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The Crucible

Aeromaterials: Past, Present and Future

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Colin Williams, RIP

Colin Williams, who died on 30th June 2015, was an influential figure in the field of lesser known metals and minerals in London, an individual subscriber to the LME at one time, one of the pioneers of trade with China from the 1960's onwards, and a man who was discretely but enigmatically involved in the communities and causes close to his heart.

Colin's great-great-grandfather George Williams had been a successful City of London merchant in the mid 1800's and founded the YMCA in 1844. Like so many families of his era, Colin (who was born in February 1942) never knew his father, who was shot down in action over Kiel in May 1942, nor his grandfather, who was killed in action in the 1st World War. Colin was educated at Uppingham School, and his love and affection for this nurturing community remained with him throughout his life. It was there that he developed a range of talents from art through music, on the stage and on the rugby field, acquiring in the process a lasting love of hymn singing and an ambition to become the Head of the Metropolitan Police. Following a brief spell at Magdalen College, Oxford in the law department and whilst playing rugby for Esher RFC, Colin's rugby captain Ian Brackenbury encouraged him to set aside his ambitions in the police force and become a metal merchant. Ian was a director at Rudolf Wolff & Co and himself an old Uppinghamian. Over the following decade, as Colin's career took shape, Esher's fly half became Wogen's lawyer, and another rugby team member became Wogen's shipping insurance broker.

When describing his profession, Colin liked to refer to being a Merchant Adventurer, although in the early days a considerable part of his job consisted of travelling up the new M1 to Sheffield in a clapped out mini-van in order to sell imported low carbon ferro chrome to the stainless steel mills there.

The adventurous part of his job involved the international physical metals trade. Colin followed his basic training at Rudolf Wolff Ltd with a sabbatical in California on UCLA's business programme, a year he funded by buying the scrap wing of an aircraft from an American scrap yard and selling it to the UK titanium industry.

In the mid-1960's he met Bernard Buckman, who had approached Wolff looking to purchase copper for Minmetals in China. Bernard was 30 years his senior and a veteran of the China trade since the Moscow Economic Summit of 1953. This started a friendship which lasted for over 25 years until Bernard's death in 1991, and a relationship with Minmetals and China which stretched from the Canton Fair during the early days of the Cultural Revolution in the mid 1960's through to the present day. It took Colin to many cities across every region of China and led to a huge fund of experience in travel and negotiations in the Middle Kingdom. Colin believed resolutely in the importance of knowing both your customer and your metal better than anyone else. He had a firm belief in the importance of friendship and liking one's customer as the basis of any successful business, and in the importance of timing.

Having set up Rudolf Wolff Special Metals in London, in the late 1960's Colin moved his base to Hong Kong, and on the back of the nickel boom travelled to Western Australia where he met up with Donald Armstrong, Rudolf Wolff's representative there. They bought a Land Rover in Perth, had a sign painted on the side saying "Rudolf Wolff Special Metals, Metal Buying Division" and set off into the outback of Western Australia where their first stop was the Poseidon discovery in Laverton, WA.

After meeting up with the Kalgoorlie Rugby Club in a pub and co-opting the team to peg some claims for them, the duo set off across the Nullarbor Desert for Sydney. While they didn't discover any new nickel prospects, the RW team gained a critical insight into Poseidon and the nickel bubble, which stood them in good stead in surviving the subsequent crash. They also negotiated the 4,000km track to Sydney and their joint efforts led 3 years later to Wogen Australia being set up, to trade metals and to represent such Australian mining companies as Hamersley Iron, Comalco, Western Mining, and Consolidated Rutile selling to China at a time when China was still off the map in a way that few countries are today.

