



THE YOUNG TOM SWIFT JR. CHRONICLES

Tom Swift and His Solar Go-Cart

By T. Edward Fox

Tom Swift, Jr.—although not even in his teens—has created two notable inventions. First, the one even his father must not tell him about, was instrumental in saving many lives during the recent World War. The second, his amazing snow making machine, had helped save the spirit of Christmas for his sister and many of the children of Shopton.

Now, Tom wants to build a little go-kart that he can drive around in during the forthcoming summer.

The problem is that he can't afford to buy one of the small gasoline engines used by some people. His father suggest finding an alternative energy source.

So, he does.

With the almost white-hot spark of inventing desire running through his veins, young Tom sets out to do something nobody has done before. Capture the Sun! But, it's a long road to even finding the path to success.

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Finally! A follow up to last year's Christmas story, just not actually about the holidays this time. Enjoy, Yahoo Tom Swift Group (I hope). This book is dedicated to you. And to kids who decide that they want something, and are not afraid to work for it. Even where it means they don't get to "play" with their friends, their enjoyment often stems from the sheer joy of setting out to do something, and finding a way to make it happen.

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Tom Swift and His Solar Go-Cart

FOREWORD

Watching young Tom grow up has been a treat. Each time he gets an idea in his head, he methodically breaks it down and finds a way to work toward his goal.

I've watched him create the first two-channel video transmitter, happen on the genesis that will become the microwave oven, develop a way to manufacture snow—and make his little sister a very happy girl—and even publish a technical paper that will eventually lead others to create the first atomic clock.

He isn't even eleven, yet!

Now, he turns his attention to something for himself. A few of his friends have been given go-karts for Christmas. Little, four-wheeled mini cars that operate from a single-cylinder, smoky and very noisy gasoline engine.

He might be able to scavenge the necessary parts to make one for himself, but his allowance could never cover the cost of the fuel, the oil, *and* the engine.

It is amazing watching how his mind works to find an alternative.

Victor Appleton II

NEW YEARS DAY, 1946**For His Next Trick...**

“WHAT WAS the issue, Son?” Tom Swift Senior, famous inventor and owner of the Swift Construction Company, asked his boy, Tom Swift Junior. Young Tom had recently created a device that could produce a fine, powdery snow—given below-freezing temperatures—just in time to provide his little sister, Sandy, with a white Christmas.

The only problem had been that it had not actually worked when he first turned it on, and had only begun shooting out snow later that night after he had fallen asleep. After he had all but given up on attempting to adjust it.

Since Christmas day, he had been trying to figure out why it had begun working suddenly and successfully, and to see what might be done to make it better and more foolproof. It was now the first day of the new year and young Tom was getting restless.

He looked up at his father and began, “Well—” he began and then faltered. “Um, it was two things. I started everything up when it was a couple degrees too warm, and I forgot to pump up the aerator chamber properly before putting any water through the thing. It took a couple hours for things to clear through the system before it made any snow.”

Mr. Swift looked at Tom with pride. His son, just a few months shy of his twelfth birthday, already had one major invention under his belt and this snow-making device,

while limited in its sales potential, showed him that Tom had both the knack for invention as well as the determination to make things work, or work better.

“I also found out something at the library that helped me make a few changes,” Tom told his father. “Tonight, I’ll see if I got it right.”

His father asked what changes Tom had made, and the young inventor rattled off a list of more than ten items along with the reasons and anticipated results from each.

Tom Sr. sat in his favorite easy chair and listened patiently, nodding slightly as his son spoke. He well knew that verbally listing items in any invention or process could often help open up other ideas. Once Tom completed his list, Mr. Swift gave a final nod. Everything sounded logical.

“You see, Dad, the best part is that I think I’ve figured a way to make actual fluffy flakes rather than the fluffy, dry, icy snow pellets that come out right now. All it looks like it requires is to make the little holes in my nozzles more like slits with a round hole at one end and then narrowing down at the other. The weight of the extra water at one end will make the drops spin as they come out and that should flatten the water as it freezes!”

"Would you like me to help you get a patent and sell the idea to someone?" his father asked.

Young Tom thought the matter over for a full minute. "I'm not sure," he finally replied. "It probably isn't worth much. I mean, all it does is make snow."

Mr. Swift chuckled. He knew that his son had hit on

something that could easily add to the boy's cache of important inventions and his savings account. After all, Tom had created a vital war-changing dual channel radio system for sending video back from the battlefield letting Generals all over Europe avoid sending men into dangerous situations as well as providing instant visual inspections of on-going battles.

That invention had been—as Mr. Swift knew it would—taken over by the United States Government and was still considered to be Top Secret, even to the young inventor himself. It would be years before it would be declassified and he could take pride in his contribution.

Without his knowledge, young Tom Swift had already amassed a huge saving account from licensing payments, running up over the half million dollar mark and growing with each passing month.

Tom Sr. understood his son. Money meant very little to the boy compared with the joy he seemed to receive from the process of inventing things. And, unlike most boys his age, young Tom had shown an amazing ability to shrug off what he perceived as failures and concentrate on the positives.

Even his teachers at school had complimented the Swifts on the maturity of their son.

He made a mental note to gather all of Tom's plans together and to have one of the engineers at the Construction Company put them in proper order, identify what might be missing, and then the father would get the son to fill in anything necessary to file a patent for the amazing snow producing device.

"Well then," he said looking at his young son, "what's next for you? Of course, whatever you have in mind will need to wait a bit until you get ahead of things at school. After all, this is your last year before junior high school and you need to really excel and make good grades so you can get into a top flight college."

Young Tom's face blanched. He had totally forgotten something that had come up the final day before the Christmas holidays when the Principal of his school had asked him to drop by his office.

What the man had proposed had taken Tom by surprise and he wasn't certain how to interpret it. But, getting his snow device working had take over his thought processes during the Christmas break, and the meeting had been forgotten.

Until now.

"Um. Dad?"

"Yes, Tom? What is it? You suddenly look very pale. Are you feeling well?" Tom Sr. leaned forward taking a close look into his son's eyes.

"Oh, I'm okay. I just remembered something important. From school." He couldn't meet his father's eyes. "Mr. Peabody wants to see you and mom at his office sometime the first couple of days of school this year."

Tom's mother had just walked into the room and only heard the last sentence. "My goodness, Tom. What does he want?"

Tom shrugged. "I think he wants to have you take me out of school, or something like that."

Tom Sr. and his wife, Mary, looked worriedly at each other.

