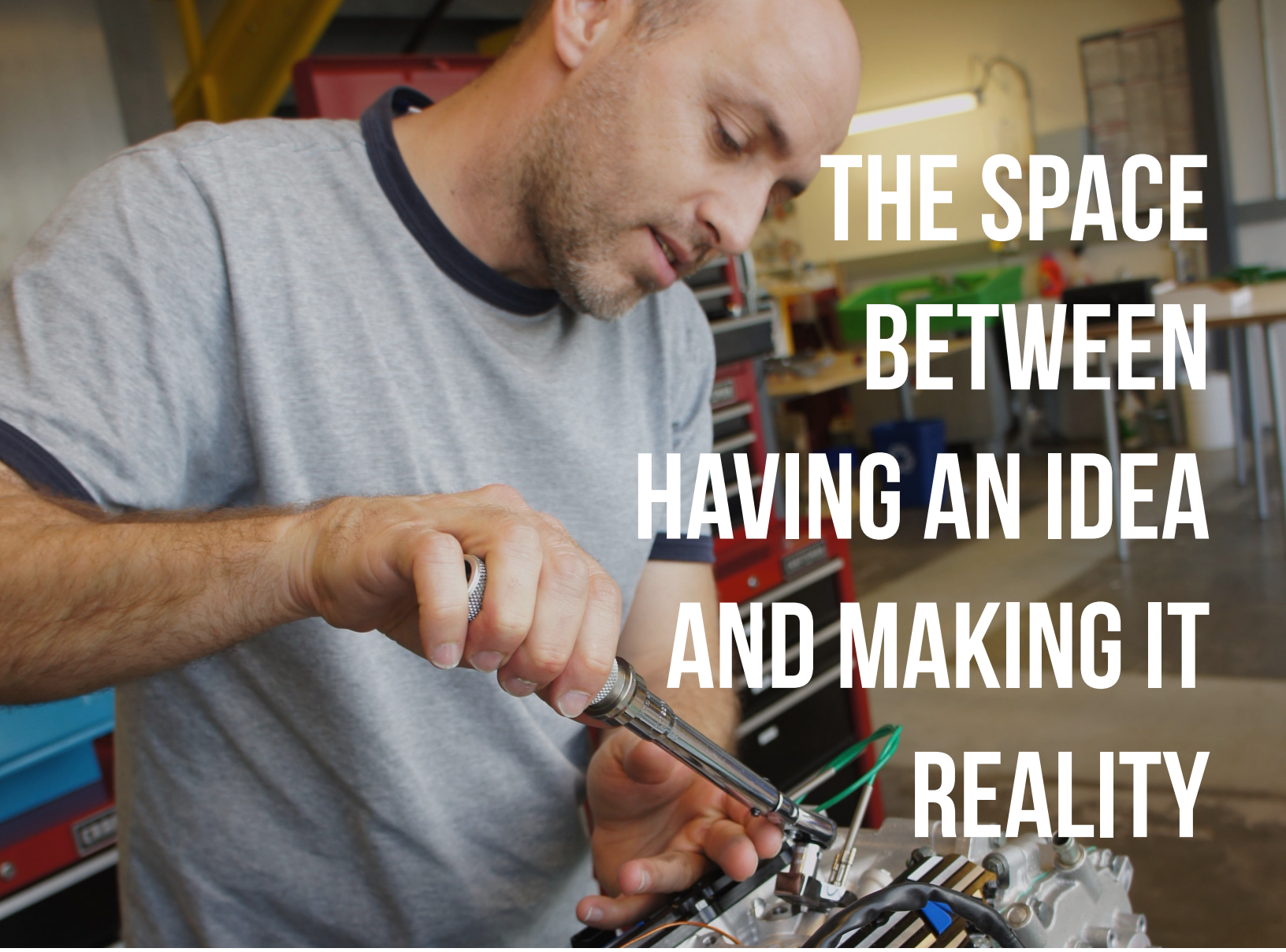


THE SPACE BETWEEN HAVING AN IDEA AND MAKING IT REALITY

BOXX CUSTOMER STORY

BY: JOHN VONDRAK

Josh Raimond of Pinnacle Engines

When Joshua Raimond was 13 years old, his friend's father gave him a ride home in his Porsche. Joshua had never ridden in a car like that before and in the moment, a passion was ignited. Oddly enough though, not as much for the style of the car, but for the sound of that engine. "I'm more of an engine guy than a car guy," Raimond says.