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EXOTECH

Aeromaterials: Past, Present and Future

Aviation design and material selection had been relatively stagnant since the 1930s. With the advent of the Boeing 247 in 1933 – followed shortly after by the Douglas DC-3 – aircraft were essentially constructed with aluminum in a "semi-monocoque" configuration. This was a considerable departure from the historical design philosophy, which mimicked that of building and bridges, using internal frames for load bearing. Semi-monocoque designs effectively distribute flight loads between the metal skin and metal aerostructure (e.g. frame, stringers, ribs). And that was the paradigm for 75 years.

Aviation is a conservative industry. The prohibitive costs – both real and imaginary – of a catastrophic failure make it unlike any other industry except, perhaps, nuclear power. And the industry is unique with its obsession for light-weight structures. Fuel cost historically represents between 20 to 40% of the operating costs of an air transport category aircraft; thus, any weight savings directly translate into increased profitability for airline operators. The aircraft original equipment manufacturers (OEMs, e.g. Airbus and Boeing) painstakingly reduced weight by using impeccably qualified materials, coupled with judicious design practices.

Perhaps somewhat disquietingly, the industry actually has one of the lowest design margins of safety: 1.5 to 1. This helps minimize weight. In other words, to support a load of 1000 kg, for example, aviation components would be designed to carry an ultimate load of 1500 kg. The automotive industry, by contrast, would use a 3000-kg rated component. Rest assured, however: the inferior margin is safely offset by exacting quality control of materials and processes that have to conform to governmental requirements. Safety is furthermore upheld by an unparalleled preventative maintenance regiment. This, too, is strictly monitored by a governmental authority. As a consequence, you can board that British Airways A320 with peace of mind that your aircraft was well constructed and maintained.

Like any industry, cost is a primary design consideration. Increasingly, the emphasis however is shifting from acquisition cost to total life-cycle cost, as operators become more sophisticated in cost accounting and data management. For aircraft OEMs, the second design constraint for material selection is predicated upon a material's strength versus weight. Aluminum had a monopoly for over 75 years; carbon fiber reinforced plastic (CFRP) composites have become the new material of choice with their applications on both the Boeing 787 and Airbus A350 within the past decade. Truly revolutionary aircraft. Part of the fundamental shift in material resulted from a third airframe design consideration: manufacturability. The manufacture of an aerostructure is still considerably labor intensive, as skilled craftsman scrupulously "buck" tens of thousands of rivets throughout the airframe, wing, and empennage.

CFRP helps to reduce labor content, as well as part count by 25% or more. Most CFRP designs still involve a semi-monocoque configuration and are therefore colloquially referred to as "black aluminum." This is due to legacy tooling and assembly practices. Given the variability of CFRP final mechanical properties in comparison to a more isotropic material such as aluminum, it is envisaged that CFRP designs will continue to be optimized going forward. Indeed, the 787 and A350 have predominately CFRP aerostructures. Many experts believe that the next clean-sheet design for air transport category aircraft will likely combine a metal (aluminum lithium?) airframe with a CFRP wing and empennage. Nevertheless, these aircraft will not appear until the end of next decade due to the "re-engineing" efforts of both Boeing (737 MAX) and Airbus (A320 NEO). An ongoing challenge of CFRP structures is damage detection and repair.

The design criteria for gas turbines is rather different. Naturally, cost is still a principal concern. The second and third order design targets are operational efficiency and "maintainability." Unlike the aerostructure, the predominant material (in this case, steel alloy) diminished markedly since the 1960s with the introduction of "superalloys" and titanium alloy. Superalloys are high-nickel (or cobalt) content alloys that have remarkable hot temperature performance capabilities which improve fuel burn and NOx emissions. They can withstand temperatures in excess of 800°C. These dense alloys include small, yet vital amounts of minor metals including chromium, molybdenum, niobium, zirconium, tungsten, vanadium, hafnium and the ever popular rhenium. Investment casted alloys – when coupled with advanced cooling-path design and thermal barrier coatings – can endure hostile environments that exceed twice their melting temperature. The caustic gas-path gases further compound the brutality of the environment.

