it had been capable of lifting a man hundreds of feet into the air for a short period of time.

He called up as much research as he could locate on the Internet. Such devices had an interesting history with the first semi-practical application taking place in Germany back during World War II.

One version used a fuel like kerosene. Another, later version used compressed nitrogen. Neither were very efficient or could run for more than a few seconds.

He finally found what he was looking for. The version he remembered used almost ninety percent pure hydrogen peroxide forced into an exothermic reaction by passing it through a mesh filter of silver, turning it into superheated steam and oxygen in an instant and increasing its volume about five thousand times.

That's the sort of energy I need to wring out of my fuel, he thought.

An hour later he had sketched a small test rocket he would build to see if an all-H₂O₂ rocket motor might be his ticket to orbit.

By carefully modeling his five-foot tall test rocket to mimic the scale weight and balance of his *Javelin/Sky Spear*, Tom felt that he might achieve a fairly accurate test and result. He enlisted the assistance of Arv Hanson, Enterprises' head of model making and the man who usually built all scale test and display models of Tom's and his father's inventions.

"Going into model rocketry, skipper?" Arv asked as he

sat in Tom's lab an hour later. "I thought you had bigger ambitions."

By the time Tom finished explaining his purpose, the model maker was fully onboard and eager to get to work building the scale rocket.

"So, while you build the control circuitry and whatever little computer is going to be needed to make this fly, I'll do a 3D CAD modeling of the body shell and the inner tank. Umm... I've got a question. Since this won't have enough room for any pump to push the fuel through the system, what should I do?"

Tom thought a moment, then answered, "Add a compressed nitrogen tank on top. There's room for it even with the electronics I need to fit in there. Nitrogen is pretty inert and we can get enough pressure to really force the peroxide out and through that silver mesh activator."

Three days later Tom, Bud and Arv climbed into one of the small four-seat planes Tom's dad had designed and that were built at the old Swift Construction Company. With Tom at the controls, they headed out to Fearing Island, a long and relatively narrow strip of land—originally mostly rocks and scrub grass—located off the coast of Georgia. Damon Swift had taken a one hundred year lease on the entire island where all of Enterprises' submarine and forthcoming rocket and missile work and launches took place.

They landed and taxied over to a parking area reserved for Tom and Damon Swift. Large enough to accommodate his giant *Flying Queen*, it stood in the shadow of the tall control tower and the island's Administration and Communications buildings.

A pickup was waiting for their use. Tom had called ahead and arranged for a tank of hydrogen peroxide to be ready at the test launch site. Not only was it safer to fly to Fearing with the rocket model empty, it meant that it could be lifted out of the plane by just Tom and Bud and placed in the back of the truck on a special cradle Tom had asked to be constructed from scrap wood.

A twenty-foot tall launching rail had already been erected and was waiting at the nearest corner of the rocket launch area. One hundred feet away stood a small temporary control room surrounded by thick Plexiglas and sandbags. While Bud and Arv carries over and then eased the rocket onto the rail, Tom checked out the control board.

Everything had been made ready for the test. All that needed doing was to fuel up the rocket, plug the launch control cable into the small socket on the bottom of the rocket, and start the countdown.

Preparations went exactly as planned and the rocket stood, aimed at the sky, ready for launch less than an hour later.

Tom made contact with the control tower and announced his readiness. He was asked to hold for ten minutes while a final check was made with the FAA, the East Coast Control Center and Atlanta Control to ensure no aircraft might stray into the test area. This was unlikely anyway because the Government had designated Fearing Island and a five-mile radius around it to be a no fly zone.

All reports came in and the skies were deemed to be clear. Tom announced start of the countdown.

5... 4... 3... 2... He depressed the two launch buttons...
1...

With no more roar than a fire extinguisher, billows of white steam blanketed the area. When they cleared a few seconds later, the rocket was nowhere to be seen.

Tom broke out into a grin and called the tracking station. "How are we doing?" he asked eagerly.

"Straight and climbing steadily, skipper," came the response. "Just passing through four thousand feet. Ascent speed: three one six and increasing. It's now up to three five five."

Bud and Arv clapped Tom on the shoulder and praised him for the excellent launch.