Fast forward a number of years, and when he left the United States Marine Corps after four years of service, Joshua decided to pursue his passion and make a career out of working on Porsche racing engines. He went to work for the renowned SoCal shop, ANDIAL. Formed in 1975, ANDIAL's name is an anagram made from the names of the founding members; the late Arnold Wagner AN; Dieter Inzenhofer DI; and former PMNA president and current consultant Alwin Springer AL. Porsche Motorsports North America purchased the brand in 2013.

"That's how I got into motorsports," Joshua recalls. "ANDIAL has a fantastic history racing Porsches and when Porsche Motorsports bought the racing side, it was literally me walking across the parking lot. I worked at Porsche Motorsports North America for six years. That's where I cut my teeth."

While there, a manager told Joshua if an engine needed to be built quickly, it did not necessarily go to him (Joshua), but if it needed to be built unquestionably perfect (like for a 12 or 24 hour endurance race) he was indeed the guy. Despite the high praise, Joshua moved on, deciding to attend college where he majored in physics at Cal. Unsurprisingly, upon graduation, he found his way back into the motorsports industry,

At the controls of the Hasselgren AVL

this time building racing engines at Hasselgren Engineering. While there, he created and managed Hasselgren's first Porsche race engine program running three teams, brought into commission and ran the AVL test cell, programmed Bosch Motorsport and Pectel ECUs, traveled to support Daytona Prototype data acquisition and engine support. Truth is, he did a little of everything.

"I'd go to the track and do track support," he says. "I would run the test cell, calibrate the ECUs on the dyno, build the engines, etc. I've just really been entrenched in motorsports most of my life."

Things changed, however, in 2008, when the economy went into the wall. "Folks weren't spending as much on motorsports," he laments. "I ended up moving over to what used to be called Cleeves Engines, founded by Monty Cleeves, which he later changed to Pinnacle Engines. It was here where I started the design phase of my automotive career."

Joshua relied on his engineering and physics background, as well as his previous motorsports experience, and began contributing to the design side. After seven years, he has contributed to three clean sheet engine projects: the first two were for a scooter project, while the current one is a 235 cc engine for the three-wheel market.

I ask him how his reputation for slow, meticulous work (dating back to his Porsche days), adapts to the Pinnacle Engines environment and Joshua laughs. "I've always been a little slow," he says. "At ANDIAL, the ethic I was taught was that perfection was what it was really all about. I was just so obsessed with getting it right and took to heart all the detailed lessons I was taught, so I ended up being a slow moving engine builder who guaranteed that everything was right—clip orientations, ring gaps, all clearances proper and all measurements were methodical and well documented. It just became my reputation to be the slow guy that didn't mess up. The work really was an art. Emphasis wasn't on turning out work quickly and bringing in a lot of money. I never felt that ANDIAL was ever about that. It was about executing the rigorous work ethic, attention to detail, more artistry than some job that was shopped—turning around cars for cash."

From Builder to Designer

By the time Joshua arrived at Pinnacle, where the company's primary focus is automotive (specifically the three-wheel and two-wheel markets), he wanted to transition to design, but forty percent of his work was still focused on building. However, in his design hours, one of his first projects was a flow bench rig for Pinnacle's novel sleeve valve engine technology.

"It took a little cleverness," says Joshua. "I designed a rapid prototype printed system, a nice encapsulated little unit that took the

Working in the Hasselgren dyno - 3.2 L short stroke 911 engine

sleeve in reality and was able to move it with a measurable and consistent amount of lift."

It was trial by fire, but his work garnered notice throughout the small company which was always on the lookout for design talent. "Valvetrains are my jam," he laughs. "With my physics background, they're a good fit because you're doing a lot of physics—active mass, inertias, forces, springs, contact stress, integrals and derivatives, complicated moving geometry— when you're designing valve lift profiles. You're creating acceleration profiles and there is so many ways to do it. I just started getting in there and doing it."

Joshua credits mentor Simon Jackson, PhD, an experienced motorsports expert who earned his stripes at Cosworth. Jackson also specialized in valvetrains (among other things) and from him, Joshua learned the finer details of a functioning valvetrain. With an engine under his belt, there was no time to rest on his laurels. Another project (with a slightly different architecture) quickly followed and Joshua just kept on going to where he is today. "I've done a lot of valvetrain design and development," he says matter-of-factly. "I designed my own spin rigs with the whole sensor suite and data acquisition. I did a piston design as well. I know what it's like to develop a skirt profile, the barreling and ovality, get into the details of ring packed dynamics, or the volume game you play to try to get the rings to stay stable for a certain period of time before the pressure causes the rings to shuffle. It's a small company, so I take on any design task that's required."