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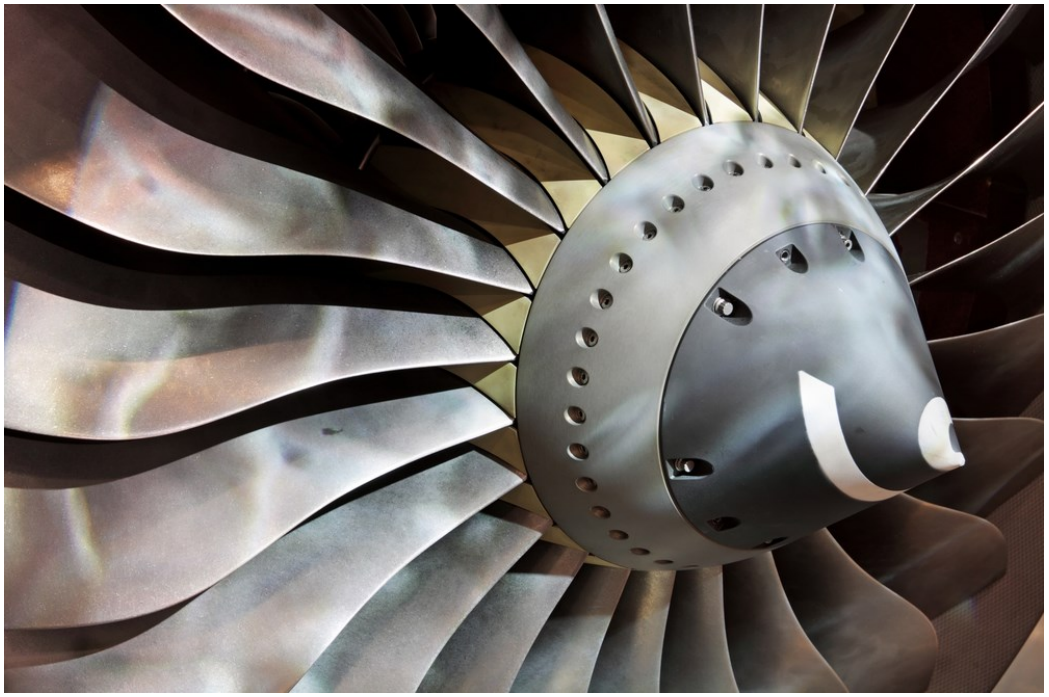
Titanium is another relatively stable metal whose role has become increasingly important throughout the aircraft. The most ubiquitous variant is TI 6-4 (6% aluminum, 4% vanadium). Its strength is equivalent to most steel alloys yet it weighs 40% less. Titanium is used increasingly in the airframe for its strength to weight characteristics and compatibility with CFRP. In the gas turbine, its application is primarily the "cold" section (i.e. front portion) of the gas turbine, since the melting temperature is half that of superalloys. The inlet fan, in particular, is often titanium ,due to the grueling bird strike certification requirements. This is a test that requires a 2 to 3 kg bird to be hurled at the inlet of an engine running at maximum thrust. The shattered blades need to be safely contained.

As discussed, routine preventative maintenance is a primary factor to preserve the overall health of the aircraft. In terms of material consumption, engine maintenance, repair and overhaul (MRO) is significantly more material intensive. Engine MRO requires periodically replacing "life limited" parts (LLPs). These critical rotating parts, such as disks and shafts, must be scrapped after a certain number of operating cycles. This equates to every 8 to 10 years, on average. Extremely costly, LLPs are fabricated from expensive metals (note superalloy and titanium are roughly five times more expensive than aluminum and steel alloy) that undergo a highly scrutinized production process (all LLPs must be ultrasonically inspected, meticulously machined and the SKUs carefully tracked). Accordingly, materials constitute some 70% of the total engine MRO shop visit cost. This compares to only 20% for airframe MRO.



