World Industry Demand Trends Panel: October 8th 8:15 a.m.
Moderator: Michael G. Metz, - President, VSMPO Tirus US

World Industry Demand Trends
Dawne S. Hickton, CEO/Vice Chairman - RTI International Metals, Inc.
Ms. Hickton will provide insight and analysis of world industry demand trends as it relates to military and commercial airframes. We are in an exciting time of explosive long-term demand growth for titanium in most of our major markets, of which airframe applications lead the way. The presentation will explore the driving factors behind titanium consumption in airframes as well as provide a forecast of future demand.
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Thomas E. Williams Jr., President - ATI Allvac
Demand for jet engines is governed by the demand for commercial and military aircraft. Titanium is used extensively in jet engines for its excellent mechanical properties, ease of fabrication, and light weight. The forecast for titanium consumption in jet engines continues to grow achieving record shipment levels. This presentation discusses what drives the commercial and military aircraft markets, the forecast for jet engine deliveries, and the impact on the demand for titanium.
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Charles H. Entrekin, President & Chief Operating Officer - Titanium Metals Corporation
Dr. Entrekin will discuss how the changing threats around the world have forced militaries to reevaluate the deployability and survivability of their forces. Specifically in regards to how it has lead to an emergence of new and existing programs utilizing titanium. A brief look at the future of US and European militaries will be provided to postulate on their acceptance of titanium.
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Carl R. Moulton, President - Uniti Titanium
The Titanium Industry has experienced another record year and received much publicity for major new aerospace and military applications. Nearly half of the total titanium shipments are not for aerospace. This part of the market is referred to as the Industrial Market. It too has been growing dramatically over the last four years. This presentation will outline the growth to date by market and product and will attempt to forecast what's to be expected in future years for the Industrial Market.
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Wang Hanchen, Board Chairman - Baoti Group Ltd.
2006 is the year that China titanium industry keep on fast growth. The paper introduces the production capacity of titanium sponge and mill products, the main producers' output of titanium material in 2006. It gives detail report on the market distribution as well as the total market demand in China for titanium sponge and the mill products. The paper also gives some report on the new inversments plan in China's main titanium sponge producers like Zunyi and Fushun, the statistic data on the titanium mill products including the technical and equipments improvements.
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Masatoshi Adachi, Senior Vice President - Sumitomo Corporation of America
Enabling Technology, Enabling Future
Japan has been committed Titanium mainly for industrial sector with use of commercially pure. Taking advantage of high level of technology and cost effective operation of Japanese steel mills, we apply those advantages to make Titanium flat rolled products better and cost efficiently.

Reviewing for past records, not only relying on to traditional demands, we have kept on working new application developments years and years.

The extensive use of composite materials on new commercial airframes has resulted in the use of unprecedented quantities of titanium in sections of the airframe that traditionally would have been aluminum.

Those enabling technology will make us enabling future. The majority of titanium will likely to continue to be Ti-6Al-4V but new alloys may be able to offer improvements in the productivity and/or performance of the titanium products on composite-intensive air flames.

We have excellent production base from sponges to mill products and good technology especially alloy development in Japan. Someday in near future, Japanese titanium industry may contribute more for global supply chain.
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Michael G. Metz, President - VSMPO Tirus US
World Industry Trends Summary
Mr. Metz will provide a world market overview for titanium shipments, global consumption and major market drivers. Presentation will also include general comments on the current state of the titanium market and its future.
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Distinguished Luncheon Speaker:
Monday, October 8th - 11:30 am
Doug Lipp

Doug Lipp, the former head of training at Walt Disney University, is an internationally-acclaimed expert on customer service, leadership, and diversity. He is the author of six books, including his most recent, The Changing Face of Today's Customer, which proclaims the use of "cultural sense" in addition to common sense.

Lipp reflects on his years at Disney and examines how the corporate culture there evolved from arrogant and self-satisfied to bold and innovative. A former instructor of Disney's highly regarded "Traditions" orientation program, he explains how to equate great leadership with great customer service and advises companies to think globally.

Military Panel: October 8th 2:00 p.m.
Moderator: Gus Gustin, Director Sales, Military Land Systems and Marine - TIMET

Craig Musson, P&W
Pratt & Whitney designs, manufactures, and services gas turbine and rocket engines for the aerospace, industrial, and outerspace markets. An overview of Pratt & Whitney's use of titanium in its engines both historical and proposed for the future will be provided. In addition, Pratt & Whitney's insight into the commercial, military, industrial, and space markets for the future will be discussed.
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Gerard (Jeff) Mercier, Carderock Division Naval Surface Warfare Center
Titanium for Naval Applications
The physical, mechanical and corrosion properties of titanium favorably impact current U.S. Navy ship design requirements for increased reliability with reduced maintenance, reduced weight, and shock integrity. Based on the excellent erosion-corrosion properties of titanium, commercially pure grades are used extensively for seawater pumps, cooling and piping applications on surface ships and for a number of seawater system components on submarines. For applications where higher strength is

required, titanium alloys Ti-3Al-2.5V, Ti-5111 and Ti-6Al-4V ELI are used for optimum toughness, weldability, and seawater stress corrosion cracking resistance.

This presentation will describe the advantages of titanium in ship applications and the obstacles to increased usage. A brief overview of the Navy's historical R&D efforts and systems where the use of titanium is service proven will also be discussed. Current and planned titanium R&D to characterize the fracture toughness of the Ti-5111 alloy under dynamic conditions in structural and fastener applications will be explained. Finally, a project focused on the reduction of titanium product cost in piping applications is underway. The plans and initial results of this project will be covered.
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Al McCormack, GKN Aerospace
Overview of military airframe forecasted production rates and the demand these structures have on global aerospace titanium production. Topics to be discussed are large and medium transports, manned and unmanned fighters and rotorcraft.
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Bill Gooch, Aberdeen Proving Grounds
The Design and Application of Titanium Alloys to U.S. Army Platforms
Titanium alloys have long been used for reducing system weight in airframe structure and jet engine components. The high cost of titanium, however, has historically prevented the application to military ground vehicles. In recent years, the cost of titanium has fallen relative to the cost of composite and ceramic armors and titanium is now a valid option for some Army applications, whether for weight reduction or improved ballistic performance. The distinct advantages of low density, high strength, a large competitive industrial base, and well established forming and shaping techniques establishes titanium as an excellent material for many military applications. The U.S. Army Research Laboratory has invested significant research efforts in understanding the material processing requirements for ground versus aerospace applications and this paper will provide an overview of that research. A major concurrent effort has been the amending existing military specifications to allow the use of lower cost, higher oxygen content titanium alloys that meet specific ground applications. The paper will end with a review of some of the current applications of titanium in use worldwide.
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Automotive Panel: October 8th 2:00 p.m.
Moderator: Paul Bania, General Manager, - TiPro

L. Wagner, Institute of Materials Science and Engineering
Status on Titanium and Ti Alloys in Auto Applications
Over the past 4 years R&D for potential ti auto applications has made goo dprogress. New applications have been introduced and existent applications have been improved through new alloys and manufacturing technologies. Today titanium definately is established in automotive constructions, at least in the niche car segment. Since the end of the 90's a number of models have been available on the market permanently with various components made of titanium and ti alloys.