They needn't have been nervous about the meeting. On Monday morning they made an appointment to speak with the Principal that same afternoon.

"I'm certain that you are very curious as to why I asked Tom to have you come see me," the man told them as he shook their hands. "The truth is, I have a problem and it involves your son!"

Mary's head snapped to the side and she stared at her husband. Tom Sr. placed a hand on hers and asked, "Is there anything wrong with Tom's work? Something that his preference for inventing might be preventing him from doing?"

Mr. Peabody laughed a deep, hearty laugh. "Oh, hardly," he assured them, sitting down. He motioned for them to take seats as well. "No. The problem is with this school. We can't keep ahead of him. He is easily two years ahead of the curriculum. Probably three. More in the maths and sciences. In fact, the only places he is even close to his classmates' level are in history and civics."

Mary and Tom looked at each other with relief. She was the first to speak. "But, if he is doing so well, then I am not certain what the problem might be."

"I think Mr. Peabody means that the school isn't able to provide the level of teaching needed by Tom. Is that correct?"

Nodding, the head of the school said, "Absolutely correct. What I would like to do is to have him finish the

year here at this school, but only taking the classes where he is anywhere close to what we are prepared to teach. History, civic studies and physical education. I'm prepared to arrange his schedule so that he only needs to be here half days—mornings would be best—and then he can have the afternoons off. Then, next year we would place him at the freshman level in high school, bypassing junior high altogether. For his math and science classes I might go so far as to suggest the sophomore level classes."

"But, what would he do the rest of his days?" Mary Swift asked. "This year, I mean."

Chuckling, Tom said to his wife, "Oh, I think that I can figure out a way for him to have some adult supervision as well as time for inventing."

And so it was that young Tom found himself at Shopton Grade School finishing the sixth grade between 8:00 and 11:20 a.m. each day and then riding his bicycle three miles to the Construction Company where he had been provided a small workshop out near the oldest of the factory buildings.

During the first week he worked with an engineer, Peter Marcus, on all the necessary paperwork for his snow device. By the end of the week, Peter was totally amazed at the way Tom could stand back from his own invention and find quick and easy ways to improve the device. With the winter weather remaining in the high 20's, even at mid-day, it had been possible for the pair to make various refinements and to test each one.

By the end of the second week both Peter and Tom were satisfied that the device had been both simplified and

enhanced to the point where it should be possible for a company to build the newly named *Swift-T Snow-Blow* devices in quantity.

"I've got to tell you that I am so impressed with your son, Mr. Swift," Peter told his boss the day after all plans and a model of the final device had been turned over to the company lawyers for patent filing. "He has almost no ego about his invention. Why, he spent a full day trying to perfect one concept he was sure was going to increase the effectiveness of the nozzle assembly that never panned out. Then, just like that..." he snapped his fingers, "...he said to me, 'Well, that was a waste of time. Sorry to put you through that.' How about that?"

Mr. Swift could only nod in agreement. It wasn't the first time young Tom had shown a greater level of maturity than many seasoned engineers and inventors.

At home that evening, over a juicy leg of lamb dinner, he asked Tom, "Now that you've got the snow nozzle project finished, what do you want to do?"

Tom's forehead scrunched into a crinkle of thought. His lips pursed and moved to one side, and then he made a few humming noises. When he looked up it was into the faces of two parents, barely keeping from laughing, and a sister who was just opening her mouth to make some snide comment.

"I was just thinking about something Larry Elmer got for Christmas. And, a couple of the guys were already running theirs around the old Masterson property last summer."

"What's that, dear?" his mother asked.

"Hmmm? Oh. Go-karts!" Tom exclaimed. When he saw that two of the other three at the table had no idea what he might be talking about, he gave them a short description.

"You start with something that has a good stiff frame with four wheels, bolt a small gasoline engine behind the seat and attach that using a chain from a gear on the engine to a larger one on the wheel, add steering, and you have a go-kart!"

Mr. Swift immediately understood the idea, but Tom had to draw a diagram of a basic kart for Mrs. Swift and his sister, Sandy.

"That looks stupid!" the young girl proclaimed. "It's a baby car. Tommy-no-mo's gonna make a baby car." She giggled as she pictured her brother driving around in a little car with a baby doll strapped to the front.

"Knock it off, Sandy!" he told her.

"Is it safe?" his mother wanted to know.

"It should be," Tom told her. "All the ones I've seen are pretty wide and you sit very low so the center of gravity is low..." He stopped on seeing his mother's face. It was obvious she didn't understand some of the concepts, so he simply told her, "It won't tip over, and nobody's got a small engine powerful enough to make them go fast enough to get hurt in."

Not wanting to discourage his son, but being a realist, Mr. Swift said, "Tom. I don't believe we have any small gasoline engines at the Construction Company and I really can't see us buying you one. Of course, you could

buy one yourself if you save up your salary, but is that a good use of your pocket money?"

Again, as young Tom knew nothing of the enormous wealth he was accumulating, all he knew was that his weekly allowance had all but been exhausted buying parts for the snow making device, and his salary at work was only five dollars a week.

Slowly, he said, "Well. I think I can build the kart now and then worry about the engine later. If," he glanced at his father, "I can take some of those small steel I-beam scraps we have out behind building two."

His father nodded, telling him, "Consider it yours. I think we've even got some old spare wheels from the roll-around tables we move parts on."

Tom smiled. He would get the kart designed and built, then figure out the engine thing later.

VALENTINES DAY, 1946

First Blush of Spring

IT HAD taken the rest of January and part of February before Tom got the opportunity to spend much time building the frame for his go-kart. So many little projects and ideas popped into his head that he generally spent two-thirds of his time at the Construction Company making notes and sketches, and the rest riding into town with various of the Swift's employees so he could spend time in the public library researching.

By the time February 10th came along he had three thick notebooks full of materials and references regarding metal strength computations, small engines, welding, gear ratios, steering controls and most of the other factors that would go into the kart.

He also had, to his father's amusement, fifteen written pages of book and technical magazine titles he asked the older inventor to purchase, "All for Enterprises, Dad," his father had been assured.

"Looks like you want us to start out own library right here at the company, Son," Mr. Swift commented with a small chuckle.

Tom looked at his father. Mr. Swift looked back and the two stared at each other for almost a minute before Mr. Swift broke the silence. "Ah. That is what you are suggesting. Isn't it?"

