As you know, titanium is a shy metal that had to be coaxed out of its comfortable hiding place in raw ore. The discoverers knew it was in there and that it might be a very good thing if they could get it out. It has since the early days been a product of reduction. Finding ways of getting rid of what is not titanium.

It’s a lot like coaxing out an idea or an innovation or a manufacturing method. You know it’s in there. And you know it’s good. Through a process of reduction, you get rid of what is not a good idea. You find better ways to get at what is.

Once out, titanium more than justifies the effort it takes to get to it. So far, this is pretty much Wikipedia-level knowledge about titanium, but the rest is a pretty good metaphor for how we think and pursue solutions at TECT. That’s what titanium is to TECT. A solution. If it were just an interesting element and not a precision, strategic solution, I suppose I would be in front of a different group of people at a different conference.

At TECT we adhere to what's known as the value stream, and you'll hear us use that term more frequently than we say “company” or “process” or “manufacture.” Because it is almost impossible to talk about any part that TECT produces without talking about the whole. I want to give you a look at what titanium brings to that whole.
The TECT company timeline starts in 1895. Here’s one of the early solutions in the TECT family history. A 1910 ad for Utica pliers from the Utica Drop Forge & Tool Company. I think these would have been good candidates for our titanium leading edge program, but 1910 was the same year M. A. Hunter was figuring out how to coax titanium out of its hiding place on a commercial level.

When the first turbine engines for aircraft came along in the 1940s, the companies that would become TECT were early providers of critical components, and we have grown that role since.

[SLIDE 3 - TECT Today, with TECT Power and TECT Aerospace logos]
Today, we’re TECT Power and TECT Aerospace. TECT Power grew from the acquisition of the Utica Corporation by UCA Holdings, and later, the acquisition of Turbine Engine Components Textron. In 2004, TECT acquired Tru-Circle Aerospace and Neuvant Inc. to form TECT Aerospace.

We’re a privately held company employing 1,200 across 11 locations, six U.S. states plus Mexico. And built on the assumption that whatever we do will add value for our clients – or it doesn’t fit. We’re wholly owned by Kenneth Glass and family. Mr. Glass, to put it as mildly as I can, is an aviation enthusiast with a keen interest in aerospace. Enthusiasm does not overwhelm strategy. We’ve grown by acquiring companies, some of which were performing well when we got them, others not performing very well. Every one of them with something of value inside them, waiting to be coaxed out. Every one of them – just like our materials, our technology and our people – here to add value to what we create. I’m going to talk about how titanium fits.
At TECT Power we manufacture critical rotating components for turbine engines for aviation, aerospace and defense, and industrial applications that have similar engineering and quality requirements, such as power generation, mechanical drive and marine propulsion, and the medical industry.

Here’s a compact view of TECT Power, as seen through the engine parts we provide: components for the turbine engine fan, compressor, turbine, blades and leading edges for those blades, where titanium is a key element.

To broadly describe TECT Aerospace, we manufacture structural and mechanical components and assemblies for commercial, military, business, and general aviation aircraft.

We create forged and machined parts and major assemblies from the cockpit to the tail and every section of the airplane in between. Doors, landing gear, struts and nacelle, fuselage, interior, wing and flight controls.
These are the companies we provide solutions to:

**[SLIDE 8 - TECT client companies color logos]**


How do I put this in technical terms? These guys use a LOT of titanium.

**[SLIDE 9 - Titanium composition of airliners]**

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[Source: http://www.radical-departures.net/articles/titanium-market-report]

I think it's interesting that when you see today's advanced aircraft overhead, you're looking at tons of titanium – replacing nearly twice as many tons of steel and other material.
For these companies and the operators that are their clients, the solution is lower operating costs. At the very top of that list is lower fuel burn, however you can get there. The solution for these concerns are lower weight and longer life of parts service. Our solution for that is titanium, plus our process.

Let’s drill into that topic of using titanium to lower weight and operating costs. Keep in mind that I’m sweeping very broadly over the TECT universe of products here. You’ll find titanium at key points in every part of it. So, I’ll focus on a few.