The total material consumed in annual aircraft production and MRO is approximately 680,000 tons in 2014, according to US-based ICF International. This is the mill material demand. Surprisingly, due to inherent inefficiencies in the production process, it takes an estimated 6 kg of virgin material for every 1 kg of final material used on the aircraft. This is known as the "buy-to-fly" ratio in industry parlance. Each material pre-form process (e.g. forging, casting, extrusion, machined plate) incurs a considerable loss of material. Most alloys have fairly high buy-to-fly ratios, in contrast to CRFP, which is closer to 1.5 to 1.

The industry has placed increased emphasis on closed-loop recycling/revert programs and "near-net" shape manufacturing processes. Near net also has the advantage of minimizing the machining of difficult-to-machine alloys, such as superalloy and titanium alloy.

Aluminum alloy is the most common material overall, accounting for 47% of the 680,000 tons. Steel alloy is the second most prevalent material at 18%. Superalloy and titanium alloy constitute 15% and 11%, respectively. As discussed, titanium is highly versatile. The engine accounts for 30%; the balance is consumed in the airframe (e.g. wing box, engine pylons, and other "hard" attach points) and the landing gear. Due in part to the low buy to fly, CFRP comprises just 4% of the total demand, yet is the fastest growing. It is anticipated to increase 6.5% per annum, per ICF's forecast. Titanium alloy will grow at 4.5% and superalloys at 2%. Aluminum and steel alloy growth rates are flat over the next decade.

Next generation materials include advanced aluminum lithium and various derivatives of 7000 series heat-treated aluminum alloy. The US Federal Aviation Administration (FAA) has certified more alloys within the past decade than it has in the previous seven, the preponderance are custom aluminum alloys for niche airframe applications. Fiber reinforced aluminum is also under investigation. Research emphasis for non-metals surrounds out-of-autoclave thermoset composites and thermoplastic extrusions, for stringers, for example.

A potentially disruptive material for the gas turbine hot section is ceramic matrix composites (CMCs). CMCs are one-third the weight, twice the strength and have 20% greater thermal capacity than superalloy. Its difficulty to machine and high cost of production are stubborn barriers for wide-spread adoption. Titanium-aluminide is another material receiving attention. Powder metal is used with greater frequency for the forged disks. And "single crystal" casting is used increasingly for investment casted turbine blades. Its lattice structure is manipulated to optimize the longitudinal strength of the blade to stave off creep and low-cycle fatigue.

In terms of the engine cold section, the primacy of titanium fan blades is being challenged. The next generation engines by CFMI (a GE/Snecma joint venture) and Pratt & Whitney have opted for CFRP and aluminum lithium, respectively, for their narrow body engine fan blades and cases. The CFM LEAP and the P&W GTF are approximately 35% larger in diameter, therefore a light-weight fan is imperative. Less mass translates into less rotational inertia and kinetic energy. These materials are part of the enabling technology package that has afforded an impressive 15% reduction in fuel burn. (Concludes overleaf)

In general, there has been only moderate metallurgical investigation for "disruptive" aerospace applications. Highly advanced new alloys cost "a few million" to develop, then one could easily triple that figure for an extensive business development campaign. It is a costly and slow endeavor. It is feasible the development cycle can take up to a decade. Consequently, many of the newer materials have marginal improvements in performance. Most of the industry's energy is directed towards cost reduction (for instance, decreasing buy-to-fly) and advanced monolithic manufacturing. Furthermore, with eight years of production backlog and the aggressive ramp up for both Airbus and Boeing for narrow body production, it is logical that the emphasis will remain on program execution and cost containment. The staggering cost overrun of the 787 development and struggling profitability of the A380 program ensure that both OEMs stay focused on incremental gain. Indeed, aviation is a conservative industry. Chances are we will remain at the technological status quo with only marginal improvements for alloys during the next decade, save, perhaps, the forays into additive manufacturing. Sound business for incumbents. Time to harvest investment. A bit lackluster, however, for the rest of us technology enthusiasts...