While at Cal, did Joshua dream of one day designing engines? "I didn't even know it was possible," he admits. "Frankly, if I did, I probably would have got a degree in mechanical engineering. I thought I had exhausted my career in engine building. I really just focused on physics and transitioning my career. I went skydiving for a couple of years and thought about what I really wanted to do. It was awesome, but base jumping was crazy. I only did nine of those and they were scary as hell."

After this "living on the edge" foray, Joshua re-discovered his passion for motorsports. While trying to determine how to transition to a new career, he started building engines again for money and while doing so, discovered a non-functioning AVL test

cell. He managed to get it working again and with the guidance of an experienced mentor, began teaching himself how to calibrate ECUs, how to do launch control and rev-limiter PID, and how to properly map an engine. Joshua was satisfied for a while, but still wanted to move on when good fortune smiled. "Frankly it was just luck that Pinnacle Engines wanted to hire me," he admits. "I saw an available design opportunity and wanted to see if I could fill it." He joined a company of 30 employees with a testing facility in San Carlos, including a main building for design and simulation. There is also an office located in India.

Joshua also considers himself lucky for the guidance of his career mentors, chief among them Tony Wilcox and the aforementioned Simon Jackson. "They really gave me an opportunity to thrive," he says. "The Pinnacle work environment promotes self-learning. It's a bit autodidactic–about becoming an expert as quickly as possible in the many different tasks at hand."

Joshua relates his Pinnacle experience to the AMC series Halt and Catch Fire. "There's a really quirky programmer and someone from a major computer corporation offers her a job where she will have all the resources she needs but she says, 'Why, so I can sit in a cubicle and be a drone and work on some long, boring project that doesn't do anything?' She'd rather work at this little company that is doing something innovative where she has autonomy. There's a great Car and Driver magazine article where the writer basically destroys our company for launching a product. He said something along the lines of us pulling this off were as likely as a Sasquatch playing a Stradivarius while riding a unicorn over a double rainbow. So there are people who think that what we're doing is nuts and not very likely. There are a lot of the big folks who have seen us and say well, maybe . . . but they're not interested in the technology. However, in India, I find it interesting that they have shown themselves to be capable of absorbing a real amount of risk for a real amount of reward. We've demonstrated the fuel efficiency that we proposed to offer and we've demonstrated the emissions we purport to offer. We're not kidding ourselves. Our technology is different. We look at our technology warts and all and then we share that warts and all with our potential customers and everyone has a realistic view of what's possible. It's an exciting time now.
I think if you had asked me this question a couple of years ago I would tell you it's really hard and it's difficult to find someone to take on the risk and who wants to do it. But now, we have a great customer, great fuel economy, increasing emission standards, and the fact that we run so lean which enables us to have incredibly low NOx. Pinnacle Engines has carved out a little niche. It's real good now."

The Design Process

For Pinnacle, the design process begins when a customer has a torque and power requirement, and/or a fuel efficiency requirement that must fit into some package representing a vehicle with a specified displacement. From there, Jackson, the VP of Engineering, creates what he calls "an 80 percent solution."

"By himself, Simon damn near creates the whole entire engine architecture," says Joshua. He'll create a camshaft, a crank, and a rod, etc. He whips this stuff up and creates a general architecture for the engine. Is the cam going to be above or below? Where will the ports be located?"

With rough CAD, some masses, and some early valvetrain design, Joshua begins producing forces using Gamma Technologies' GT Suite to create a one-dimensional simulation—a mechanical simulation of the entire valve train. "I'll build it, simulate it, and

pull out those forces" he says, "run FEA on SOLIDWORKS Simulation, then refine CAD on the components that need it, and converge on a design that gives the desired dynamic lift profile."

Joshua also relies on a MATLAB script to narrow down what can be tens of thousands of possible valve spring designs. He specifies wire properties and geometry, spring frequency, the necessary load at installed and full lift, even the cost of materials. Ultimately, he arrives at a solution that works with all the other components, crankcases, and all the other things that define the space: including a Converge CFD combustion simulation, port design, and injector spray pattern—anything that is captured.

"It's really up to the engineers to start working out the details and that's where we get into the feasibility and the engineering issues of SpaceClaim (3D modeling CAD software) and making things work," he says. "It has to be designed for manufacture. The cost has to be low so you have to be careful about your features, materials, etc."