A minute later the tracking room called, "She's slowing. Must be out of fuel. Approaching apogee... now! We have her coming back down. Uh, skipper? Does that rocket have a recovery chute?"

Tom was about to reply that it did when the man called out, "Wait. There it goes. I've got a red and yellow chute out and opened fully. We show that it should come down about a quarter mile off the east shore. I'm dispatching a boat now. Good launch, skipper!"

The three picked up their equipment, straightened the site and hopped back into the truck. It would take about an hour to recover the rocket so they headed to the commissary for lunch. By the time they returned to their plane the rocket had been delivered, now fully wrapped in a waterproof covering.

Although he was anxious to find out how everything had gone, Tom knew that the proper equipment to read

the data was back at Enterprises, so they climbed into the refueled plane and headed back north.

After landing at Enterprises Tom could hardly wait to download the onboard computer's data. It required a few moments for the computer to turn the digital data into something readable on the screen and he sat there eagerly waiting the results.

His eagerness turned into resignation once he saw the final readout.

Although the rocket reached the scale velocity required, it had run out of fuel almost eight percent lower than Tom's current dual-propellant mixture.

He sighed. It wasn't going to be easy after all!

PART 2**I'm Giving It All She's Got**

BY THE SAME day one week later Tom was near to admitting failure when his father made a suggestion.

“Why don't you call Dr. Karl Van Voorhies at NASA, Son. When I was doing my little project for the Space Shuttle program he was working with some of the top folks in the field of applied energy. He told me once about a scheme to electrically energize one possible new fuel that would make it burn faster or burn longer or something. Whatever. The end results were supposed to wring out more energy from that fuel.”

“I hope Dr. Van Voorhies can give me some new direction to try. Bud tells me I need a way to kick the fuel into high gear somehow. I guess he's right.”

“In his own way, I think he just may be,” Damon replied.

Tom placed a series of calls to various NASA facilities only to discover that the doctor had retired five years earlier and was currently living in a nursing facility in Connecticut suffering from senior dementia.

Replacing the receiver after getting that news Tom began considering what he might do to follow along the same lines as the doctor had, as hinted at by his father. Knowing an old Swift family motto that stated that “Wheels only need inventing once!” he redialed one of the first numbers he had tried, hoping to avoid any known mistakes and false leads.

Asking to be connected back to a Dr. Rebecca Davis he went back over what he needed to ask.

“Rebecca Davis here. Is this the same Tom Swift I spoke with several hours ago?”

“Yes, ma'am, it is. I just hit a dead end with my search for Dr. Van Voorhies.” He told her about the man's current status.”

“Oh, dear. That is a tragedy. He had such a brilliant mind. Such a pity. Is there something you believe I might be able to assist with?”

Tom explained his own experiments and the results. “I was hoping that Dr. Van Voorhies' old notes and experiment reports on energizing fuels might be available. I know it's a long shot, but I have to try.”

She offered to do some research and to try to get back to him the following day. Tom thanked her and hung up.

“I'm probably going to end up doing this on my own,” he told Bud a few hours later as they drove to pick up their dates—Tom's sister Sandy and the beautiful Pakistani girl Tom met a few months earlier, Bashalli Prandit.

“Too bad. That little test rocket sure seemed to be zooming up and up. Can't you do something with that hydrogen peroxide and some other fuel together?”

Tom shook his head. “Not really. The breakdown of the peroxide like in the test makes just too much water vapor. It's a good oxidizer on its own but I calculated that I would need a tank about forty percent larger to hold the necessary amount. No, there has to be something else to do. I'm bummed that Dr. Van Voorhies is in no condition

to even give me some clues. I just hope that Dr. Davis can find some of his old notes.”

The dinner date was somewhat subdued, but both of the girls tried to come up with suggestions. “How about an afterburner like on a jet fighter?” Sandy suggested.

“Perfect, but only if we could carry the extra fuel necessary. I haven’t actually done an experiment but the figures don’t pan out. We might get a higher velocity earlier on, but then run out of fuel low enough to not even reach the previous high altitude. Sorry.”

Dr. Davis called first thing the next morning. “I was able to find microfiche of seven of his notebooks. Now, before you get excited I took a quick scan and only one of them has anything to do with his fuel and propulsion experiments.”