Nevertheless, it has to be stated that no advancement of more cost efficient ti production-processes has been made preferably dedicated to automotive applications. In addition no scenario shows any realistic perspective for a change. Even worse the drastic worldwide demand for ti has caused a price increase that contradicts nearly any use of ti even for cars in the top price segment. Considering further price increases the research departments of many automotive companies do already focus on alternatives to titanium.

A number of new cars have been introduced to the market since 2003 incorporating titanium applications. All these applications are focusing to the high end market, mainly on super sports cars such as Porsche Carrera GT and Corvette Z06 (ti connecting rods), Koenigsegg (connecting rods and exhaust system) and Bugatti Veyron (various applications). The latter is a good example for all imaginable ti applications like connecting rods, exhaust, bolts, brake bells, suspension springs etc. These

cars & applications demonstrate once more the potential of titanium as a contribution for weight reduction, performance improvement and corrosion resistance.
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Kyo Takahashi, Honda R&D
Trend of Titanium Parts for Motorcycles
Light, strong titanium for racing machines has been of special interest ever since it was discovered and much research has been performed as it was expected to improve the performance of the internal combustion engine. As a result, Honda started to apply titanium for race usage domestically since the 1960's. Based on this racing technology, we developed low cost alloy and surface treatment technology and applied it to mass production motorcycles. Titanium connecting rods of Ti6Al4V that uses scrap material was applied to mass production motorcycles by Honda in 1987 followed by titanium valves and exhaust system? that utilizes off grade sponge titanium in 2002. However, high material cost and manufacturing difficulties have limited titanium part development. Motorcycle manufacturers have made an effort to resolve these problems. To reduce the raw material cost, many methods are used such as recycling scrap, using off-grade sponge, substituting a low cost element for a conventional element, and so on. Generally, titanium parts are manufactured by facilities that primarily produce steel parts. So, the difference in properties between steel and titanium creates many problems for the manufacturer. We have overcome these difficulties by the accumulation of experience and Know-How. These developments intend to make titanium a commercial material comparable to current steel materials
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Hideki Fujii, Nippon Steel Corporation
Automotive Applications of Nippon Steel's Titanium
Over the recent several years, Nippon Steel made an extensive effort to apply titanium and its alloys for automotive parts, and considerable amount of our products are now successfully used in four-wheeled vehicles and motorcycles. In this presentation, some of our technological breakthroughs which have been attained in cooperation with our customers and have contributed to the expansion of this emerging market are introduced : More than 1,500 tons of CP titanium a year (20% annual growth rate) is now used for exhaust systems to respond to tightened exhaust controls, and newly developed Ti-1Cu and Ti-1Cu-0.5Nb alloys having excellent high temperature performances and formability are now rapidly enlarging the application range. Both intake and exhaust engine valves made of conventional titanium alloys are fully used in quite a lot of motorcycles by optimizing the valve manufacturing processes to extract their best performances. To further enhance the use of titanium in automobiles, new low-cost and/or high-performance alloys have been developed. In addition, to realize clean hydrogen societies through the reduction of CO_2 gas emission in the near future, Nippon Steel is also challenging the hydrogen-related technologies including fuel cell vehicles. Some of our activities in this field will also be presented.
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Energy & Mining Panel: October 8th 3:45 p.m.
Moderator: Pat Boster - RTI Energy Systems

Murray Pearson, HATCH

The use of titanium and titanium alloys in the pressure hydrometallurgy sector with examples of corrosion resistant applications, the service conditions, and history of it's successes and failures will be presented
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Russell Kane, Honeywell Process Solutions
Titanium Alloys for High Pressure, High Temperature Wells
Petroleum developments are trending to deeper, high-pressure and high-temperature (HPHT) wells. Potential HPHT well design limitations exist due to combinations of depth and high pressure and temperatures. Honeywell is conducting a Joint Industry

Project (JIP). The JIP group includes both oil companies and suppliers of titanium. Sponsored work includes studies on corrosion and additional testing of titanium alloys for down-hole tubular goods, and equipment in HPHT wells. This presentation will be an overview of the JIP.
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Steven Shademan, BP America
Titanium ~ A Solution for Deepwater High Temperature High Pressure Applications
Energy company ultra deep-water projects include challenges of increasing drilling depths beyond 25,000 ft. Certain envelopes are characterized as being High Pressure High Temperature (HPHT), and include corrosive media requiring high strength lightweight corrosion resistant materials such as titanium. This presentation will review these High Pressure High Temperature (HPHT) applications and material requirements
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Craig Thomas, High Performance Tube, Inc.
The Application of Titanium in Direct Seawater Cooled LNG Plants
LNG is the fastest growing sector of the energy market with over 60 new projects currently in planning, design, or construction. The majority of liquefaction trains in operation today utilize a direct method of seawater cooling for the main shell and tube heat exchangers, including the refrigerant condenser, sub-cooler and compressor coolers. While direct seawater is typically the most efficient and least expensive means of heat rejection, it brings increased challenges in terms of reliability, and maintainability when compared to alternative methods. The lessons learned from 40 years of seawater cooled LNG plant experience serve to highlight the unique value of titanium, which can dramatically reduces the cost of maintenance and down time. First introduced 18 years ago as part of a retrofit solution, titanium is now the specified standard for grassroots plants. New heat exchanger technologies such as anti-vibration baffle supports and extended surface tubing have further improved the reliability, performance and cost effectiveness of titanium for LNG plant service.
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Commercial Aerospace Panel: October 8th 3:45 p.m.
Moderator: Wade Leach - ATI Allvac

Rod Boyer, Boeing Commercial Airplanes
The Boeing Perspective on Titanium Development
The titanium situation has changed dramatically in the last few years, with prices increasing dramatically and lead times stretching out. The primary focus is to reduce cost. The primary focus for achieving this has been reducing the buy to fly ratio. This reduces the amount of material purchased, which also helps mitigate titanium shortages, and the amount of machining required. This involves the development of technologies such as nearer-net forgings, more extensive use of extrusions, rolled shapes, welding, and single melt products. There are also ongoing efforts to improve performance involving higher strength alloys, hydraulic tubing and high strength castings. While future aircraft may not have as much titanium as the 787, it appears that they will continue to use more than prior aircraft, so titanium demand should remain high in the aerospace sector.
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Shinya Ishigai, Kobe Steel. Ltd.
Activities of Kobe Steel for Aerospace Applications of Titanium Alloys
Kobe Steel has been manufacturing titanium alloy forgings for aero-engines since early 70's. In commercial aero-engine field, we started to develop manufacturing processes of Ti-6Al-4V large ring and LPC disc forgings for IAE V2500 engine in middle 80's. Under recent situation of strong demand for titanium alloys in commercial airplanes, we have made effort to develop advanced manufacturing technologies to produce valuable disc forgings and near net shape rolled rings continuously.
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Pierre Herron, Pratt & Whitney Canada
Market Trends in Business and Regional Aircraft, and Helicopters
Pratt & Whitney Canada (P&WC) is an active participant in the Turboprop, Turbofan and Turboshaft jet engine markets, all segments that are all currently experiencing strong growth.