[SLIDE 10 - Blisks/IBRs]

For example, we’re specialists in critical rotating components such as impellers and blisks – or integrally bladed rotors (IBR) – that have to be machined from a solid piece of hard metal, like titanium.

If weight reduction in every part of an airplane is crucial. Well, just add high-speed rotation to the equation and it’s critical. The complexity multiplies. So, the industry relies more and more on advances in multiaxis machining, for example, as we do. Then at some point you say, “You know what? We need to make our own machines and write our own software to solve the complexity and best serve the value stream.” I’ve just described our process in a microcosm.

[SLIDE 11 - The strongest link in the chain]

That’s the weight-advantage story for titanium in aviation, aerospace and defense. On the strength side, I’m going to zoom in on a single TECT Aerospace example, out of dozens, where titanium is the strongest link in a critical assembly:

[SLIDE 12 - Engine Mount]

TECT Aerospace supplies engine mounts and associated parts and assemblies. Hard-metal machining produces these components, like this engine mount, which attach the engine pylons to the wing or fuselage. For these obviously critical components, we
machine titanium for close-tolerance strut attach fittings, engine pylon attach brackets and pylon brackets.

We’ve developed our own machining cells to make this production practical. We don’t look at automation and robotics as virtues in themselves, just simply to be adopted wholesale. Instead, complex production with hard metal puts special demands on in-feed, forging and cutting. This is one place where the relationship between TECT Power and TECT Aerospace is especially evident: We partner to manufacture the intricate titanium forgings for these pieces, which ensure the load and stress developed by the engine is effectively spread through the pylon to the wing or fuselage.

You begin to see the shape of our value-stream model here. It involves the processes, the supply chain, right down to the cutting head – should we make our own multifluted cutting head, for example?

Here are the demands and the rewards of this particular material in our operation:

**[SLIDE 13 - Demands and rewards in our Ti process]**

**[SLIDE 14 - Demands and rewards in our Ti process]**

**[SLIDE BULLETS]**

- Predictive simulation software
- Die treatment
- Milling (line and trochoidal)
- Forging and machining concepts
- Cutting and cooling
- Tool evolution (vibration)
- Adaptive milling and probing, e.g., measuring inside the machine

The demands of this essential – and very HARD – metal ripple through the production process. We’ve had to adapt and often invent solutions for optimum work flow, highest quality and longest life of the titanium part. Here’s what titanium asks of us and what it brings in return:
We use forging simulation software to evaluate dies and predict metal flow, all in order to drive forging toward zero defects. Treating the die surface gives the die a longer life and the part a more finished surface coming out of the forge. Titanium has prompted automated chemical milling and innovative trochoidal machining. And it puts special demands on cutting and cooling, requiring special tools, better methods for clearing away debris, higher-pressure cooling, and lower vibration in the machining. Titanium’s practically created its own cottage industry inside TECT to solve for its demands on the machines. It’s led us to very interesting methods of adaptive milling and in-process inspection of the forging. That is, measuring and surface probing the part while it’s in the machine. Very important in our patented titanium process, as you’ll see.

[SLIDE 15 - Titanium rewards the effort, drop-down bullet points]

[SLIDE BULLETS]
Longer life of tools and parts manufactured
More material removed more quickly
Fewer defects
Automatic deburring, eliminating human process

Of course, the big reward is that you have the weight and strength advantage of a titanium part answering the need. There are also rewards to the process and the economy of production, and ultimately in the value returned to the client.

The benefits of investing in technology and adjusting the value-stream to answer the demands of titanium practically describe themselves. Tools last longer. Parts can see longer service life. Cycle times are cut. Waste is cut. Parts are forged not just with few defects, but with surfaces that are much closer to finished right out of the forge. I’ll venture to say that the days are numbered for the old deburring shop. Automatic deburring is part of the overall trend toward removing human time and error from production.

[SLIDE 16 - Titanium Leading Edge – with fan blades]
Titanium is literally the leading edge in one of our key programs. We’re talking about the part of the fan blade known both as the leading edge sheath and metal leading edge (MLE). We’ll just say “leading edge” or “LE.”