“Oh,” was all Tom could say.

“If you want, I can have a digital copy made and sent to you. Should just take a day or so.”

Tom agreed that he would like to have the notebook information. Thanking her he hung up and went back to pondering.

He could come no closer to any possibility by the time the digital files of the microfiche arrived by overnight courier two days later. He read Dr. Davis’ note that gave a starting date and page for locating possible answers. He accessed the indicated page and sat back to read. More than three hundred pages were devoted to many of the doctor’s earliest experiment at NASA.

What caught his eye was the section regarding electromagnetic alignment of the fuel. By carefully introducing a

positive charge to the fuel and forcing it through an equally but negatively charged steel pipe, the molecules could be forced into a more aligned state.

The doctor theorized that it could make the mixing of oxidizer and fuel easier, faster and result in a higher degree of energy production. In this case: thrust.

The experiment never made it to the actual burn stage as Van Voorhies had been reassigned to work on the maneuvering backpacks that would some day be used by shuttle astronauts during the construction of the intended space station.

When Tom brought up the experiment with his father at dinner that evening, the older inventor just looked at him. “So, when do you intend to try it?” he simply asked.

Tom smiled. He had expected a much harder sell to be necessary. “I made a few preliminary sketches before coming home. I think I can get everything ready for a static mount test by next Monday. Can I ask the guys in the Volatile Materials Lab to use their test equipment in the southern field?”

Mr. Swift nodded placing another bite of his wife’s meatloaf in his mouth. Tom’s appetite seemed to increase in seconds and he ate the rest of the picked-over meal quickly.

When Bud arrived at the test site five days later he watched as Tom rigged up what looked like an undersized car muffler wrapped in a great many spirals of thin, purple-colored wire.

Stepping forward he pointed. “Purple?”

“It’s the ultra-thin insulation on the wiring that will

create the magnetic field necessary to energize the steel pipe,” he explained. “And that round container behind the shield,” he said motioning to a two-foot diameter white sphere with several wires and tubes running in and out of it, “is where the fuel is energized in the opposite direction.”

“So, when the two meet—*blammo!*” Bud stated.

“No. No ‘blammo’ involved. What I’m doing is just like the old trick kids do with magnets. Like poles repulse and opposite poles attract. In this case I’m hoping that it means what Dr. Van Voorhies believed, and that is the alignment of the fuel molecules allows the oxygen molecules to slip in between them faster and more efficiently, causing what I hope will be greater thrust for the amount of fuel.”

Bud scratched his head, saying, “Simple once you think about it. I guess.”

As soon as all the equipment was connected and a technician with the Volatile Materials team was satisfied that all safety precautions had been met, they stepped into the reinforced test bunker.

“Thanks for your help and letting me use the test rig, Alan,” Tom told the technician. He glanced at Bud and then back at Alan. “Ready?” They both nodded. “Here goes.”

He flipped the protective cover from the firing button and poised his finger over it. With the other hand he activated several remote valves using the computer. As soon as they could all see green lights across the panel, he pressed the button sending the electrical charges into

their respective components.

A full second later smoke and flame came out the rocket motor firmly bolted in a horizontal orientation. Numbers began flashing across the panel far too fast for any of them to register more than perhaps an occasional impression of a seven or perhaps a three.

Fifteen second later it was over. The metal nozzle at the rear of the motor was glowing a dull red and an automatic system was drawing any residual fuel back out of the tank and into an underground storage vault.

“I’ll get the results over to you within the hour, Tom,” the tech offered.

When they came through the computer network Tom and Bud were sitting at Tom’s desk. The initial results looked good. There had been a slight increase in the level of thrust trying to force the motor sideways. Tom’s hopes began turning when he saw that the total burn time was practically identical to his existing fuel and oxidizer mix.

Before giving up hope for the current experiment he ran several calculations. Bud sat quietly while Tom did his work knowing that questions or even lighthearted comments would not add to the situation.

Tom looked at him when the final results appeared on the screen. “Well, even with the same burn time, we have a greater thrust per pound of fuel mixture. That’s the good news. The not so good news is that it would still leave us about fifteen to twenty miles too low to achieve orbit.”