The usage of titanium has increased in the more recent PW&C engine designs, with the benefits of titanium being challenged by recent higher costs and longer lead times relative to competing materials. The achievement of cost reduction in titanium in the future is necessary to enable its usage to continue its growth in aerospace applications where its properties are highly valued.

This presentation will give P&WC's perspective on the market trends for business and regional aircraft, and helicopters. In addition, this presentation will discuss the development of the Very Light Jet (VLJ) market, a segment being watched closely by the entire business jet industry, and where P&WC has secured a strong position with its PW600 series of engines.

Pratt & Whitney Canada (P&WC), based in Longueuil, Quebec, is a world leader in aviation engines powering business and regional aircraft, and helicopters. P&WC's operations and service network span the globe. We power the largest fleet of business and regional aircraft and helicopters – 40,000 engines in more than 190 countries. We employ 10,000 people around the world including 7,000 in Canada. P&WC is a subsidiary of United Technologies Corporation (NYSE: UTX), a high-technology company based in Hartford, Connecticut.
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John Fanning, TIMET
Titanium Development for Commercial Airframes
As exemplified by the Boeing 787, the usage of titanium on new commercial airframe programs has significantly increased over the past several years. This presentation will discuss various development efforts to support existing and future titanium needs, including alloys with improved machinability (TIMETAL 54M), near-net shape profiles, and more flexible manufacturing routes. The processing and properties of new high strength alloys (such as Ti–5Al–5V–5Mo–3Cr) will also be discussed.
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Opening Keynote Speaker: Tuesday, October 9th - 8:00 a.m.
John Polites, Manager of Materials Cost Productivity for GE

John is currently the leader for Technical Sourcing in GE Aviation focusing on Material Cost Productivity. He began his GE career in 1980 with GE - Aviation in Lynn, Mass., until 1988, when he moved to Evendale, OH as a project engineer in Commercial Engines. John continued taking roles with increasing engineering and management responsibility, working on a variety of engine lines including CFM56, GE90 and GP7000. John then took a role with GE Corporate Research and Development as the Aircraft Engines Programs manager in 1997. He came back to Aviation in 1999 as the Global Engineering Manager establishing sites in India, Mexico and Poland. His most recent assignment prior to Sourcing was the Engineering leader of the Engine Alliance GP7277, a joint venture with Pratt & Whitney.

World Industry Supply Trends Panel: October 8th 9:30 a.m.
Moderator: Sylvain Gehler, Managing Director - Specialty Metals Company

Sylvain Gehler, Managing Director - Specialty Metals Company
Titanium Sponge Production in Kazakhstan, Russia, and Ukraine

Mr Gehler will review Titanium ilmenite mining and sponge production in Ukraine, Russia, and Kazakhstan. The speaker will forecast titanium sponge production in these countries, with particular attention paid to any capital investment planned, such as down stream operations, that would change the availability of titanium sponge in the world market from these countries.
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Henry S. Seiner, TIMET
How are we Positioned for the Future?
For the past several years, the titanium raw materials market has been upside down. Driven by both external market forces and internal industry dynamics, supply and demand have interacted such that lower pedigree and more difficult to use raw materials have often been costlier than higher pedigreed and more flexible materials.

As 2007 progresses, the titanium raw materials world seems to be righting itself. Increasing sponge supply, increasing scrap generation and developments in external markets are allowing more "normal" conditions to evolve.

In addition to analyzing historical sources of supply and examining capacity increases, this presentation will consider several demand scenarios and contemplate future market conditions over the next decade. Players throughout the titanium supply chain are jostling for position including both forward and backward integration in addition to consolidation.

Projecting supply into the future is difficult with many announcements and potential new entrants into the market. But projecting demand for titanium raw materials is even more difficult. This presentation will examine the supply chain along with the demand sensitivities and attempt to draw some conclusions regarding the future.
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Furkhat Faizulla, Advanced Material Japan Corporation
China Titanium Metal Import and Export Trends
The economy of China keeps on growing as usual. The demand for titanium mill products and equipments in chemical engineering, power engineering and non-ferrous metallurgical facilities is strong in China. The Chinese titanium industry was developed at a much higher pace in total and boosted by the shortage of supply especially in last two years. At the mean time, they begin to involve in world market more then before. This trend will continue and its influence will strengthen for no doubt.

In 2006, China's total titanium export volume reached 9121mt, import was 8220mt, altogether 17,341mt. This is a near 30% increase compared with the level of 2005. First time in the history China has become a net sponge exporting country and this trend pretty much looks like to be continuing. For mill products, in 2006, it was still a net importing country but the amount is relatively decreased obviously. It's quite certain that in near coming years, China will be a net mill products exporting country too.

If we look into details, China is still weak in thinner sheet and welded tube production and mainly relying on importing but this is going to be changed in coming few years without doubt due to some on-going new related production projects in China.

So far, main importing source of sponge, ingot and slab is Ukraine, the export destination of sponge is USA, EU, Korea and Taiwan, but it is sure Japan will be added up to this list soon. Main source of scrap is Kyrgyzstan, Russia and Kazakhstan because of Chinese government favorable import tax rate with bordering countries. The main destination of export is UAS and UK; this map may not go to change for a while. China's total production of sponge and mill production will continually go up driven by domestic stronger needs. At the same time, manufacturers may look for foreign markets as well in order to have balanced sales.

Raw materials, energy and environment cost increase may slower the price of the sponge and mill products falling down further but Chinese manufacturers will manage to keep their products at a competitive price level anyhow as we have experienced in other metal industries. No doubt, China titanium industries will continually strengthen its influences in global market by increasing its export as well as import.
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David E Moore, David McCoy - TZ Minerals International Pty Ltd.