Tom smiled and nodded. "I'm not the only one who goes downtown to look up things," he stated. "I calculated

that at least thirty people around here go to the library to look up facts and figures at least once a week. If you assume that they spend about two hours driving there, finding the right book or journal, looking things up and writing them down, then driving back, that's one and a half man weeks of lost time. Every week!" He looked innocently into his father's eyes. "How much lost money is that, Dad?"

Tom Sr. rubbed his chin in contemplation. *Not just becoming a great inventor, he's turning into a negotiator to boot!* he thought, trying to suppress a smile.

"I see where this is heading, Tom. Of course, if we had our own library on the premises those men and women would only be spending an hour and a quarter a week looking things up. All we'd save is the driving time."

Tom nodded vigorously. "That's right. So, that's still over thirty seven hours a week of lost time and at an average per hour cost at the level most of them get paid, that's over a two hundred dollars a week. More than ten thousand a year. The cost of all the books on my list is only about two thousand dollars and the magazines and journals would cost about three hundred dollars a year. In the first year alone, we'd save—"

"Okay! I give up," his father said, now laughing out loud. "I give in to your facts, figures and logic. So, I want you to ask Miss Trent if you may borrow her spare typewriter. Then, you take your lists, alphabetize everything, type things up—along with costs and the publishers' names and addresses—" he added shaking a finger in friendly warning, "and give them all back to her. I'll arrange for her to get that to our Purchasing folks.

Happy?"

"Yes, sir!"

"Oh, and be careful with that electric typewriter. The little ball spins and twists around fast enough to break a finger. No reaching in to see how it works!"

It took two days, but Tom did as he had been asked. He even used carbon paper so that he could give his father's secretary one copy to save and one to send to whoever was going to buy things. Miss Trent was somewhat bemused at the length of the list—twenty-seven pages, all neatly typed and double spaced—but promised to "get right onto it."

In truth, she had been warned about the size of the list by Tom Sr., but was very impressed at Tom's thoughtfulness in giving her two copies. She had not been particularly looking forward to having to retype everything.

By the 14th, Tom was able to turn his attention to picking out as many of the parts for his go-kart as he could find on the premises. His first stop was to the piles of scrap metal, wood and cables that could be found behind each of the three main factory building at the company.

His searching yielded more items than he thought he actually needed, but he believed in having extras in case he did anything wrong or made changes mid way through the project.

Both Mr. Swift and Tom's mother had insisted that any cutting of metal sheets and tubes, wood and anything else

that required specialty equipment be performed by employees at the company. What both had neglected to do was to arrange for welding services.

So, Tom borrowed a heavy, two-tank welding system from the Fabrication department, usually kept around as an extra to roll to whatever location it might be needed. Donning the large and unwieldy helmet and gloves, he closed his eyes and tried to picture everything the welders did. He opened them and reached out to turn on the acetylene valve and lit the gas with a wooden match. He was surprised to see the large size of the yellow flame and how uneven it appeared until he remembered being told by one of the company welders that the flame didn't get small or hot until the oxygen was added to the mix.

It took seven tries before he got the mixture correct and could keep the flame going, but a few minutes later he had what appeared to be the best possible blue pinpoint flame.

Twenty minutes after that he turned off the gases, took the gloves off of his cramping hands and the helmet from his sweat-streaked face. He hadn't realized how hot welding could be.

He looked at the fruits of his labors. Although a little crooked, he had completed a rectangular frame using box steel tubing, including two cross braces. Taking out a measuring stick, he checked the dimensions. It was a half-inch wider on one end—he could decide if that was going to be the front or rear later—and exactly the same lengths on both sides. The only thing he worried about was the one inch difference in the cross dimensions measuring front to back. That meant the frame was twisted or 'racked' as he had read about.

"How's it going, Tommy?" came a deep voice behind him. Spinning, Tom was about to correct the man that he preferred to be called Tom, when he saw who it was. "Like the welding, do you?"

"Oh. Hello Mr. Gilbert. I have to tell you that it isn't exactly what I thought it might be. It's dreadfully hot for starters."

Laughing until his eyes glistened, the senior welder for the Construction Company came over to Tom. "Let me tell ya something, Tommy. The first time I picked up one of them oxy torches I nearly took my own eyebrows off. I turned the gas on and then took too long getting it lit. Enough of it formed a sorta cloud in front of me that went *WHOOSH!* when I lit the match. After that, it really started to get hot." He laughed again and slapped his own thigh. "So, let's see what ya've done."

He ran a practiced eye over the rectangle on the ground in front of them. "Well, you did a pretty good job keeping things flat, and on those three corners," he said pointing at the two closest and the one in the far, right corner, "but this other one is gonna break on ya. Not right away, mind. But, see that sorta hazy color in the weld?"

Tom did. Now that it was pointed out to him.

"That's a spot where ya didn't get the heat right. It's gonna be fragile. Plus, it's a little racked from my point of view. If ya like, I could give ya a hand. I don't wanta take away all your fun—"

Tom knew that he was in over his head so he readily agreed to accept the offered help. The two things he didn't see were the thumbs up sign Mr. Gilbert gave behind his back, and the grateful father who smiled knowingly on

seeing that sign before disappearing around the building corner and heading back to his large office.

The two worked to fix Tom's inexperienced job on the existing frame and then Mr. Gilbert began adding piece after piece as Tom showed him what had been cut, and where it fit in the plans he also had sketched.

Half way through their work, the two stopped as a small group of school children passed by on a tour of the famous facility. One of the young girls, probably in junior high Tom realized, pointed at him and said to another girl, "Isn't he cute?" loud enough for everyone in her group to hear. They all laughed. She let out a little squeak, tuned bright red, and ran to the other side of them.

Tom felt his face go bright and hot with embarrassment. It was the first time any girl other than his mother had paid him a compliment like that. He wasn't certain if this were a good thing or not.

By quitting time they had cut, shaped and welded just about everything that Tom would need in order to begin attaching things like the steering mechanism, axles, wheels, a seat and the mount for the engine.

Wiping his face with a bandana handkerchief, Mr. Gilbert graciously accepted the offered bottle of Coca Cola Tom had just purchased from the machine inside the nearby factory building. "Mighty obliged, Tommy. I guess I should learn to call you Tom, though. Right?" He had seen the boy wince slightly at the more childish name.

"If you wouldn't mind, Mr. Gilbert," Tom replied.

"Hey. I'll call you Tom and you can start calling me Gilly. Everyone else does. Mister Gilbert is my pa.

Cheers!" He held the bottle up, tilted it to his lips and drained it in seconds.