“It’s something, though,” Bud said getting up. “Little steps?”

Tom only nodded and went back to studying the figures.

After a few minutes, Bud slipped out of the room.

A few days later Tom had a new idea he wanted to try. It could also be performed on the test rig at Enterprises like the previous test. That was the good part.

What he wasn't too certain about was the safety aspects.

Neither was Mr. Swift, but he gave his son the go-ahead to try the experiment.

He again enlisted assistance from the Volatile Materials team. He sat in their main office explaining the nature of the next test.

"I want to try squeezing the exact same amount of trust out of the fuel," he began. Seeing that comments such as "Yeah, but..." and "Are you feeling okay," were on their minds, he hastened to add, "But, I want to do it over a greater period of time. And, to do that I want to try to go with a much higher pressure system than before and get a much finer disbursement of the fuel mix."

"Okay, so I recall we're running a four hundred PSI system right now. I thought that was pretty high. What kind of pressure increase are you thinking about," a technician named Larry asked.

Taking a breath before replying, Tom said, "Twelve hundred." He looked for their reaction and saw three stunned men sitting opposite him.

Finally, Larry spoke. "Uh, okay. Possible, surely, but the injector would just shoot the fuel out the nozzle and into the air before it has the chance to ignite. Could even be too far past the igniters to catch fire. Even if it did ignite it would be too far out the back end to give a good propulsive ratio."

Tom smiled at them. "Ah, yes. In the current configuration you would be correct. However, I want to switch from the current shower head style injector to a dual-output centrifugal injector. Something like this." He opened the notebook he had set on the desk and showed them a drawing of a device that looked like an old fashioned steam engine nozzle. A central chamber with two curving tubes that would eject the steam out and back to cause the nozzle to spin.

"It should also have the added advantage of causing the mixture closest to the burn chamber walls to be pressurized even more. Like any internal combustion engine, higher compression means more power from a similar amount of fuel."

The three technicians were intelligent men and all recognized what Tom was showing them, as well as the implications of using such a device with high-pressure fuel and oxidizer.

Steven, the youngest of them was the first to speak. "Skipper. That's... well, that's inspired. If I understand it you want the fuel and oxidizer to get shot around inside the combustion chamber instead of down toward the exit point." Tom nodded with a grin forming on his face. "It might require a rework of the chamber to keep the fuel and all from just slamming into the sides and running down and out, but I think I see what you're trying to do."

"Actually," Tom told them, "While this centrifugal nozzle is spinning it will be spraying out an even finer mist of the liquids and in a pattern that will go both out and down. I want to get a wider dispersal of everything as it ignites. I'm hoping to make this a rocket version of an

internal turbocharger!”

Tom worked with the technicians at the lab along with testing the strengths of several structural and composites over the next week. Everything was taking shape and not too soon either.

Damon Swift was getting closer and closer to having his *CosmoSoar* complete and ready for launch. Father and son—though neither would admit it—were locked in a who-can-beat-who contest.

Because of the possibility of a high-pressure explosion, Tom opted to have the new test moved back to Fearing. Their rocket motor test rig was larger—almost too large—but had the advantage of being about as far from anything on the island as possible. In the event of a catastrophic accident he realized that there was no possibility of destruction of important systems, or—as he knew was even more important—harm to anyone.

The new half-scale motor system was set up and everything was ready for testing when Bud and Tom arrived.

At Mr. Swift’s suggestion, the pressure was being built up very slowly and would require at least four hours to reach test levels. Tom was tempted to begin the test when it reached just one thousand PSI but knew that this wasn’t supposed to be a partial test with partial success and partial results. Fifty minutes later all was ready.

Because of the possibility for something disastrous, Tom was glad to be down in a buried bunker with only one other person. Even Bud was more than a full mile away observing through binoculars.

The alarm sounded and a loudspeaker announced the upcoming test. “Clear the area! Clear the area. If anyone is in the area and unable to leave, make yourself known if possible. Blast damage possible. Clear the area!”

When nobody suddenly stood up or waved anything, Tom called for the test to commence. The countdown started and ten seconds later the fuel and oxidizer began their barely-contained explosion sending the standard smoke and flames out and away from the test area.