While representative of our process and innovation, and importantly, our integration of titanium, the leading-edge solution for turbine fan blades has very broad application. For one, it shows how well titanium integrates with other materials. More and more, that means composites, especially in aerospace.

[SLIDE 17 - TECT PowerForm® with blade edge photo, brush out PowerEdge on art]

[SLIDE BULLETS]
Automated and controlled for near-perfect leading-edge profile
Increases engine efficiency
Consistency along entire edge, beyond specifications to design intent

TECT PowerForm® is the name we give to a patented process to forge and machine titanium leading edges that protect composite fan blades. The goals are greater precision and efficiency in forming this edge. Ultimately, the use of titanium results in a more efficient engine, because, again, it’s stronger and lighter weight. But the truly interesting and unique characteristic of the leading edge is its consistency all along the blade edge, not just at measurement points. So the bar is raised. Now we reach toward the intent of the design, rather than minimum specs.

[SLIDE TECT 18 - Leading edge PowerForm® with patent page]

Here’s how that’s done for the titanium leading edge. The patented part of the process, to put it simply, is the opening and closing of the blade edge. In technical terms, we manipulate the geometry of the part. The cutter moves through the opened leading edge – or sheath – and it’s followed by high-pressure mechanized coolant to evacuate the part in-process. So, straight out of the cutting process, the leading edge is ready to be closed on the blade by what’s called “creep forming.”
There are challenges in manipulating the titanium edge in this way. For one, inspection of the pieces, especially the internal contour, is critical and has to be done on the part while it’s in the machine. Also critical: control of the thickness of these thin side walls and the geometry of the internal cavity. Modifying the opening of the part during the process lets us use larger, stiffer angle cutters for this very small cavity inside.

[SLIDE 19 - The advantages of titanium leading edge]

[SLIDE BULLETS]
More stable part
Better surface finish
Closer tolerances
Consistency and less scrap
Faster cycle
Removal of setup time
Thin wall thickness control
Less distortion in the process
Creep forming results in low free-state distortion

The titanium leading edge results in a very stable part for the stress conditions that are magnified by high-speed rotation. When you’re starting with smaller machine stock to begin with, and all along the way staying closer to the finished part, you’re going to see a shorter cycle, less waste, and better control. When there’s less heat stress and less distortion in the making of the part, there’s less free state distortion.

[SLIDE 20 - The process is as important as the machine]

Obviously, we employ many other processes and many materials at TECT. But you might get the idea from the ones I’ve described, like the LE program, that titanium has a way of raising the stakes. Greater challenges, greater rewards. And absolutely necessary to our being competitive in our industries.

You could say that the process is as important as the machine. Take LE, for example. It’s a particular area of application, but it hardly confines us to fan blades and aerospace – because the processes and value stream are universal in application. Ultimate control
over the critical hard metals machining process is achieved by weaving capabilities into
the supply chain. High-speed machining gets even faster and more practical when you
start closer to the finished part, add speed and cut waste. Providing oversized and
hybrid forging of complex shapes and closed-die forging – all of these concepts we’ve
refined in aerospace, have us looking forward to a much larger titanium picture ...

[SLIDE 21 - Titanium, looking forward]

... and what do we see? Internationally, titanium demand will double in many key
industrial countries. The Russia Federation, China and Japan are predictable in this
consumption. TECT is looking at major development in the near term in key Asian
markets, notably India and Malaysia.

The word “new” in aerospace language translates to “titanium.” We’re talking about a lot
of brand-new aircraft, new aerospace ventures and defense development by people who
were not big players until recent years.

The commercial airline fleet is full of 20-year-old airplanes, and the airlines are
positioned to upgrade by an estimated 34,000 aircraft in the next couple of decades. So,
titanium demand in aerospace alone should reach nearly 80,000 tons in the next three
years. The operating cost factor is going to continue to be in the captain’s chair. That’s a
prediction I’m willing to carve in titanium.

While carbon fiber reinforced polymer – composites – are contending with titanium,
many CFRPs share titanium’s thermal expansion rates and titanium as a composite
interface material is highly desirable. Industry analysts say – and our own leading edge
program tells us – increased use of composites should also apply to titanium.