"What are ya going to do for power?"

"Well, most of these karts have little gasoline engines on them," Tom said, "but I don't have one and dad says I ought to hold off because they are expensive. Besides, if I buy one I probably won't have any money left over to buy gasoline and oil."

After thanking Gilly, the two parted and Tom went to his father's office. On their way home he told Mr. Swift about the assistance before realizing that he might get the well-meaning employee into trouble. "Don't be angry with him, Dad. Please? He was really nice and it didn't take that long and... uh... and..."

Mr. Swift reached over and patted Tom on the knee. "And, he helped you to make certain you didn't get injured and got that frame done in just a couple hours. No. Don't worry. I'm not going to be mad at our Gilly."

It was Friday night so the family had a quick hamburger and baked macaroni with cheese sauce dinner and pulled out one of their favorite board games. Two hours later it was time for Sandy, protesting every inch of the way, to head up to bed. "It snot fair!" she declared. "Tommy isn't even twelve yet and I'm almost eleven. We're the same age and he gets to stay up. Snot fair!"

"Language, Sandra," her mother warned. "I've told you about purposely running words together to make questionable other words, haven't I?"

"Poot!" Sandy exclaimed, emphatically crossing her

arms over her chest. "I was just about to start winning, too." She turned and made a big show of stomping across the room to the stairway where she paused—Tom was certain it was all for effect—and then let out a huge sigh before walking dramatically up the stairs. As she headed down the hallway to her room, she called out, "If anyone wishes to see me, I will be reclining in my bedchamber."

"What in the world movie do you think she got *that* from?" Mr. Swift asked his wife.

Shrugging, she replied, "I think out little girl is destined to be an overly dramatic actress on some radio soap opera." She got up and took the coffee cups and hot cocoa mugs from the table and into the kitchen.

"Tell me a bit more about your kart racer, Son."

Taking a deep breath, Tom told him about all of the work that had been done so far. "And, it's just about ready for the steering and the seat and the engine."

"Hmmm. I've been giving that engine a little thought," Mr. Swift told Tom. "The problem with those little engines is that they aren't very efficient and have a bit of a safety problem. Rev some of them too high and they break down. If I let you buy one and it explodes and you get hurt, why, your mother will take her favorite carving knife and open me up like a trout. We've got to think of some way to make it truly safe for you."

Tom was disappointed, but he figured that if he had a few weeks to work on both of them, his parents would relent and let him buy an engine.

The next morning Tom rose bright and early. The sun

was up and the weather report on the radio the night before had promised the first non-freezing day of the year.

He pulled on his denim pants and a plaid wool shirt and raced downstairs. He was about to bolt out the door when Mary Swift stopped him.

"Hold on there, Tom. Breakfast first, then socks and shoes and then outside. Okay?"

Tom blushed. He hadn't realized that he'd forgotten his shoes until she mentioned it.

"That's the sign of a good inventor," Mr. Swift said coming into the room. "Absentmindedness about little things. You must really have that kart on your mind, Son."

Tom admitted that he had been thinking about it. "But, right after breakfast I really want to go out and enjoy the last of the snow, Dad. The newsman on the radio last night said it all will disappear today with the hot weather."

ST. PATRICK'S DAY, 1946

The Luck of... Someone

TOM HAD BEEN working on his kart, designing a steering knuckle and a set of swivel brackets for the front wheels, along with locating a chain, a pair of sprockets, and other things the kart needed. Finding an appropriate seat had taken a bit more time as the Construction Company scrap piles could offer nothing along those lines.

In the end, he had scrounged two old padded kitchen chairs from a nearby junk yard, and he and Gilly removed the flammable parts, welded the good back frame of one to the usable seat frame of the other—with a little extra bracing for strength—and reassembled that into a fine, solid seat.

In the month since they had started, the two had met a few times in the company cafeteria where the older man always asked his young friend how the project was going.

"As long as you're willing ta talk to me, Tom, I'd love to get status updates on the thing. I kinda feel like part of it is me, ya know?"

Tom did and was happy to keep his friend up to date.

"I've been doing a lot of research in our new library room," he told Gilly. "Dad told me how dangerous some of the little engines can be and I read an article in a mechanical safety journal last week about how they are only supposed to run at about twelve-hundred rpm, but a lot of people are putting them in karts and even little

motorcycles and running them without their governors at twice that speed. There was a kid down in Texas that had one leg blown right off at the knee when his motorbike went boom!" Tom's eyes went wide and his hands flung out as if simulating the explosion.

"Yeah. I heard about that, too. So, what are ya gonna do?"

Tom grinned. "I found something over by building one the other day. I'll have to learn how to rewind it because it looks burned out, but it was an electric motor. The plate says it'll put out two whole horsepower. Can you imagine how fast I could go with that sort of power? It's twice what a gasoline engine can make!"

"Well, sure. But, as you say, ya got to figure out how to rewind it. It might not even work. Our electricians rewind a couple motors a week. If that one was on the heap, it might be beyond all help."

But, even with the friendly warning, Tom could not be deterred. He spent nearly the remainder of the week reading and practicing with some old wire and a block of wood he had cut notches into. By the time the weekend rolled around he believed he was ready.

With Mr. Swift's help he carried the heavy motor to their car. Once home, they carried it to Tom's little shed in the back yard where the young inventor got right to work.

Tom made several drawings of the layout and directions of all the wires before he picked up a pair of cutters and began removing the scorched and melted old wiring. An hour later, as Mrs. Swift called out the back door to bring

him in for dinner, he had the outer case on one side of his workbench, the central rotor in front of him and a pile of old wires on the floor.

He picked up a short piece of the wire and put it in his pocket.

On Saturday, Mr. Swift took him to the hardware store in town where Tom purchased a spool of the correct size wire. As they drove home, Mr. Swift asked, "Do you want any help, Tom?"

"I don't think so, Dad. I think that I understand how it needs to be done. Even if I goof up a little, I can unwind things and then rewind. But, thanks!"

Three hours later Tom had the entire rotor rewound and the rotor installed in its case. All that remained was to connect it to the right power source.

That was when he realized he had just made an incredible mistake. The motor he had just fixed—or believed he had fixed—required a 220-volt power source, something he could never carry on his go-kart.

He let out a good, deep sigh before closing up his shed and going into the house.

Sensing something was wrong, his father asked, "What's the matter, Son?"

Tom told him. "I should learn to check these things before I dive in, shouldn't I?"