Trends In Supply Of Feedstocks For The Kroll Process

Historically, titanium sponge has supplied over 3% of the demand for titanium minerals. The industry is underpinned by the demand for TiO2 pigment, now a US$10 billion industry, showing a long term growth rate of around 3% p.a.

The recent surge in growth of titanium sponge production has brought increased focus on the most suitable feedstocks for the Kroll process. These sources included ilmenite for slag production by the molten salt process and for high TiO2 feedstocks such as rutile, synthetic rutile and upgraded slag in chlorinators, similar to those used in production of pigment by the chloride process.

Aspects discussed include supply sources and availability, quality, historical and current pricing trends plus the future outlook to 2015, which may encompass other feedstocks for new technologies under evaluation.

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James W. Robison, Jr, and Scott M. Hawkins, Reading Alloys, Inc.

The Relationship between Composition and Density in Binary Master Alloys for Titanium

Each year we field several calls from consumers of master alloys asking how they can estimate the density of master alloys. Common approaches are weighted averages of elemental densities and mole-fraction averaging. As several lower-density titanium alloys are showing growth, there is accompanying interest in master alloys with lower density and often lower melting ranges. To address these issues, in this paper we examine the variation of measured densities as a function of composition for Al-V, Al-Cr, Al-Mo and Al-Nb alloys across the entire range of possible composition. We also compare the “estimated densities” obtained by the above approximations, and the composition-liquidus curve for each of the four binaries. It is hoped this information will be useful to the titanium industry.

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Bob Bunting, STRATCOR, Inc.

Vanadium

Vanadium is a critical metal in the production of titanium alloys. It has recently experienced record price levels as a direct result of a massive imbalance between worldwide supply and worldwide demand.

This presentation analyses the reasons for this supply/demand imbalance. Historical sources of supply are described and future potential sourcing is also reviewed. Current production capacity by source is also listed as is the potential for future increases in capacity and production.

The reasons behind the recent surge on worldwide consumption are also described, and future prospects for demand are analyzed.

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Jerry Faitelson, Goldman Titanium Co.

The Titanium Scrap Market and the Marketplace

The titanium scrap market has always exhibited a unique, complex interdependence with a variety of international and domestic factors, an interdependence that has caught many in the industry by surprise over the past few years. Extreme fluctuations in prices and production lead-times have characterized the industry during this time. Demands of the aerospace, auto, fuel, desalinization, and forging industries have influenced the titanium scrap industry in supply and demand situations that are easy to identify. At a more complex level, the titanium scrap industry has been newly effected by the influx of sponge or raw materials that compete with recycled materials, by advances in technologies that have created demand for composite materials, and by the political situations and business exchanges with countries such as Russia, China, and Japan. The delayed production of a new line of aircraft caused dedicated materials to enter the open market, bringing prices down. The emotional marketplace has had its place in the past few years too, with customers reaching to over-supply themselves with titanium product in reaction to perceived future price increases and shortages. Other customers have elected to arrange for the processing of their own scrap towards future production needs rather than sell their scrap on the open market. This is a discussion of how fluid, ongoing market forces and single events have effected the titanium scrap market in the past few years,

with some consideration of how current factors and trends may effect the future.
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Industrial Panel: October 9th 2:00 p.m.
Moderator: Markus Holz, Managing Director - ThyssenKrupp Titanium GmbH

Ingegard Burling, Alfa Laval Group
Why Plate Heat Exchangers and why in Titanium – today and tomorrow
The Plate Heat exchanger market has a wide base due to its features. The Industrial Titanium market is strengthening its position by developing different segment like the Plate Heat Exchanger market, that has both a stable growth over time and a demand on quality and other performance parameters.

Alfa Laval, one of the major companies producing Plate Heat Exchangers in Titanium, wants to see the business continue to grow by our own efforts in R&D, Production, Marketing and Sales, but also by the Titanium Industry's ability to meet our demands.
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Frank McGorty, ELTECH Systems Corporation
Titanium in Industrial Chemicals
Titanium has been a substrate of choice for electrodes in the industrial chemical sector for over 35 years. Titanium electrodes replaced graphite as industries looked for more efficient use of power and longer lifetimes. The most prevalent use of titanium electrodes is in the Chlor-Alkali industry for the production of Chlorine and Caustic Soda an important feedstock for the production of PVC or plastics. The properties of titanium that make it resistant to corrosion from salt water assist in many other applications. Some primary uses are impressed current corrosion protection for bridge decks, parking garages, and pipelines for natural gas and oil. The swimming pool industry has accepted the use of titanium electrodes in sanitizers for pool water disinfection. This has been a high-growth sector that has demanded additional supply over the last few years. Other uses are an important ingredient for both marine sanitation and disinfection for cooling towers at power plants.

There are many other processes in the industrial chemical sector that could utilize titanium electrodes provided it remains a cost-effective alternative particularly to lead. Recent volatility has made penetrating new markets more difficult particularly when economic payback takes longer than industries are willing to wait.
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Hiroyuki Matsuhisa, Morimatsu Industry Co. ltd.
Shanghai Morimatsu and the demand of Special Materials in the Chinese Market
In 1990 Morimatsu Industry established a facility in Shanghai. This has expanded dramatically. Shanghai Morimatsu now comprises 8 companies with 1200 employees. Products are pressure vessels, reactors, heat exchangers, towers for chemical plants and equipments for the pharmaceutical, nickel minning and other industries.

As is well known, rapid advance of economic development in China has led to great demand for products with high corrosion resistance. In order to satisfy that demand, Shanghai Morimatsu developed expertise in special alloy fabrication based on materials such Titanium, Zirconium, Tantalum and others.

Regarding special materials requirements and application in China, we would like to introduce from vessel manufacturer's point of view.
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Dennis Schumerth, VALTIMET
TITANIUM – The Material Of Choice For The Nuclear Renaissance

Amidst the clamor and increasing world demand for energy, the continued use of fossil fuels for electric power generation has recently emerged as the bane of the industry. Green power is being championed as the new fuel de jour kid on the block. Environmentalists and other global warming advocates are successfully lobbying their political agendas for emission caps, carbon sequestration, N0x and S0x and other greenhouse gas limits. In many cases, these efforts have resulted in the outright cancellation, delay or unit reductions of new coal-fired plants. Similarly, simple and combined cycle gas turbine (CCGT) units, popularized during the Enron "gas bubble" era are at the mercy of unstable fuel prices which have, in large part, relegated this generation type from base load to load follow. Wind, biomass, hydro, photovoltaic and other renewables continue to produce an increased percentage of the power base but total contribution remains costly, inefficient and pitifully low.