With the assisting technician keeping an eye on the readouts, Tom let his gaze linger on the large monitor showing a split screen of both the side of the motor and another view from slightly behind the test stand.

“Overheating!” warned the technician. “Almost in the red zone.”

Tom’s hand slammed down on a large, red button shutting off all systems. First the flame and then the smoke ceased leaving behind a noticeably white-hot motor casing.

That’s way too hot, Tom thought. *There’s no way that will be safe*. To the technician he asked, “What’s the sensor in the combustion chamber showing?”

When he heard the answer, Tom winced. “Another two seconds and we would have had melt-through.”

Half an hour later when things had sufficiently cooled they went out to take a look. As Tom feared, both the spherical combustion chamber as well as the conical motor case showed signs of slumping. The heat had been far too intense.

It was even worse when Tom reviewed the results later.

In spite of the greater level of heat generated and the longer burn time for the amount of fuel he *had* been able to let through before aborting the test, the overall thrust was only slightly more than that good old liquid oxygen and petrochemical kerosene.

It was yet another failure.

PART 3

Let The Sun Shine In

TOM LOOKED one final time at the readout. There was nothing slightly encouraging about what he saw. He thanked the technician and left the area and was soon flying back to Enterprises.

While flying back, Bud tried to give his friend some encouragement. “It looks like you got a lot of good flame out of that. Isn’t that good?”

Tom shook his head. “No. The numbers tell me that we got flames and heat, but it came out before it could be effectively turned into thrust. It has to be the pressure, but after seeing what happened I’m not certain that dropping the pressure down will make it any better.”

The rest of the day he reviewed and considered the printout of all the data. He spent an hour changing some variables in his thrust simulation program and found that there might be a very narrow band where a measured increase in the pressure of the fuel could give him greater thrust, possible enough for successful orbital height and speed. However, nothing he did could mitigate the dangerous heat build-up in the engine.

It wasn’t so much that he would be unable to build a combustion chamber and nozzle that could withstand the heat—he had to fall back on—but unless he could increase the size of the rocket to incorporate the variable pumping and pressure relief equipment that would be mandatory in order to fully control things it would do no

real good.

He knew that was not an option to continue exploring at the present time.

He and Bashalli spent the next day, Saturday, sitting on the little island in Lake Carlopa across from the Shopton Yacht Club. Lots of other teens and young adults were there dancing and listening to music, but they found a spot where they could stretch out and converse without being bothered or overheard.

Bashalli, already moderately dark-skinned from her Pakistani heritage, was laying on her back, enjoying the warmth of the bright late spring day.

Tom sat a few feet away watching her. *She is, he considered, about the most beautiful girl I've ever met. She looks so good there with the sun on her. She almost glows.*

Ten minutes later she sat up and caught him staring at her. She blushed believing that her bikini, the somewhat revealing blue one that she had been given by Sandy Swift, was the source of his attention. With more bravery than she had ever exhibited, she asked, "Like what you see, Thomas?" She blushed an even brighter shade at her own boldness.

"Hmm? No... I mean yes, Absolutely. It's just that I was thinking about my rocket and you were just something very nice to look at while I thought about it."

Unsure whether to be pleased or not, she chose to think he was trying to compliment her. "Well, while you were off thinking I was enjoying the wonderful feeling I get from the Sun. It's so invigorating!"

He nodded at her and smiled. Something she had said was wiggling in the back of his brain, but he couldn't figure out what it was.

It took until Sunday evening for it to make it's way to the front and for Tom to realize where it would lead him.

"Bud? While looking for the impossible I overlooked the obvious. I'm a real dummy. It's a wonder they ever let me graduate from high school," he told the young flyer as they sat eating a late breakfast in the staff canteen at Enterprises.

"It was probably that pesky four-point-oh-plus average of yours and the fact that you finished all your classes two years early. Just a guess, mind you..."

"No. I mean, yes, that's right, but it isn't what I meant. Bash actually gave me the idea. Let me ask you something. What's the most powerful thing around us?"

Bud thought for a moment, then said, "Sandy when I've said something wrong or haven't said something I was supposed to, or did something wrong or forgot to do something she wanted. Or, an atomic bomb. Kinda the same thing at times."