Mr. Swift nodded. "It could help avoid future problems. But, all is not lost. If you really got that motor working again then I'll have a 12-volt motor from one of our old

forklifts pulled out and you can have that. You'll probably get another chance to rewind a motor, but that should be easy now that you have the experience." He winked at Tom who gave him a lop-sided grin.

On Monday Tom found out that his rewinding work had fixed the motor. He admitted to the shop foreman who received it from him that he had to clean out some melted metal that had fused the rotor to the magnets. "I had to use a hammer to break the rotor out. It left things a little roughed up in there so I took some sand paper and a file and smoothed it down. I hope that was alright."

"Ah," the man told him. "My men should have discovered that before they chucked it out on the junk pile. Tell you what, Tom. We just mothballed one of the first forklifts we ever bought, but it had just had a bit of service including having a brand new motor put into the drive train. It's a twelve volt motor. I'll have it delivered to you this afternoon. Probably has less than fifty hours of use."

Tom was elated. Now, all he had to do was to collect a few batteries, wire them together and connect them to the motor. And, mount the motor. And, attach the sprocket and chain drive. And, now that he thought about it, he still had to mount the other sprocket on the rear axle.

It took another five days to complete everything he could do himself. School had gotten in the way with spring exams coming on the last two days of that week, and that meant that Tom was stuck in his room a few afternoons supposedly studying. He didn't think he needed to; with the reduced school load he had plenty of time to concentrate during class and absorb whatever the

teacher was saying.

If nothing else, Tom Swift's mind was like a sponge soaking up whatever it read, heard and saw. He passed all three of his exams with good grades.

Finally, Tom and Gilly pulled the rear axle off of the kart, enlarged the hole in the sprocket, slipped it over the end and welded it into place. It was the first time Tom had seen the welder use a straight edge and a level.

"It's got to be pretty exact," the man explained, "or else you'll get friction. Same with mounting that motor. Precision, not sloppiness. Know what that'll do?"

Tom thought for a minute. "If you mean things rubbing together, then that will cause heat. Right?"

Gilly nodded. "That, plus it'll put a real strain on the sprocket and chain and even the axle. And all that will do is slow ya down and maybe cause ya to break down."

Tom and Gilly drove to the local auto wrecking yard Friday afternoon so that the boy could find four or even six good car batteries. Any more than six, he reckoned, and the weight would be too much. Any less than four and he wouldn't be able to drive his cart more than a few minutes at a time.

In the end he had to be satisfied with four; he didn't have enough money for more than that.

While Gilly welded a few pieces of thin steel to form a tray into which the batteries could be placed, Tom fabricated the necessary wiring harness. Gilly had to leave promptly at six, so once he finished, Tom walked to his father's office.

"Finished?" Mr. Swift asked.

Tom shook his head and explained about the final hook-up. "I'll do that on Monday." He told his father how excited he was getting as the time to drive his cart came nearer.

Mr. Swift knew the feeling. He had felt that more times that he could even remember.

A few minutes later, they went home.

Tom lost a few more days the next week when Mr. Swift asked him to assist with the afternoon tours. "We've got all sorts of school and civic groups coming through, Son. We need to do two tours a day. You're a well-spoken young man and the experience will do you some good. Besides, you need to earn all of the time and help you're getting with your go-kart."

Each afternoon at 1:00 p.m. and again at 3:30, a bus or fleet of automobiles would arrive, bringing between fifteen and fifty people of various ages.

Tom dutifully took the Monday, Tuesday and Wednesday groups around pointing out what was produced in each of the large buildings, talking about the history of the Construction Company, and then showing them the small airfield at the back of the property where a small aircraft was parked.

"This is a prototype," he told them, and then explained what the word meant. "Swift Construction Company is going to make that plane by the dozens or even the hundreds in a year or two. We believe that aviation should be affordable and available to anyone who wants it. I

think it's going to be called the *Robin*."

A man called out on the Wednesday tour, "So, sonny. You gonna fly one, or can't you see over the dash?" He let out a raucous laugh at what he thought was a clever remark and was promptly hushed by several matronly women standing nearby.

"As soon as I am old enough to fly, sir, I will be doing just that." It had been a knee jerk reaction to the rude man, and before he went home he had laughed it off, but the remark planted a seed.

Why shouldn't I learn to fly, he thought to himself as he prepared for be that night.

APRIL 1st, 1946

Tom Is No Fool

TWO WEEKS later Tom rolled his completed go-kart out of the corner inside building three where he had finished its construction and out into the empty field behind. Between the building and the airstrip was almost two acres of mostly flat, bare ground.

Two of the first set of batteries had not taken a charge and he had had to haggle with the auto wrecker yard man over replacing them. In the end the man relented when his boss came out to see what the fuss was all about.

Once Tom explained how he had purchased the batteries with the expectation that they would work once charged and then said he wanted either replacements or his money back, the manager rolled his eyes and told his employee to go find another pair. "Make sure they work this time. Put the meter on 'em!" he ordered.

Now, with four fully charged batteries wired in parallel so they would have more overall power rather than higher voltage, Tom was ready.

With his father, Gilly, and several other Swift employees looking on, Tom climbed into the seat, took a deep breath and flipped the power switch. He had rigged a rheostat to a foot pedal to act like gas pedal would in a car. His right foot gingerly pressed down on the pedal.

To his delight, and a round of applause from the small crowd, Tom's go-kart moved forward. It wasn't very fast, but he only had the pedal pressed about half way. He tried

the steering and the little kart moved left and right as he commanded it.

After stopping for a moment to waive at everyone, Tom tried a second run at a high speed. The little kart was soon moving at about ten miles per hour over the slightly rough ground. Tom drove out to the farthest point of the field, drove back and forth for about four minutes and then turned around, and drove back, slowing as he approached them.

Everyone came over to where he was climbing back out and congratulated him. He grinned but soon asked for silence.

"Thanks everyone. Especially Gilly. And, Dad. But, the thing is I've got as many batteries as I think it can carry, along with me, and it can only run about as long as it just did. You see, I barely made it back to here. I was slowing down on the way. Guess I've got to find a way to generate more electricity."

They all helped him roll the kart back to the construction building, then the crowd dispersed.

"What do you think you might do, Tom?" his father asked. "If you can't add more batteries, and there just aren't any affordable ones that are any lighter or more powerful than the ones you already have, is there some way to generate power as you drive?"

"Well, if I had a gasoline engine, I could hook that to a generator out of an old car and make electricity without having to rev up the engine," Tom said, giving his father a hopeful look.