Going over the crankcase assembly of a Porsche 911

And the manufacturing location depends upon the customer. The general intent is that the customer specifies the engine, Pinnacle designs the engine, creates the 3D and 2D documentation to take it into manufacture, and deals with tier one feedback, but the customer ultimately takes that data and mass produces the parts. So essentially, Pinnacle licenses the technology created and becomes the steward of it.

Beginning in SOLIDWORKS

Joshua begins in SOLIDWORKS, creating designs which are close approximations of what he thinks the part will be when it's finished. Because he focuses on valvetrains, Joshua pays close attention to geometry, the locations of things, cam axes, pivot axes, roller follower axes, etc. He then moves into Gamma Technologies GT ISE mechanical simulation. "On my BOXX, I have the software and I'll run this mechanical 1D simulation after spending a lot of time populating the model with material properties and 1D contacts, oil properties, clearances, masses, inertia values, stiffness, etc., I'll then go back into SOLIDWORKS, open up my rocker arm, apply a force to it, pull out a stiffness value, and then put that stiffness into my 1D simulation which helps the 1D simulation predict the dynamic motion of the valve train. We'll use MATLAB to narrow down the field of possible springs, model the springs in the GT software in a number of ways including inputting the actual helix of the springs into the model to help predict dynamics. Then it becomes an iterative process where I'll get a dynamic valve lift profile. I'm looking for valve motion, valve float, and control in the ramps. I'll go back into CAD and say I could lower the forces if I changed the rocker ratio—is that feasible? It's sort of interesting how when you get into engine design it seems like you can do anything, but once you start putting things in position, it about designs itself and you are fighting for millimeters. It gets tight real fast. It's an

iterative process where I'll try to change some geometry, go back, look at the forces, make sure it clears all the other components and again, more FEA with the different components. The good idea in valvetrain design is to get it as light as possible, so I'm always chasing that. Just a lot of optimization circles. My workflow involves a lot of FEA , a lot of CAD, and a lot of 1D simulation."

Accelerating SOLIDWORKS

Since his arrival at Pinnacle Engines in 2010, all Joshua had ever heard (and all he had ever experienced) was terribly slow SOLIDWORKS. "It was such a pain to watch it rebuild," he recalls. "We had these Dell T1600s and we would start developing a pretty complicated engine assembly with each component well-modeled in CAD for manufacture. When we would start rotating it around, it would get clunky. We would always spend a lot of down time as the design phase went on, and you have to interact with the assembly. You can pretend, just do it in lightweight mode so it looks all graphical, but that just isn't good enough. You need to section things and you want to measure things in sections. You want to measure proximity of components. You just have to have it at full weight. We spent a lot of time waiting for the computer to work. We were also setting up some reasonably complex FEAs, press fits, and applying different loads at different cases because we have to work out the fatigue life. FEA takes a while and you're wasting a lot of time waiting for it to chug away."

Raimond's custom designed piston, connecting rod, and wrist pin (DLC coated)

According to Joshua, the real casualty of slow computing was that the design department was unable to focus on nuance. "You don't get the time to do nuanced design if you're just sitting there," he says. "It may not sound like a big deal, but it becomes one when it takes six minutes or more to rebuild and you have to wait six minutes over and over again, day after day. That's just talking about pure rebuild time. There are so many other things happening that are slow and really adding up to wasted time. It kills creativity. You walk away, you go to the kitchen, the computer is working, but you're not. You don't have your head in the game."

To make matters worse, Joshua is the SOLIDWORKS admin, so any time there was a problem, his colleagues would seek him out. "We would spend all this time looking for little ways to speed up SOLIDWORKS," he recalls. "I'd get more RAM, turn off Windows Aero, until I finally thought, 'This is ridiculous. I'm going to figure it out. So I started searching around and finally I came to the conclusion that the rate determining step in SOLIDWORKS is processor speed. There are other things like having a nice fast HD, which is also great, but the number one rate determining step is proc speed. So where was the fastest processor I could get? I knew about overclocking, but thought, that seemed sort of absurd, so I dismissed it at first.

I began looking around at computers with fast processors. I saw a lot of gaming computers, which didn't feel like a good fit. Then I found BOXX. I was sold just based on clock frequency and the fact that you guys were overclocking the APEXX S3 and the build quality seemed really good, very professional. Not that SOLIDWORKS is the sun of your solar system, but I felt like it was one of the big planets. It seemed like you guys were doing a great job of it and could verify your systems for SOLIDWORKS."