Bill Bihlman, Aerolytics LLC, www.aerolyticsllc.com Speaker MMTA's International Minor Metals Conference 2015

POTENTIAL RECORD BREAKING METAL FOR HIGHEST MELTING TEMPERATURE

A new material with a higher melting point than any other known substance has potentially been discovered by scientists.

The alloy, which is a combination of hafnium, carbon and nitrogen, (Hf-N-C) would theoretically only begin to melt at temperatures of more than 4,126°C (7,460°F), which is approximately two thirds of the temperature of the surface of the sun. The current record holder is a combination of hafnium, tantalum and carbon (Hf-Ta-C), which melts at a temperature 3,526°C, so this new material would signify a significant leap forward.

Unfortunately the researchers still need to actually synthesise the material and to test its real-life properties in the laboratory.

The research was undertaken at Brown University, Rhode Island, USA, where scientists used computer modelling to try out different combinations of materials without the expense of actually making them. The researchers calculated the formula for the new alloy by simulating the physical processes that occur at atomic level when a substance melts.

They started by analysing the properties of the Hf-Ta-C material and then looked for other combinations that might maximise these further. Hf-Ta-C combined a high heat of fusion (the energy absorbed or released when the substance transforms from solid to liquid) and low differences in disorder of the atoms, or entropy, as a solid or liquid.

Metals melt when their molecular structures get enough energy to break with the behaviour of the atoms as a liquid, and this also determines the melting point.

The researchers found that the Hf-N-C alloy would absorb similar amounts of energy when it melted but had a smaller difference in the entropy between solid and liquid.

The researchers are now working with the University of California to synthesize the metal, as well as considering its mechanical properties and corrosion resistance.

Suitable applications for such a material would include protective plates on aircraft and in gas turbines.

For more information visit:

http://www.brown.edu/academics/engineering/news/2015-07/researchers-predict-material-record-setting-melting-point

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With future prospects in sight, RCI Analytical Services is working on getting all the laboratories accredited under ISO/IEC 17025.

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- X-ray Diffraction (XRD) Analysis.

Additionally RCI Analytical Services performs analysis on metals such as Gold and Silver in Copper and Lead Concentrates following Fire Assay / Cupellation techniques with ICP-OES Finish in combination with Graphite Furnace AAS and Titration in a state-of-the-art equipped laboratory.

Since April 2015, the company is proud to announce it is now accredited as by ISO/IEC 17020:2012 compliant organizations with RvA registration number: I 308. This accreditation recognizes that the policies, practices and procedures of the company can be ensured with consistent quality and excellent expertise in the knowledge of the products and the provided services. To obtain this accreditation, RC Inspection underwent an evaluation process that included quality management system development, a management system documentation review, pre-audit, initial assessment and clearance of non-conformances, all of which work to identify corrective actions that eliminate non-conformance to the quality management standard. This accreditation is one of the many developments which proves that RC Inspection is dedicated to maintaining the highest efficiency and responsiveness in achieving its ultimate goal – guaranteed client satisfaction.

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Yale University: Criticality Consortium