Tom chuckled. He knew how his sister could be. "No. I mean what is around you almost every day and is big and really, really powerful?"

"Well," came Bud's reply a little slowly, "that would be you. Or, your brain. You have to admit—"

"No, Bud. Look up. What's the most powerful thing you see. I mean if we were standing outside. Okay?"

Bud nodded and then it hit him. "The Sun? That's really

big and really powerful.”

“Right. It puts off an enormous amount of energy that gets absorbed into plants to make nutrients, into rocks and dirt and most everything to make heat, and into water to break it down to release oxygen. So, here’s another one for you. If you have a splinter of wood and a test tube full of oxygen, then you set fire to the splinter, what happens when you put it into the tube?”

“That’s easy. We did that back in the sixth grade in school in California. It bursts into flames.”

“Yes. That’s because the extra oxygen makes the ignitable fuel burn furiously.”

“Okay. So what does that mean for your rocket?”

“Just this, and I’ll do some experiments to verify it, but we can only carry X amount of fuel and Y amount of oxidizer. In standard proportions that means the ship carries around twice the oxidizer as it does fuel and we get X plus Y divided by the area in which to burn it all, plus a few other factors, and that ends up equaling Z, the total amount of push that comes out the back end. I’ve been trying to energize the fuel all by itself. It has been a dead end. What if energizing the oxidizer, or even a mixture of the fuel and oxidizer just before ignition is the answer?”

Bud’s eyes had opened wide as Tom spoke. “Do you really think that might do it?”

Tom had nothing more to add so he gave a single, definitive nod of his head.

“Need me to stick around to get in your way?”

Tom shook his head, again just once. Bud smiled, shook

his friend’s hand and left.

“Now,” Tom muttered as he sat back down to his computer, “where to begin?”

He spent three entire days and one evening deep in researching solar radiation and its effect on various objects and substances. The one thing he knew that was *not* the answer was using solar rays to merely heat the oxidizer or mixture.

He still had not come to a definitive conclusion but wanted to try to replicate something he remembered early during the third day.

He called Bud and asked him to come to the small lab and office he kept in the underground hangar where the giant *Sky Queen* was berthed. “Do you remember my describing the explosion of that small satellite rocket several weeks ago?”

“Yeah. Up it went. Boom it went. Down it came. Right?”

“Pretty much, but it’s how it went boom that interested me.”

Bud waited for Tom to continue, but the inventor had a far away look in his eye, so he asked, “And, what was the part of the boom you particularly liked?”

“Actually, it wasn’t until I viewed the video footage and made some measurements followed by a couple small experiments, that it hit me. When their rocket went up, it was using the same mix of kerosene and liquid oxygen that I have been using in both stages. The thing is that the ball of explosion at the altitude things failed, roughly fifteen miles up, was larger than it should have been. Roughly, it caused a twenty-five percent larger fireball by

my measurements—not accountable purely from the lower atmospheric pressure—and that’s what got me thinking.”

“I stand ready for your enlightenment, oh professor. What’s it all mean?”

“Do you remember that glass of iced tea Chow made me? That *you* drank. The one brewed just using the power of the Sun? The water never got very hot yet the tea infused into the water better than it would if dropped in boiling water. Almost as if the Sun’s rays had energized the water somehow. And, that is what I think happened in the case of the rocket. The upper stage began exploding and as it did it split wide open and spilled out the fuel and the liquid oxygen. My theory is that something in the Sun’s rays, some wavelength or cosmic radiation or whatever, provided instant energization to the expanding cloud of unburned gases.”

“So, when they did ignite, they burned better?”

“Better. Bigger. With more energy if I can believe some spectrometer data I was able to get NASA to send me.”

“Jetz! And you think there might be some safe way to do the same thing in your rocket?”

“I sure do. That’s why I did a pair of experiments yesterday while you were on a test flight out to Chicago. I headed over to Fearing with everything needed to fill two big balloons with a mix of hydrogen and oxygen. I couldn’t use kerosene vapors and hydrogen is nicely explosive.”

He told Bud about setting up two observation stations: one just one thousand feet from the site of a ground zero

explosion and another in a helicopter four miles away and five thousand feet up.