Enter the nuclear renaissance. A dramatic paradigm shift, even by the green power advocates, market pressures, generation efficiencies, increasing ROI revenues and an enviable safety record since TMI and Chernobyl has allowed the nuclear phoenix to rise with the promise of emission-free power. Assuming this energy source conceives and bears the gestated fruit of the renaissance, the next decade will be telling in terms of the challenges brought forward by licensing, design, financing, construction and operation of a new generation of nuclear power reactors.

Paramount among these is a new, time-tested generation of construction materials that will be considered to insure a 40 - 60 operational life of the plant. Consider the problematic copper materials that were chosen during the early 70's for their high thermal conductivity, competitive cost and ease of fabrication. Contrast these past lessons-learned to current-day, state-of-the-art generation fleet construction materials where titanium can emerge as the prominent industry player and material of choice. The paper will examine these and other relevant aspects of the technical and commercial supply chain that is predicted to both challenge and reward the titanium material suppliers well into the next decade.
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New Materials Panel: October 9th 2:00 p.m.

Susan M. Abkowitz , Dynamet Technology, Inc.
Titanium Matrix Composites: The Growing Commercial Applications
The Dynamet Technology development of titanium alloy matrix composites reinforced with ceramic (TiC and TiB) particulate are finding applications beyond those in which titanium alloys can typically be employed. These hard, stiff, tough, wear resistant CermeTi® (ceramic-titanium) composites offer higher modulus, improved elevated temperature strength and significantly greater wear resistance than any commercial titanium alloy.

This presentation will describe the manufacturing technology, the metallurgy and mechanical properties achieved and the growing commercial applications in production for industrial components and for orthopaedic medical devices. Also ongoing research for DOD indicating that the improved properties of these titanium composite materials will offer the unique opportunity for introduction of lightweight wear resistant titanium for replacement of steel components in military vehicles will be reviewed. These specific products and a wide range of potential applications for these materials currently under development will be presented.
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Chongmin Kim, General Motors R&D Center
Technical Cost Analysis of Modified Armstrong Process for Titanium Production
There has been increasing interest in emerging methods for producing titanium metal from titanium dioxide and titanium tetrachloride during the past decade. A number of new approaches have been proposed over, but at this time none have proven to be commercially viable. Considerable work is still needed to reduce the costs associated with these processes and bring them to the point of commercialization. A US Department of Energy study in 2001 provided an economic analysis of a variety of innovative titanium production methods, with an update to that study carried out in 2004. The results of these studies indicated that one of the most promising approaches is based on the Armstrong/ITP/ITP process. The cost analyses showed that the Armstrong/ITP process could become an economically viable means to produce titanium metal only if the

process can be further refined and optimized to reduce production costs. The Armstrong/ITP Process involves reacting titanium tetrachloride vapor with liquid sodium to produce titanium metal plus sodium chloride in a continuous process. Energy intensive materials preparation steps are needed to promote the reaction. Additional post reaction processing steps are necessary for recovering unreacted precursor material and titanium fines. Recent advances indicate that some significant process improvements can now be achieved, including the elimination of several of these process steps. These include materials preparation steps such as sodium melting and titanium tetrachloride boiling, as well as post reaction cooling, filtering, sodium distillation and condensation steps. Elimination of these steps not only results in large savings in processing costs, but also results in a significant reduction in energy consumption and materials losses. Preliminary cost analyses indicate that these process improvements may result in an overall savings of up to 17% savings off of the total cost and a 60% savings of the production costs excluding materials, when compared with the baseline Armstrong/ITP process. Additional work is under way to refine the manufacturing conditions for this process and to better understand the resulting cost savings.
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Toshiharu Noda, Daido Steel Co., Ltd.
Development of New Alfa+Bata Titanium Alloy of Vanadiumless
Ti6Al4V alloy is the most popular alpha + beta titanium alloy. Recent extreme price increase of the raw material of vanadium forced to increase the price of Ti6Al4V alloy. Hence, in order to supply more economical and stable price alloy, we developed new alpha + beta alloy VLTi(Ti6Al1Fe) which does not contain vanadium and employed off-grade Ti sponge. VLTi has the same properties as Ti6Al4V and can be applied to consumer products and automobile components such as golf clubs and engine valves.
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Takashi Maeda, Sumitomo Metal Industries, Ltd.
Microstructural Design and Mechanical Properties of a Newly Developed a + B Titanium Alloy for Cold Strip

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Supply Chain Panel: October 9th 2:00 p.m.
Moderator: Mike Skorija, Director - RTI International Metals Inc.

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Mike Skorija, RTI International Metals Inc.
Supply Chain Execution – Back to Basics
In today's complex and growing global economy, many companies do not have the time or the resources to invest in expensive operating systems or consultancy firms to define their way forward. We firefight day after day and feel that we are achieving results, but may not be impacting the bottom line. Understanding the basic common sense approach to defining the components of a supply chain will help you to stop the firefighting and enable you to become more forward thinking and grow with the visibility needed to improve profitability.

Many Supply Chain Interventions are hours upon hours in a conference room looking at eye watering presentations. When you leave the room, you are exhausted and walk away feeling empty. A normal comment could be "now, what do we do?" Wouldn't it be easier if the discussion content was in simple laymen's terms showing you "What to do" and walk you through common stumbling blocks instead of hitting the problem with tactical brute force".

I use the SCOR model as a foundation and initial learning and then utilize a sequence of visibility metrics with the explanation of how to read them and then define the next actions. These sequence of structures will allow you to realize numerous bottom line results of significant value such as:

· Reduced working capital through Global Planning strategies.
· Reduced materials spend through Global Purchasing initiatives.
· Increased stock turns by having the right material at the right time.

The main objective of any supply chain intervention should be to allow visibility into all segments of the business to drive and measure the performance and to take a complex set of situations and business requirements and break them down into manageable components where actions will receive clear bottom line benefits. If you understand your basic business requirements and can steer to your core products. The changes you make will impact your bottom line in record time.
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Kathleen M. Galbraith, Croda International
Simplifying the Import / Export Process
In today's global market, many companies are highly dependent upon the importation, or exportation, of raw materials, intermediates and/or finished goods. Many of these companies are burdened with late deliveries and maintain higher than desirable inventory levels to off-set this problem. Unplanned transportation and storage expenses can result. The complexity of supply chain management can be daunting. The flow of materials within the delivery process must be coordinated. Logistics service providers must be selected based upon equipment capabilities, and partnerships, which are subject to change. Increasing security demands, and ever-changing regulations, demand robust compliance programs which are fully integrated with daily business processes. Many companies do not know where to begin or how to address these challenges.