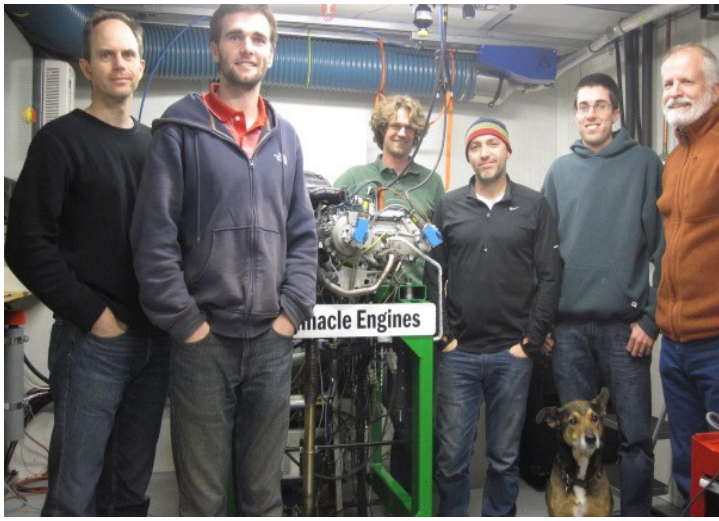
Joshua's next step was to go to the boss. "Yeah, it was a hard sell," he admits, "but I'm a hard salesman. I really just had to put my foot down and say all I hear all the time as the admin are SOLIDWORKS issues." He discussed his findings regarding clock speed and after "a lot of kicking and screaming" received approval for BOXX workstations. He also managed to finagle better graphics cards and 4k monitors that provided ample real estate when looking at large assemblies.

Prior to the new BOXX APEXX workstations, Joshua says that substantial investment in the design department had never been a serious consideration. "We were crippled with the processing time," he says, "but also graphics cards and everybody had two different monitors, etc. The design department is the space between having an idea and making it reality so it was frustrating that we were under-investing in it." Having successfully pleaded his case, Joshua tried to "get the best of everything." He called BOXX and spoke to BOXX MPD Performance Specialist Rich Petit who he says was "fantastic." "Rich was great to talk to," he recalls. "I told him what we were thinking, that we wanted quotes, and he sent them right away. He was flexible regarding whether we wanted this, that, or the other. It felt like I was talking to someone who was genuinely interested in our problems and wanted to help us solve them any way he could. It was reassuring knowing that I was working with someone in the know, who was giving us options, and gave me space to make the decision. He'd give a quote, and I would approach my boss who would ask about something else and I'd circle back to Rich. He always provided the information I needed to make the right decision." Pinnacle was finally sold on the APEXX 2 equipped with NVIDIA Quadro GPUs and SSD drives. He also added dual 4K monitors for each designer.

BOXX APEXX Workstation

Because every BOXX customer story has a happy ending, the conclusion to this one is that Joshua Raimond succeeded in getting Pinnacle Engines' design department up and running on BOXX workstations and everything is running smoothly. "The compliments came so fast, but there was initial hesitation that this would even work," he recalls. "No one really understood what the difference could be. Now no one is going to work on anything else. Wielding large assemblies, running FEA, and doing 1D simulation benefits greatly from having a fast computer, so it's really those background things. Running the actual CAD is trivial. It's everything else that comes from doing a lot of that CAD—that's the main determining step in my workflow. The screen real estate is amazing and makes work easier, while the speed of the BOXX enables us