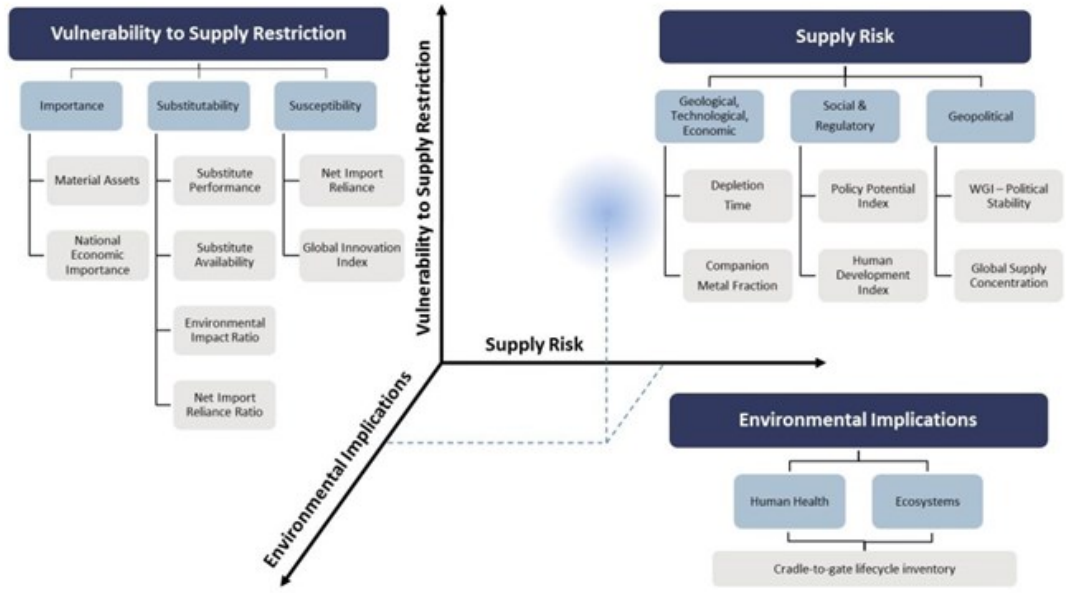
Spring Meeting 2015: Conclusion

I should like to conclude my review of the spring meeting of the Yale Criticality Consortium (the Consortium), organized by the Center for Industrial Ecology at the university's School of Forestry & Environmental Studies, with a look at just one further presentation and, in particular, the research paper with which it is associated.

As a reminder, together with the National Science Foundation, the Consortium has helped fund the Criticality of Metals project at the school's Center for Industrial Ecology. The research group there has recently completed the assessment of the contemporary criticality for 62 elements. These comprise the metals of the periodic table, together with metalloids and some other elements. The methodology created to quantify the degree of criticality comprises three dimensions – supply risk, environmental implications and vulnerability to supply restriction. This provides a structural, and robust, approach that "*reflects the multifaceted factors influencing the availability of metals in the 21st century.*"

National Level Methodology

Source: Yale University, School of Forestry & Environmental Studies, Center for Industrial Ecology



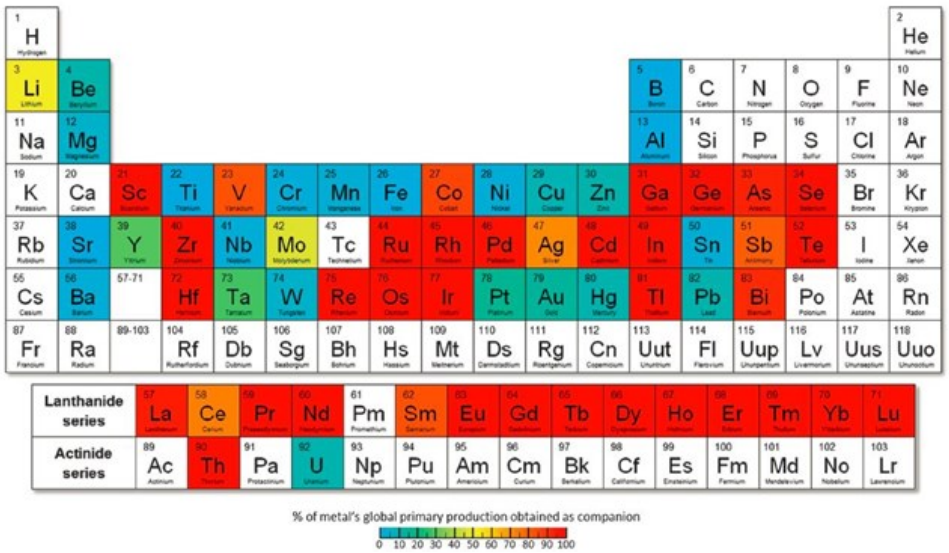
The presentation, "*Platinum-group metal cycles, companionality, and substitutability*", was given and the research paper, "*By-product metals are technologically essential but have problematic supply*" was "lead authored" by Nedal Nassar, then one of the stalwarts of the Center's criticality research group. (Dr Nassar has since been appointed Physical Scientist at the U.S. Geological Survey down in Reston, Virginia where, I am sure, he will continue to exercise his exceptional intellect in solving a stream of knotty problems in the field of the material flows of critical metals!) Dr Nassar's presentation provided us with excellent illustrations of some of the fascinating findings described in his research paper. I shall, in turn, try to describe some of these.