"Do you mean to say you believe that running a gasoline

engine to make electricity is a good use of the engine?" Mr. Swift asked incredulously.

"I think it would be better than just running the engine to power the kart. I mean, driving something with an engine means running the engine slower and faster depending on where you are driving. Like, when you go up a hill you have to push the gas pedal and burn more fuel. An electric motor can do that while the gas engine runs at a single, slower speed, just fast enough to run the generator."

"Have you calculated the possibilities?"

Tom nodded and grinned. "If I ran a small engine at idle, just enough to turn the generator, it would run about fifty minutes on a quart of gasoline. Driving a kart this heavy relying on the gasoline engine alone would get me about fifteen minutes of use from that same quart."

"So, is that the way you want to go?"

Tom paused and sighed. "Personally, I'd rather just run it all on batteries but as you saw, they can't power the thing long enough. At least, not yet. But, I'll find something that'll work. I promise!"

For the next few weeks, young Tom read as much as he could about batteries and different ways to improve on their power delivery.

It had been tough going as he was constantly having to set one book aside in order to research the meaning behind various concepts and scientific advancements. He was getting less and less sleep at nights and his schoolwork began suffering.

It was on the final Sunday of April that a new possibility germinated in his young mind. As he sat in his father's favorite easy chair being bathed in the warming glow of sunshine streaming through the big picture window of the Swift's living room, he suddenly stopped reading and looked up.

But, as quickly as it appeared, the thought went away as his eyes focused on an article about the use of capacitors to store and enhance the delivery of electricity.

Hours later, when Mrs. Swift called everyone to the dinner table, Tom brought a small stack of papers on which he had been drawing various electrical circuits along with many, many pages of notes. After saying grace he asked his father permission to show him the pages.

"Let's wait until after we eat your mother's delicious roast chicken dinner, Son," he requested, giving Tom a look that silently added, *Don't argue this one. Just smile and eat!*

Tom did and finished ahead of everyone else. He sat impatiently as he waited for the rest to clean their plates. The worst was Sandy. *She always takes too long, he thought, especially tonight. She's doing it on purpose!*

"Sandra. Don't doddle over your potatoes. Your brother has things he wants to discuss and you're eating teeny, tiny bites. Come on... eat up!" Mrs. Swift told her daughter. Sandy narrowed her eyes and looked sideways at her brother. Turning her head slightly in his direction she stuck her tongue out at him through the corner of her mouth.

Tom chose to ignore her. He knew that any discussion

would just slow her even more. Finally, after what seemed to be hours, Sandy set her fork down on her plate and leaned back. "Happy?" she asked looking directly at Tom. "I want you to know that I'm absolutely going to have *unrelenting stomach indigestion* all night because of you. I'll need a BromoSeltzer!"

"Sandra. You may be excused. Go up to your room and finish your school work," Mr. Swift told her, a little irritated at her apparent attitude. "And stop quoting advertisement slogans!"

When she stomped off, he turned to Tom. "Now, Son, please help your mother clear the table and then show me what you have there."

Tom showed him the papers and let his father have almost ten minutes to read through them before asking, "Do you think that will work?"

"Hmm? Well, I can't fault your logic. The Construction Company has been looking at the use of high-energy capacitors for a new type of welding machine we want to build. It's called arc welding and uses very high levels of electricity to melt and fuse metals together. We might have a capacitor or two you could borrow. Borrow, mind you! They are expensive but I think the ones I'm talking about are fairly unbreakable as long as you only put in the right amounts of power and observe polarity."

Tom smiled at his father. He knew all about electrical polarity from both his research and through experience with his bank of batteries when he accidentally touched a negative lead from one batter in his parallel group to the wrong pole of another. The arc and the sparks and stench of what he would find out years later to be ozone had

given him a lesson he wasn't going to forget.

From his research he also knew about the tremendous shock capability of capacitors. One mishandling could kill a man. He vowed to himself to be extra careful. And, to never mention the danger to his mother.

At school on Monday morning, his civics teacher asked him to remain behind after class.

"Tom," she said pointing at the seat to the right of her desk, "I wanted to have a little talk with you before things get out of hand. You know that we all understand what an exceptional boy you are, but I need to tell you that I think you are letting yourself down a little. Your last test results were below the classroom average where earlier you were above that level. Is there anything going on at home that is keeping you from studying?"

Tom looked at her with embarrassment. "Um, well, there's nothing going on at home. It's my job I guess."

"Job? At your age? My goodness. Don't tell me that your father is forcing you to work at that factory of his!" she said in horror.

Tom started to laugh, which confused her. "No, Mrs. Abernathy. I *want* to work there. I really like it. I invent things. I even have an office and workshop and everything. Guess I'm spending too much time doing that. I promise I'll do better in class. Really."

She told him she believed him and sent him on his way, but she made a note to call the Construction Company to find out if he had been telling her the truth.

FIRST DAY OF SUMMER, 1946

School and The Sun are Out!

TOM SPENT the month of May and the first week of June concentrating on his schoolwork. It paid off with high marks and favorable comments on his report card at the end of the year.

The principal called him into his office on the final day of school and gave Tom a large sealed envelope. "Those are your school records, Tom. You need to give them to the principal at the high school on the orientation day before school begins. He will make certain that all of your new teachers understand your high aptitude and skills and give you everything you need, academically, to succeed."

He reached over the desk and offered the young man his hand. Tom stood up—something his father taught him years earlier—and shook the offered hand firmly. "Thank you sir," he told the man.

After dropping off the envelope at his father's desk, Tom raced over to his work shed and picked up the special electrical energizer circuit he had designed and built all by himself.

The two capacitors he had been allowed to borrow were fairly heavy, weighing in at more than ten pounds each, and everything else brought the total weight up to just about thirty pounds.

It took him an hour to connect everything, double-checking all points where polarity was a must, but he

was ready to test his kart before three that afternoon.

The sun was shining brightly and the air was warm and comforting. Tom loved the sunshine. Even back during the winter, he had enjoyed the icy cold days filled with crisp, clear blue skies and a sun that warmed the dark gray jacket he would wear.

Mindful of a promise he made to his father, Tom walked over to the small Administration building to see if his father wished to be his "spotter" and safety man. Mr. Swift was off the premises, Miss Trent, the Construction Company secretary told him. "Can I assist you?"