“When I exploded the ground-level balloon I got a final energy reading of zero point zero zero zero two seven nine kilo tons of TNT. Let’s call that a force of ‘one’ to make things simple.”

“My favorite kind of information.”

“So, next I launched the other balloon tied to a helium weather balloon and let it get up to fifteen miles. Luckily it was a very calm day. When I set that off—and using our revised scale—it produced an explosive force of nearly one point eight two. Just under twice what the same mixture had on the ground.”

“And you think that something from the Sun energized the mixture enough to do that?”

Tom smiled and his head bobbed up and down. “Here’s the best part. I now believe that the kick the Sun gave that mixture up there could mean that we can get into orbit by using less fuel per minute of flight than ever before while giving us greater thrust and speed.”

“What’s next?”

Tom told him of his plans.

Over the next few days he worked closely with his engineers and with Arv Hanson to build another pair of small scale test rockets. These featured a large section in the nose where the fuel and oxidizer could be pre-mixed and then directly exposed to the solar rays in a glass-sided section. A full package of telemetry instruments would complete the rockets.

When they set up the first one at Fearing Island, Tom

gave the team a review of the basic results from previous tests and what he hoped to accomplish.

“In scale and computer model tests we have been able to get identical versions of this rocket to a height of seventy-one hundred and eight feet. In my full-sized rocket that would get us to just over ninety-nine miles, one mile short of the lowest Earth orbit point, but not at a speed that could keep it in orbit. I want to be able to get my ship to at least one-and-a-half times that. I’ll accept one hundred thirty miles in a pinch.”

“How high does this smaller rocket need to go to prove that, Tom?” Arv asked.

“I’m hoping for an extra thirteen hundred feet or just a bit more.”

He showed them how the fuel would travel under pressure provided by a nitrogen cylinder. It would go up into the nose of the rocket and into a wide and partially flattened tube. The tube was filled with a fine mesh Tom explained would help stir up the mixture without impeding its flow. It would pass under a special optical glass lens in the side of the tube that would focus the Sun’s rays on the fuel mix flowing inside, forcing an extra oxygen atom to attach to the atom pairs and turning them into a form of ozone thereby energizing it.

“I’m thinking of calling it something unoriginal like a Solarizer,” he told the assembled team. “Bud over there says it should give the fuel a kick, but that isn’t the intent. However, in his own special way he verbally thumped me on the head and made me think. Perhaps there is a way to ‘kick’ the fuel as well. That will be something we can test in a larger rocket. Just no room in this one.”

“What do you mean kick it, Tom?” The question had come from one of the Fearing Island men.

“Well, I’m considering using the very mass of the fuel itself to help propel the rocket. I intend to build a device to accelerate the fuel mass once it has been solarized and kick it backwards. If I’m right, by forcing the fuel mixture back the length of the rocket at a speed faster than we are traveling we will, in effect, use that mass to push us faster in an upward direction. Newton’s old ‘equal and opposite reaction’ law. My hope is that the rocket knows it needs to obey the law!”

He smiled as the group laughed.

Half an hour later he asked for everyone except Bud, Arv and the safety technician to move back to the observation area.

The little rocket stood proudly at the bottom of its launching rail, waiting to show what it could do. Tom radioed to the helicopter.

“Take her up, Red. Same position as before but this time you’ll just be trying to follow the rocket with your camera. Give me maximum zoom, please and keep it in sight as long as possible.”

“Roger, skipper. I’ve got Zimby Cox with me. If you don’t like the picture, blame Zim.”

Tom had to smile at the little pun. “Thanks. Tell him to be sure he isn’t recording over his girlfriend’s soap opera tape. I’ll give you a one-minute call. Out!”

His next call was to the island’s control tower.

“As soon as you get FAA and everyone else to give the

okay, we'll go with a two minute countdown. Let me know when we can get started, please."

Fifteen minutes later he received word that all was clear. He checked with Red Jones to be certain the helicopter was in position and got a verbal thumbs up.

"Okay then," he said to Bud and Arv. Flicking on the arming switch, he set the counter at 02:00:00.

When it reached almost sixty seconds he called out to the helo. "Coming up on launch minus sixty, and... Mark! Tell Zimby to get the camera pointed and turned on now."

"Roger."