There are markets that have been part of the popular imagination for some time, that
industrially we’ve only gotten a glimpse of, such as alternative energy. We think of wind
energy as new, but it’s old enough that retrofitting very large, very expensive wind
turbines and blades with durable, lightweight titanium could be a significant potential
market. Addressing emerging markets, technologies and needs will have as much to do
with process as material. Manufacturing processes and supply chain philosophy are
inseparable from TECT titanium use. Again, if you have the process and the supply chain, it’s scalable. You can make big parts for a niche market.

We’re all going to see processes overall that reduce human error and interference in the use of the material. This will be industry-wide, globally sought-after.

Extracting more titanium, more quickly and economically is a perennial topic of ITA member body as it is at TECT. The evolution of volume titanium production will be key. Getting enough titanium at a viable cost.

We foresee harder titanium alloys, and we’ll all be addressing the increased difficulty in machining.

[SLIDE 22 - TECT strategies for the future]

TECT’s own strategies for the future are very generally this:

[SLIDE 23 - Working the product]

In working the product itself, you’ll see us develop more customized programs, like LE, that measure and adapt to the condition on the machine. Making our own machines and writing our own software have justified the strategy, so we’ll continue to develop smart machining. We’ll continue to improve technology of billet cutting and increasingly, we’ll provide products that simply don’t need polishing and deburring coming right off the line.

[SLIDE 24 - Refining the value stream]

As we’ve always done, we’ll add strategic capabilities through acquisition, including technical niche acquisitions. Our customers will see completely integrated supply chain solutions, including off-shore/low-cost manufacturing where appropriate. We’ll minimalize error and waste, reducing the human factor, while valuing the human contribution. By that, I mean drive and ingenuity.
Clearly, we’re talking more broadly about TECT than our titanium use right now. But think of all the examples I’ve shown where titanium has driven us to create new processes, to build our company and to put more people to work. How has it coaxed the best from us. If you can have a partnership with a metal, I think this is it.

And I’ll leave you with this metaphor for the titanium-reliant future we all have in common. Look at element 22 on a molecular level. Its crystalline structure packs as much substance into as economical a space as possible. It’s nature’s model of efficiency. Strong, tough, light and adaptable. This should also describe every company that will thrive by employing it. To find a model for the future, where better to look than to titanium itself?

Thank you.

[SLIDE 25 - TECT & Ti]
Emerging Process Technologies for Titanium Aerospace Components
TECT Origins

The Ladies' Home Journal for May 1910

Buy Him the Tool of a Hundred Uses—Help the Poor Man!

Don't let him try to break picture wire with his fingers or cut it with scissors. You can show him how to hang pictures, also how to cut wire, twine, cord, pull tacks from carpet, fix the water faucet, and do many things around the house if you buy a pair of Utica Pliers.

He will appreciate them more than any other tools in the house.

The next time you go to your Hardware or Supply Store, be sure to get UTICA PLIERS. Cutting edges are tempered. Jaws are strong and the handles are scientifically shaped to give great leverage power and not injure or tire the most sensitive hand.

We want YOU to appreciate the various uses of a pair of UTICA PLIERS in the home. You may be called upon to fix something yourself before you can locate a man to do it for you. A pair of UTICA PLIERS will solve the problem. They are as adaptable as your fingers and have strength that enables you to do things.

Ask your dealer to show you No. 708 UTICA PLIERS for general household use. It costs at dealers, 15 cents extra for postage from us. There are many different sizes of UTICA PLIERS. If your dealer cannot show you the one you want, write us and we will see that you are supplied. Use a pair of UTICA PLIERS three times, and if you are not satisfied with your investments, mail them to us and we will refund your money.

Utica Drop Forge & Tool Co., Dept. A, Utica, N.Y.
TECT Today

- 1,200 employees
- 11 locations
- 6 U.S. states plus Mexico
This is TECT Power

- Aerospace and defense gas turbine and structural components
- Industrial (power generation, mechanical drive, marine propulsion)
- Medical forged components
Titanium composition of a few aircraft we provide for:

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