Tom shook his head. As efficient and organized as Miss Trent was, and as beautiful as Tom found her head of reddish auburn hair, she was just a grown up girl and girls weren't going to do him any good if he got into trouble. If she were anything like his own mother—who had just about fainted at the sight of blood the first time Tom had sliced open a finger on an old, sharp wood chisel—Tom knew it would be better to wait for a man.

He thanked her, and with a final look at her hair, he departed.

He spotted Gilly sitting on a bench outside of building two. "Hey, Gilly," Tom yelled out as he ran over to the man.

"What's going on, Tom?"

Tom told him about the kart and how he wanted to do a test run.

"Ah, Tom. Wish I could help ya but I'm doing a job in there and just taking a little cool off. I just don't have the

time today. Sorry. If ya can't find anyone I'll be available part of tomorrow," he offered the disappointed boy. Tom thanked him and headed back to the waiting kart.

He climbed into the seat and looked at the steering wheel. Placing his hands on it, he gave it a little steer to the left and then to the right. He sat there thinking about how it wasn't fair that he couldn't just drive it a little. After all, it would just be right here next to the building.

Tom took a look around. There was no one to be seen. Everybody was inside the buildings doing their jobs. He squared his shoulders and took a determined breath. His heart was racing as he reached for the cutoff switch and gave it an experimental flick up.

He was rewarded with the faint yet growing hum of the capacitors as they began drawing and storing power from the batteries. Pretty soon, the pitch was so high that he could no longer hear it. And, even if it was impossible, he believed he could feel the power sitting right behind him, just waiting to be released.

Giving another quick look around, Tom Swift made a decision. He knew he could get into real trouble for it, but his foot pressed down on the pedal, sending power to the motor.

The car lurched forward. A hundred feet later he pulled his foot from the pedal, slowed down and turned the kart around. He made it about ninety feet back before the motor quit.

His shoulders slumped. He tried turning the switch off and then on, but that failed to bring back the capacitor charging sounds. The only sound he could hear was that

of footsteps coming across the ground from just a few feet away.

"I thought I told you to never try to do something like this without an adult present!" Mr. Swift growled. Then seeing the sadness in his son's eyes his voice softened and he asked, "What happened?"

Tom sighed. "It only went about two hundred feet and then it just stopped." A thought hit him and in a panicky voice he added, "Oh, Dad. I hope I didn't ruin your capacitors. If I did, you can keep my allowance and my salary until I pay for them. I'm sorry!"

Tom Sr. knelt next to his son and rested a hand on the boy's shoulder. "If you believe you did everything right, then I have to believe that if they really blew out it must be because they were defective. They are rated at about ten times the power you gave them. No, actually I think that they just sucked everything out of your batteries all at once. Let's get this kart into your shed and check them out."

Father and son pushed the kart back to Tom's little shed. He connected a volt meter to the batteries and then turned to face his father. "Dead. Nothing, Dad. You were right."

"Tell you what, Tom. It's a beautiful day outside. Why don't you take a walk around the area and see if something comes to you. I know you are on the right track with trying to run this with electricity. It may just be a little early in the game to rely on batteries." He patted Tom on the head. "Go enjoy the sun."

"I wish I could find a way to turn the heat from the sun

into power," Tom said quietly as he turned to go out.

Mr. Swift told him, "Wait, Tom. What was that?"

Tom turned around and repeated his wish.

"You know, there *is* a way to get some electricity from the sun. I suggest that you try looking up the work of a man named... ummm... I think it was Owl or Ohl or something like that. It was back at the start of the war when I read an article by him."

Tom raced out the door and headed for the library room where he grabbed a half a dozen volumes before sitting at the central table.

An hour later he had read several articles about Russell Ohl who had created a basic sun-to-electricity device using silicon crystals and gold. It hadn't been very efficient but it *had* produced electricity.

Tom considered whether he could use such a device to actually power his cart, or if it should only be used to keep the batteries charged.

He decided that the latter was probably the best. He doubted he would get enough power to make the motor turn using sunlight alone.

After running to the Administration building and asking Miss Trent for permission to use the company telephone, Tom dialed the operator.

"Yes, ma'am. May I please speak to someone at Shopton Grade School? No, ma'am. I don't have a number. I guess someone will be in the main office, though."

A few minutes later he was speaking with Miss Veach,

the art teacher. "Hi, Miss Veach. It's Tom Swift. I was in your class last year when we did some things with clay and metal foil."

"Oh. Hello Tom. I do remember you. You weren't so much into our gilded art project as you were into trying to mold airplanes and rocket ships out of clay and old newspaper, as I recall. What can I do for you?"

Tom explained what he hoped she might provide.

"Why, yes. We do have a whole box of that foil. I suppose I could let you buy some of it. We certainly won't need any until school after begins again. With the tissue in between each one that makes about forty-eight or fifty sheets per inch. I seem to recall it costs about two dollars per one-inch stack of the four-inch squares. Do you know how much you'll need?"

Tom did a quick calculation. "I think I need one inch, but I might need two inches. If I pedal over there right now, can I get it? I have a five dollar bill and you can keep the extra dollar."

She explained that she had just been leaving when the school secretary hailed her for the call. "Could you come by tomorrow, say, after ten? And, I'll bring you proper change."

He agreed and hung up after thanking her.

Tom next made a call to the science department at Shopton Regional College. The man who answered the phone began with an impatient tone but quickly became intrigued as Tom described what he hoped they might assist with.

"Well, master Swift. We do have a high-temperature oven that we grow some types of crystal salts in and facilities for making glass. It might just be possible to grow some crystals of silicon. If, that is, we could get good quality sand. Do you know anyone who can provide that?"

Tom said he didn't but would find someone.

Two days later and seven phone calls completed, Tom had things on the way. He would know if his ideas, notes and designs were right in a couple weeks!

FOURTH OF JULY, 1946

Time To Celebrate

IT WASN'T the most auspicious start, he had to admit. It was, however, a start he could live with.

Tom had asked his father for a few days off so that he might go to the college to watch the summer Mineralogy students fire up their furnace, melt down and the form the first of the large crystals and then to flatten them under a high-pressure press. He sat, transfixed, behind a thick glass barrier in the broiling hot room for hours each day.

The first several crystals had broken apart under pressure, and Tom began to have a hollow feeling in his gut. It wasn't until the professor had come to sit with him and explain that the temperatures weren't quite right, yet, that he felt the knot in his stomach unclench.

"When do you think you might have it, sir?" he asked.