Bud ducked outside and did a visual scan of the launch area. Coming back in about the timer reached twenty seconds he announced that the area looked clear.

Tom turned on the loudspeaker and the link to the observation area. "Coming up to launch minus ten..." He counted down the final seconds and then pressed the button sending the little rocket skyward.

"While we're waiting, Tom, I have a little question," Arv said. "If what you told us about the balloon test gave results at fifteen miles, what sort of results do you think you'll get at under three?"

Tom smiled. He liked it when his people asked the sort of questions that kept him on his toes. "The truth is that I don't expect to see a lot. But, having said that, the focusing lens I added to this rocket will increase the apparent solar ray strength about threefold. If anything is going to work, we will see a measurable difference. And, if we see a little result, then I've got that second rocket you built. We'll send that up hanging under a helium balloon,

then set it off at about fifteen miles. That's when I expect to see the real results."

Red Jones radioed in a report. "We've got her still coming up, Tom. She passed us at five thousand like there's no tomorrow, and Zim did some mental trigonometry and thinks it's already passing eight or nine thousand."

"Do you still have a trail?"

"Affirmative. What are your instruments showing?"

Tom glanced at the rudimentary readouts. He could only see velocity and G-force. "I've got it going about fifty miles per hour faster than the earlier rocket and at one point one additional Gs. Looks like we've got a winner!"

Less than a minute later the readout for G-force dropped to zero and the velocity began dropping quickly.

"She's coasting up to apogee now," he announced to everyone. "We have almost no wind and it appears the rocket went almost straight up. I'll let you all know where it will land a minute or two after the chute opens."

When the time came it was apparent that the rocket would most likely land about a mile away, but still on the island.

He and Bud jumped into the truck they had used to drive to the launch bunker and headed that direction. They arrived while the rocket was still a few hundred feet up and dropping straight down.

It landed practically upright but a small gust of wind shoved the parachute to one side knocking it over. They rushed forward to disconnect the chute. Bud attended to

bundling the lines and fabric and shoving them into a small bag.

Tom plugged his laptop computer into a data port on the side and downloaded all of the telemetry data. Moving back to the truck he set the computer on the hood and launched the program that would tell them if the test had been a success.

When the final display came up, Tom spun to face Bud.

“It worked, Bud! By golly it worked! We got up an extra nineteen hundred feet. This proves it. We can harness the Sun and get into orbit. I’m sure of it!”

They headed back to the launch bunker to pick up Arv and the technician and then drove to the observation area where Tom addressed everyone. After he announced the positive results they erupted into a cheer that lasted a full minute.

As soon as they quieted down, he told them, “Tomorrow morning we’ll launch the second rocket. It goes up attached to a big balloon and won’t fire until it reaches about fifteen miles, the point where I believe the best solar rays begin.”

Nobody involved in the test got much sleep that night.

When the take-off time came, the crowd had grown to almost a hundred people. Anyone not specifically working on the island came out to watch even though they all knew it would take an hour or more for the balloon to reach the proper altitude.

Tom discovered that he was more nervous as he stood with his thumb poised over the firing button than he had been on any other test. His hand was shaking slightly.

Bud noticed it and simply commented, “Too much coffee, skipper.”

The altimeter neared the magic number of seventy nine thousand feet. Tom activated the microphone and gave them a count from “Five... four... three... two... one... launch!”

Because of the distance, it took a quarter second for people on the ground to see the exhaust, but it soon appeared that the rocket was zooming higher and higher. In a minute even the exhaust was difficult to see, and then it disappeared.

“She’s still burning, folks. It will be another minute before we get a parachute and then maybe six minutes before it gets back down here. I’ll keep you posted.”

It took more than an hour for Red Jones and his helicopter to locate the floating rocket; it had drifted several miles east and over the shore.

Tom dried the data port and plugged in. Five minutes later his legs almost buckled. The numbers told the story. The power had almost doubled from the standard rocket and the burn duration had increased by almost thirty percent.

He heaved a huge sigh of relief. “We did it, Bud! Now, we can get my rocket up and into orbit.”

“Okay, Tom,” Bud said draping an arm over his best friend’s shoulders. “You’ve got this Solarizer thing working. When are you going to get working on the actual fuel kicker?”