International supply chain challenges are no different than any other obstacle which businesses face from time to time. Classic approaches to continuous improvement can be successfully utilized to identify issues, quantity impact and focus resources. Typically, employee engagement is a critical element of improvement processes and workers are more than willing to let you know about the problems they face. Process flow mapping exercises can be used to identify delays and potential delivery breakdowns. The costs of rework can be quantified to help drive decisions needed for change management programs, which often involve reorganization of resources and implementation of management tools. Improving import / export processes in not 'rocket science', but it does require management commitment and a disciplined approach, as does any business performance improvement.
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N. David Campbell, West Penn Testing
Lean LEAN
One of the greatest challenges faced by companies providing support and services to the Titanium industry is responding effectively to dynamic production scheduling. Meeting customers demands' is paramount. Material producers, forgers, machine shops, and testing organizations must accommodate schedule changes created by evolving end-user needs. These changes create ripples that impact every facet of the supply chain.

Learn how a major titanium supplier worked in close collaboration with West Penn Testing Group to apply Lean and Six Sigma principles to optimize supply chain responsiveness. The joint project substantially increased throughput, reduced lead times, enhanced schedule flexibility, increased visibility, and profoundly affected customer satisfaction. The overall result is a highly deterministic supply chain that improved on-time performance to the highest levels - all in less than 6 months!

Key to the cross-chain implementation was the deployment of Lean Manufacturing principles, in a LEAN fashion, i.e. doing Lean LEAN. Small and mid-size suppliers seldom have the resources, or time, to implement all the esoteric intricacies of Lean or Six Sigma. The skill and determination to choose the most compelling techniques and execute in a compressed timeframe is key to success.

If there is one presentation to attend at Titanium 2007, this is it. Learn first hand how two industry-leading, world-class organizations worked collaboratively to optimize supply chain efficiency and effectiveness. You will leave with practical information you can use to accelerate your programs.
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Frank Cackowski, TIMET
Unlock Opportunities to Reduce Wastes in your Titanium Supply Network at the "Push / Pull Boundary"
Review an opportunity to reduce the total cost of procurement in your titanium supply network. Your company's push-pull boundaries create logical focal points to apply Continuous Improvement resources and reduce Wastes. When accurate supply

network decision support information combines with the “pull concept” additional savings become possible. A candid review of the concepts, the potential benefits and overcoming the obstacles to titanium supply network optimization.
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Powder Metallurgy Panel: October 9th 3:30 p.m.

Stanley Abkowitz, Dynamet Technology, Inc.
Low Cost Titanium by Advanced Powder Metal Manufacturing Technology – Distinguishing the Current Opportunities from the ‘Wishful Thinking’
This presentation discusses the current commercial applications that employ advanced powder metal technology for the production of near net shape titanium alloy components for military and commercial applications. Significant cost savings are achieved along with realistic delivery schedules for material meeting the standard tensile requirements of CP titanium and titanium alloys. With the price escalation and significantly extended delivery schedules occurring with the supply of ingot metallurgy product, the economic advantage of this advanced powder metal technology is shown to extend beyond near-net shape to the supply of “mill product” billet, bar and plate.

The economic advantages of this manufacturing technology, the homogeneous microstructure of the fully dense product and the mechanical properties achieved are reviewed. This approach which employs current production titanium powder and existing full-scale isostatic consolidation equipment offers billet, bar and plate for forging, extrusion, rolling or direct component machining. This commercial opportunity will be discussed in view of the widely publicized new titanium powder production processes still being developed that project very low powder manufacturing cost.
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Gordon Goranson, LMC Inc.
The Adiabatic High Velocity Compaction Of Titanium Powder
LMC’s High Velocity Mechanical Press compacts titanium powders to net shape components with reduced sintering time and temperature, or no sintering. One Tool – One Impact – One Part. The patented impact unit achieves ram velocities up to 100 meters per second creating adiabatic phenomena in powder to dislocate molecules and rejoin them in a solid state. Material yield is maximized. Surface finish is determined by the tooling. High cycle rates are achieved. No lubricants. Part densities have been achieved to over 99%.

The LMC process will produce (1) pellets that can be controlled for processing by smelters for extrusions, rolled or machined, (2) near net shape billets to be finished machined, and (3) net shape parts. Presses capable of components to 20 kilos.

The High Velocity Adiabatic Impact Process is fully commercialized for cutting, blanking, and forming. Environmentally friendly. No recyclables, minimum material waste and up to an 85% reduction in energy consumption compared to conventional presses.
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W. H. Peter, Oak Ridge National Laboratory, Materials Science and Technology Division
Mechanical Behavior of Solid State Consolidated, Armstrong Titanium and Titanium Alloy Powders
In the last few years, low cost titanium and titanium powders have been developed and consolidated into CP Ti and Ti-6Al-4V plates with wrought like properties. Vacuum hot pressing (VHP) and pneumatic isostatic forging (PIF) are two technologies that have been used to produce plate from ITP’s Armstrong Process powders. Previously, only monotonic tensile tests have been reported on vacuum hot pressed Armstrong, CP Ti and Ti-6Al-4V plates. In this investigation, tensile results will be expanded to include Armstrong plate produced by the PIF process. In addition, ballistic results, early fatigue data, and fracture toughness values will be shared on plates produced by both the VHP and PIF technologies. Chemistries and microstructures will be compared to the mechanical results. A brief description of the PIF process and the potential titanium product forms from low