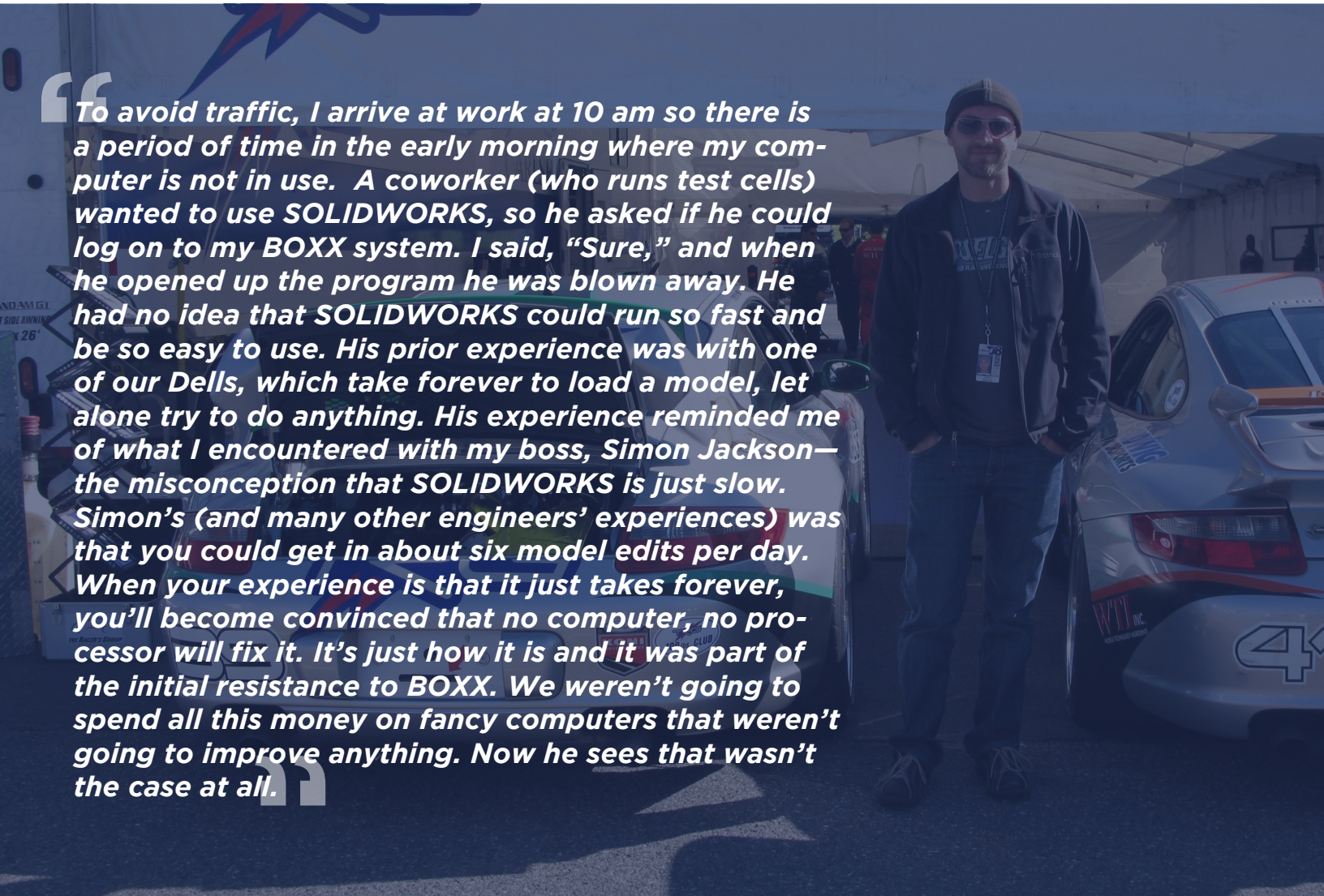
ers to spend time on creativity, not wasting it on rebuild times and other ridiculous things. Simulation goes so much faster. It has just made everything so much nicer. We're better suited to focus on design. There really is a stress that has been lifted off of the designers. No one complains about speed."



As for the future, Raimond says the capacity of the design department, enabled by BOXX, has Pinnacle Engines well-positioned for a long time. But as the company grows and the department expands, Joshua believes that a BOXX workstation will be the first tool a designer would receive. "Make customers happy and you get return customers," Raimond says. "I'd buy another BOXX in a heartbeat." ■

Author's note: As this story went to press, I received this message from Joshua Raimond:

"Turns out I did buy another BOXX in a heartbeat. I now work at a Stealth Space Company designing the architecture and packaging of an entire rocket engine—and the very first thing I did was insure I had a BOXX computer before I did anything."



"To avoid traffic, I arrive at work at 10 am so there is a period of time in the early morning where my computer is not in use. A coworker (who runs test cells) wanted to use SOLIDWORKS, so he asked if he could log on to my BOXX system. I said, "Sure," and when he opened up the program he was blown away. He had no idea that SOLIDWORKS could run so fast and be so easy to use. His prior experience was with one of our Dells, which take forever to load a model, let alone try to do anything. His experience reminded me of what I encountered with my boss, Simon Jackson—the misconception that SOLIDWORKS is just slow. Simon's (and many other engineers' experiences) was that you could get in about six model edits per day. When your experience is that it just takes forever, you'll become convinced that no computer, no processor will fix it. It's just how it is and it was part of the initial resistance to BOXX. We weren't going to spend all this money on fancy computers that weren't going to improve anything. Now he sees that wasn't the case at all."