"Oh, tomorrow or the next day for sure. We've only done this once before and that was with turning giant salt crystals into flat blocks about fifty times thicker than your little leaves. It will just require a little fine tuning."

The next day had seen the first success, and by the end of day three there were fifty silicon leaves, each about seven inches across with jagged edges and a twentieth of an inch thick, sitting in an oven being slowly brought down to room temperature. It would be two days before Tom could take them.

With the assistance of one of the men at the Construction Company, Tom trimmed all of the crystals into five-inch squares. Three were destroyed in the process, but Tom believed he only needed twenty-four of them for his first test.

He began by coating each one with selenium he purchased from a chemical supply company. This step had come from Russell Ohl's research and provided a conductive surface for each silicon sheet. Thin wires were placed on top of this on two opposite sides of each crystal and Tom would use them to interconnect the thin wafers.

To each of these he carefully applied a layer of the micro-thin gold foil he had purchased from the art teacher's supplies, doubling the thickness over the top of each thin wire. This was basically a combination of the methods used by the very first solar cell researchers and the more recent Russell Ohl work.

Two days later he had an array of six cells by four cells arranged on a thin piece of beaverboard. One wire from the first in the upper row and one from the last in the bottom row were considerably longer than the others, and Tom fed them through lengths of rubber tubing for both safety and added strength.

A thin sheet of scrap glass covered everything, holding down the individual cells. He carefully attached padded spring clamps at all four corners to secure it in place.

Tom connected the two wires to his volt meter. Contrary to the zero voltage he believed he would find, there was a small amount of power being registered. He was puzzled and went to ask his father what might be happening.

"Well, think about it, Son. What are your little crystals supposed to do?"

"Uhhh," Tom began, trying to organize his thoughts, "when the sunlight hits them, it excites electrons which turns the sunlight into electricity."

"Just sunlight?" Mr. Swift asked with one eyebrow arched.

"That's what all of the research material says. Sunlight. Hey? Do you think it's the light coming in through the window?"

Mr. Swift laughed. "As I understand it, any light at certain wavelengths does it."

"Oh, I see. So even the lights in the ceiling make a little electricity. That's why I'm getting results before I take it outside. Thanks, Dad!" he said racing from the room.

Tom pulled a roll-around cart out of building three and over to his shed. There, he carefully picked up and placed the beaverboard and crystals assembly on top and hung the strap of the meter on a screw on one side. He pulled the cart outside and into direct sunlight.

He knelt down and squinted at the volt meter. It read almost thirteen volts!

He was elated and ran back to his father's office with the news.

"That's fantastic, Tom. Well done. Now, all you have to do is to mount it to your kart and off you go!"

It took a full day and some help from Gilly to build a roof for the kart to hold the solar array. Running from

front to back of the kart and ending up looking more like a spindly-legged table, it was just about three times longer than Tom needed, but it would provide shade for the driver.

Gilly brought out a sheet of dull orange-painted aluminum he then bent and cut to form a rear panel, complete with a cut out window, to shield all the electrical parts.

"We got to keep prying fingers and hands out of the dangerous bits," he told the young inventor with a grin. "Besides, it gives it a little class. All ya need to add is a rumble seat!"

Tom mounted the panel on top and ran the protected wiring down the two front 'legs' and then back to a small box he had designed and built to keep the electricity running in just one direction; down from the panel into the batteries and not back up. If it worked like he believed, the panel would provide a small power charge to the batteries and would extend their range. He just didn't know by how much.

On the Fourth of July, he found out.

The Swift Construction Company treated its employees more like family than mere workers, so every Independence Day they had a big, bring the family barbecue and picnic. This year it was a special celebration commemorating both the end of the war as well as the start of an brand new building that would begin erection the following Monday.

With the adults enjoying lots of food, iced drinks and even some beers for the men, all of the kids gathered

around Tom's go-kart. Their parents had warned most of them to keep clear but a few eager little boys wanted to sit in it.

Tom obliged the brave ones by letting them sit in the seat and turn the wheel for a few moments before getting out to let the next child have a go. Even a few girls took turns, giggling as they did.

Sandy stood to one side, a smile hidden behind her hand. She sometimes thought of Tom as a real pain, but she was enormously proud of her big brother.

Soon, Tom asked them to all stand back and then called over to his father.

"I'm ready, Dad!"

Mr. and Mrs. Swift along with Gilly and more than four dozen other men and women walked his way—including Miss Trent who was wearing short pants rather than her usual long dress, quite a shock to young Tom who had only ever seen her standing or at her desk as he secretly believed that she might have no knees.

With mothers holding back their children and the men all smiling in anticipation, Tom flicked the switch. This time, with no capacitors to fill, there was no extra noise. Tom depressed the pedal a little and the kart moved forward.

He grinned as the crowd broke into a round of applause.

Waiving back at them, Tom took the kart on the same route he had the very first time. It would be an important mark to see if the new solar panel would extend his range.

When he completed the run and pulled back up in front of the crowd, some of the children wanted to rush forward, but Tom held up a hand.

"I need to measure the batteries before going on," he explained in a fairly loud voice. "Just give me a minute, please."

Mr. Swift came forward holding out the volt meter. "Here, Son. Let's see what you've still got."

Tom's hands were trembling as he connected first the positive and then the negative leads. He was about to shout for joy when the needle shot right up to the limits, but then remembered he was also measuring the power coming down from the panel and the bright overhead sun.

He disconnected one of its leads and the re-measured the batteries.

Everyone held their breaths as they saw Tom's shoulders hunch slightly, but he did not turn around immediately to tell them the results. When he did turn to face them, he had a lopsided grin on his face.

"Well," he told them. "I've still got a pretty good charge. Not a full one but I think I can get another run out of the kart. Let's see."

He reconnected the panel, climbed in and started off across the field.

EPILOG

"TELL ME, Son," Mr. Swift said that evening at dinner. "How do you feel about the results of the test drive?"

"I think it went pretty well, Dad. I made it almost fifteen percent farther with the panel on top providing a trickle of power to keep up the battery charge. It's a little wobbly with all that weight up there, but it made a difference."

Mr. Swift nodded. Mrs. Swift, on hearing the word "wobbly" looked like she wanted to say something but was restrained by a gentle hand on her forearm from her husband; she smiled weakly.

"Is it what you hoped for?" his father asked.

"Well, Dad, it's pretty good, but I'm certain that it will go even farther once I add another two sets of crystal panels. Gilly made sure I have extra room up there. Some day, I might even make a whole car covered with them!"