cost powders will also be discussed.
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Bhanu Pant, Vikram Sarabhai Space Center
Development of Gamma Titanium Aluminides through Reaction Synthesis Route for Space Applications
Gamma titanium aluminides possess significantly higher specific stiffness and similar specific strength as that of superalloys. Hence, these materials can replaces superalloys for high temperature applications up to 1273K, reducing component weight by upto 50%. Aerospace sector and high performance automobiles put a large premium on these properties because lighter parts provide direct advantage of need to carry smaller structural mass for same payload capability while the improved transient response provides higher engine efficiency for rotating turbine parts. The PM (powder metallurgy) route alleviates/ circumvents major hurdles faced for processing intermetallics by IM (ingot metallurgy) route like inherent brittleness, alloy inhomogeneity and elemental loss. The PM route provides fine-grained uniform near – net - shape components with excellent properties for this class of materials. Authors are working on development of gamma type titanium aluminides through emerging PM route based on reaction synthesis (RS). In RS, exothermic heat of reaction between elemental powders has been utilised with application of moderate pressures to achieve intermetallic full density compacts. The present paper provides details of RS experiments conducted to on gamma titanium aluminides based on Ti48at%Al composition. Results of these experiments viz. DSC reaction kinetics studies, XRD, Optical Metallography, SEM, Elemental Mapping using SEM, EDAX and Density Measurements are discussed in this paper. Initial experiments are conducted in specially designed set-up for producing 30mm diameter compacts. After achieving full density small compacts with this set-up, larger billets of size 75mm diameter has been successfully RS pressed using 250-Ton vacuum hot press. The tensile property retention of the RS synthesized Ti48Al2Cr2Nb aluminide has been demonstrated to 1073K.
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Vladimir S. Moxson, ADMA Products Incorporated
Low Cost Blended Elemental Titanium Powder Metallurgy
Substantial increase in price and delivery of the components produced by the traditional ingot metallurgy (IM) processes caused by recent shortage in Titanium market renewed an interest in titanium powder metallurgy (PM) approach. P/M approach offering cost reduction in manufacturing titanium parts as well as substantial reduction in lead time. In this paper, Titanium PM is reviewed as a possible substitution of IM processes when a price reduction and shorter delivery time make PM approach more favorable to compare with the traditional IM. Blended elemental (BE) approaches which are potentially the lowest cost processes to produce Ti alloy components will be discussed. BE processes are based on use of the alloying elements or master alloys which are added to titanium powder to achieve the required chemistry of alloy, room temperature consolidation to the required configuration and sintering in vacuum to produce the final components. Room temperature consolidation in BE approach (die pressing, cold iso-static pressing, and direct powder rolling) will be presented as the low cost manufacturing processes to produce the fully dense Titanium alloy components with the properties meeting the various application requirements. Other advantages of PM approach to produce discontinuously re-enforced, multi-layered titanium components and composite structures not achievable by the conventional IM processes will be presented.
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Chongmin Kim, General Motors R&D Center
Sonochemical Method for Producing Titanium Metal Powder
We demonstrate a novel method for producing titanium metal powder. The method uses ultrasound in a hydrocarbon solvent at near-ambient temperatures to first create a colloidal suspension of alkali metals. The finely dispersed metals then reduce titanium tetrachloride to titanium metal under cavitation conditions and at near-ambient temperatures. The resulting sub-micron size particles may facilitate compaction and sintering of the powder, as well as alloying through shortened diffusion distances, but are also highly susceptible to oxidation. Based on the experiments carried out thus far, we propose a new process for producing titanium metal powder. The GM process may require only 5 steps, compared to 12 steps for the Armstrong process, currently the most promising titanium cost reduction technology, which may lead to additional cost savings.
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Machining/Testing/Processing Panel: October 9th 3:30 p.m.

Albert R. Fletcher, West Penn Testing Group

Surface Inspection of Titanium Bar Stock

Titanium bar stock is subject to numerous process related surface flaws that are objectionable for a variety of medical, automotive, and aerospace applications. Detecting both internal and surface flaws is critical to meeting stringent parts manufacturer requirements. Greater assurance of inspected bar stock quality reduces costs and enhances customer satisfaction.

In a real world case study, West Penn Testing Group worked closely with Titanium producers and metals service centers to develop multi-method inspection processes to enhance the probability of detection of surface indications in titanium bar.

This presentation details a study of surface defect detection using various non-destructive testing methods alone or in combination including:

· Ultrasonic shear wave
· Fluorescent Penetrant
· Visible Dye Penetrant
· Eddy Current
· Eddy Current Array Imaging
· Visual Inspection

The attendee will gain a better understanding of the limitations of each inspection method and the preferred combinations for the detection of specific defect types and defect orientations. A review of the applicable specifications and required inspection methods is also included.

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Xiqun Wang, TechSolve, Inc.

Titanium Machining Optimization

In the manufacturing industry, many of titanium's material and component design characteristics make it expensive to machine. A considerable amount of stock must be removed from the initial form such as forgings, plates, bars, etc. In some instance, as much as 50 to 90% of the primary form's weight ends up as chips. Maximum machining efficiency for titanium alloys is required to minimize the costs of stock removal and maximize productivity.

Historically, titanium has been perceived as a material that is difficult to machine. There are certain reoccurring challenges that are associated with machining titanium and titanium alloys. First, titanium is a poor conductor of heat causing higher tool temperatures. Second, titanium has a high tendency for chemical reactions with tool materials, tool coatings, and coolants, etc. Third, the modulus of elasticity of titanium is low compared to steel and aluminum. Fourth, titanium is difficult to machine due to its fatigue properties and work hardening characteristics.

Due to titanium's growing acceptance in many industries, along with the experience gained by progressive fabricators, a broad base of titanium machining knowledge now exists. Additionally, due to improved technologies of machine tools, tooling, coatings, and coolants, etc., titanium can now be machined with less difficulty when utilizing proper procedures in terms of machining parameters, i.e. speed, feed, depth of cut, etc.

TechSolve is currently in the process of developing a Titanium Machining Optimization System for machining processes on titanium alloys. The objective of this project is to develop an intelligent application for automatic selection of cutting conditions to achieve optimum machining performance in machining titanium alloys. The first phase of the optimization engine has been completed. Implemented as a stand-alone software program, the optimization method has been validated for a dozen of tool-material combinations in face-milling and end-milling operations. Optimum cutting parameters, speeds and feeds, are derived based on the user requirements of the overall machining performance including surface roughness, cutting forces, material

removal rate and tool-life.
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Mathilde Chabin, ESI Group
FEA Simulation with PAM-STAMP2G for Design and Process Optimization of Titanium Parts
PAM-STAMP2G is a well known process simulation software for Aluminium and Steel parts. This numerical tool allows prediction of wrinkling, excessive thinning, cracks… due to the forming process. Based on the simulation results, the process can then be optimized for better product quality, and design changes can be done before to cut the tools.

ESI Group is now extending PAM-STAMP2G software capabilities to Titanium by introducing a specific material model within the application. Titanium is a growing industry for which ESI Group with PAM-STAMP2G simulation software can bring tremendous time and cost saving.

Industrial examples of problem predictions and eventual corrections during the forming of Titanium parts will be presented.
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John K.Schueller, University of Florida
An Experimental Study of Tool Wear in Miniature Endmilling of Ti6Al4V
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Frank Parente, Advanced Manufacturing Park
The Low Cost, High Quality, Titanium Process Route at the AMP
With the ever increasing demand for stronger, lighter, corrosion resistant structures and components, titanium has become the material of choice in many high performance applications. However, the limited availability of titanium and its subsequent high cost, combined with the difficulty in working with it, has presented industry with a challenge in adopting it widely.

The United Kingdom's Advanced Manufacturing Park (AMP) has risen to that challenge, pioneering news of producing, casting, machining, welding, fabricating and recovering titanium. Metalysis's FCC process promises to produce titanium in larger quantities and at lower cost than traditional electrolytic methods, whilst being less harmful to the environment. At TWI Friction Stir Welding of titanium is now well understood, giving strong, defect free welds and improving the performance of titanium fabrications in the most demanding of applications - including armor for ballistic protection.

Using techniques developed by Boeing's Advanced Manufacturing Research Centre, one of the many organisations utilising the AMP, titanium components can now be machined at higher speed than traditional aluminium and steel parts, and with previously unheard of surface finishes. Novel techniques are also being developed which can eliminate machining in many applications; parts being grown from powdered titanium with no waste and the ability to vary the alloy blend throughout the component.

Castings Technology International (Cti) has invested heavily in state-of-the-art technology for the fast manufacture of precision, thin-wall titanium castings. This technology provides a higher superheat and more uniform temperature in the melt, facilitating the manufacture of thin wall castings. Much of the activity is focused on the development of new components, particularly the development of rapid prototyping and fast manufacturing techniques.

The presentation will outline the development of these improved techniques, and how they can benefit ITA members.
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Consumer Panel: October 9th 3:30 p.m.
Moderator: Paul O. Jones - Reading Alloys Incorporated

Dr.Vasily Semeniuta, Dr.Igor Krjenitski, Grandis Titanium

Titanium in Consumer Applications

Titanium over the last years became widely accepted material for a number of consumer applications. This presentation tracks historical development of consumer markets for titanium, starting from first application of titanium in bicycles and currently going onto wide variety of uses. The following applications described, and dozens of pictures of articles made from titanium materials presented: sport (golf, diving, mountaineering & hiking, ski & snowboarding, skating, ice fishing, etc), consumer electronics, sound equipment, watches, jewelry, body jewelry, marine hardware, architecture, sculpture, arts, souvenirs, work tools, medical equipments, prosthetics, spectacles, auto and motorcycle parts, guns and body armor, and number of other applications. Presentation also discusses properties and suitability of different titanium alloys for different applications.

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Peter Boucher, 3V PRECISION MACHINING, INC. and Dr. Farrand C Robson D.D.S.

Introduction To A New Science

Oral Systemic Balance® Therapy is innovative and scientific and developed from over twenty-five years of work by Doctor Farrand Robson of Tacoma, Washington. OSB Therapy helps people with snoring, sleep disordered breathing, muscular pain problems, and other concerns by recruiting normal body mechanisms that restore or maintain normal function.

All the air you breathe goes over the back of the tongue and through the throat. Any disturbance in the normal muscle reflex mechanisms that maintains muscle tone and tongue position will result in some level of interference with the primary oral functions of breathing, swallowing, and speaking. Many of these muscular reflexes that keep the throat open are the result of the shape and position of teeth and are modified by routine dental procedures. When the tongue is properly positioned and airflow is unrestricted, oral functions are effortless and effective and sleep is restful and pleasant.

Difficulty with breathing, swallowing, and speaking often can be traced to the configuration of the mouth. This is most often related to problems involving muscle tone of the tongue. An excessively narrow or broad mouth, crowded teeth, loss of teeth, bulky dentures or partial dentures, and other oral conditions all can interfere with tongue space as well as interfere with the normal reflex mechanisms that maintain muscle tone. In such cases, the only place the tongue can go during oral function is backward, into the throat. Lack of appropriate tongue space can be apparent when observing the tongue, and is obvious when the tongue is scalloped or when tongue thrust is present.

Disordered breathing is usually caused by tongue obstructing airflow down the throat. In this situation, every inhalation requires extra effort and puts negative pressure (suction) on the soft tissues of the throat. The chest wall works harder than normal to draw air in, and the resultant forceful and turbulent airflow over these enlarged tissues produces snoring. The continued effort of the chest wall that is required to maintain breathing interferes with normal cardiovascular dynamics and interrupts and/or prevents deeper and more restful sleep stages. People who snore often sleep lightly or fitfully, awakening at the smallest disturbance, and often blaming their awakenings on the need to empty the bladder. They still feel tired on rising and often can sleep for ten or more hours without feeling fully rested.

There are several systems that aid in the body's adjustment to keep the throat open. One of these compensations is clenching and grinding of the teeth which causes a reflex called the Jaw Tongue Reflex (JTR) that actually opens the throat more and makes breathing easier. This is a frequent cause of Jaw pain and headache pain in the temples and behind the eyes. When severe, many people can have nausea and be very sensitive to light and sounds.

Forward head posture, which changes the posture of the whole body, is another compensation that lets us breathe more easily. Like the clenching of teeth, forward head posture may be associated with muscular pain as muscle contracts to maintain breathing. The weight of the head in a forward position puts an enormous strain on the body, especially muscles of the neck, shoulders, and back. This can result in pain anywhere in the axial skeleton. People with this posture may experience difficulty and have less stability with Physical Therapy and Chiropractic care since restoration of normal head posture makes it more difficult to breathe freely. The head and body will again move forward to reopen the throat. OSB Therapy can reduce or eliminate the need of these posture alterations and allow the body to self correct. In this way, OSB Therapy complements these other therapies.

Another major compensation that the body makes for an obstructed throat is to activate the sympathetic "fight or flight" component of the Autonomic Nervous System (ANS), releasing neurotransmitters such as adrenaline. Adrenaline facilitates muscle function, allowing stronger and more rapid muscle contraction, which helps the body adjust to maintain an open throat. This is the reason that we feel more on edge at the same time we are experiencing muscular pain. Adrenaline also raises the heart rate, which is one reason people with nighttime breathing problems, also known as choking, may wake with the heart racing. There are many other effects from this adrenaline release, including digestive and stomach acid concerns.

The adrenaline that is needed to maintain breathing is often associated with diagnoses of anxiety, depression, and even panic attacks. As Doctor Robson of OSB frequently says, "My patients who are`viciously choking' appear to be anxious, depressed, and on edge." The on edge feelings are often thought to be "stress," "anxiety," or other psychological concerns but in reality are a survival "fight or flight" response.
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Peter Hurley, Brad DeVaney, American Bicycle Group
Enhancing Properties to Compete in a New Marketplace
In recent years, the cycling industry has become much more scientific in the way it measures the performance of a racing bicycle. For frame manufacturers, two very basic tests have been developed which provide a torque value required to deflect a given bicycle frame design 1° in two different planes.

Until recently, titanium bicycle frame designs have been based on performance characteristics desired twenty years ago. All other components of the bicycle were much heavier and stiffer. A more flexible frame was welcome in that era of bicycle design.

In today's market, where carbon composites are very popular, titanium bicycle frames suffer from a stigma of being too flexible and have a lack of styling elements. Bladder molded composites are easily designed into stylish oversized forms yielding stiffness values beyond those of titanium designs.

In order to compete, specific performance values were targeted using the latest testing methods. To bring titanium designs up to new standards, new tube forms were developed. Most new tubes were developed by forming and multi-shaping readily available tubing. However, the most innovative were developed by creating new processes yielding tube forms with very unique performance characteristics and styling.
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