Companionality

All of us involved with minor metals are, often, too well aware, that many are by-products, or "companion" metals, recovered during the processing of other "major" or "host" metals, for example, copper, iron, lead or tin. Having already assessed the contemporary criticality for 62 metals and metalloids, Dr Nassar and his colleagues then turned their attention to assessing the "companionality" of these same elements, with companionality being described as "*the degree to which a metal is obtained largely or entirely as a by-product of one or more host metals from geologic ores.*"

While the results of this research may not necessarily come as a surprise to us, to anybody outside the business, they should, if nothing else, both reinforce the importance of the market in which we are involved and illustrate very effectively its complexity. Of the 62 different metals, 61% (38 of 62) have companionality greater than 50%. Essentially, what this means is that nearly two thirds of all these metals have the majority of their global production obtained as a companion metal. (I should note, however, that, while the results are based on 2008 production data, and, as Dr Nassar describes it, represent a "snapshot in time", even having reviewed more recent data, he and his colleagues saw only "*modest revisions*".)

The periodic table of companionality on a global basis for 2008



Source: Nassar, Graedel, Harper Sci. Adv. 2015;1:e1400180 3 April 2015

Metals that are mainly produced as hosts appear in blue, and those that are mainly produced as companions are in red. As Dr Nassar further points out, included in the companion metals groupings in the periodic table are a number of metals increasingly being used in:

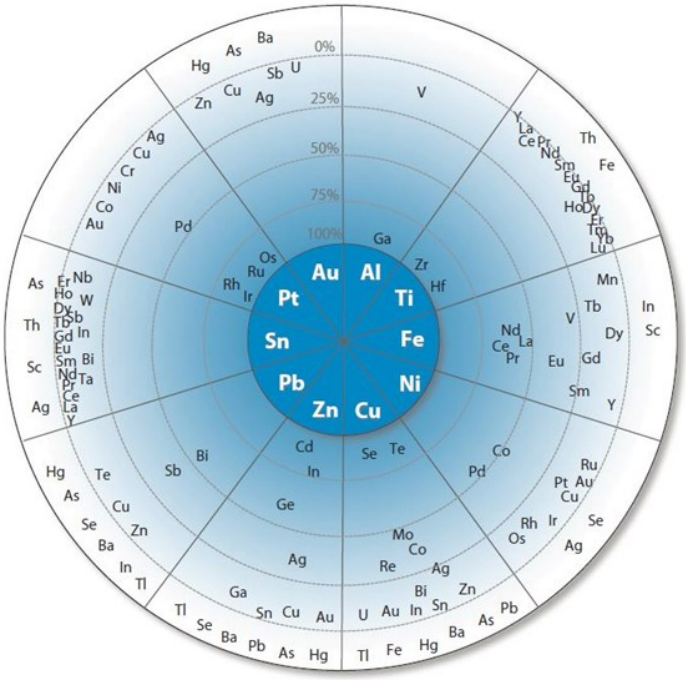
- Electronic and solar energy applications (Ga, Ge, In, Se and Te)
- Alloys in high-temperature applications (Co, Hf and Re)
- Wind energy, lighting and medical imaging (Dy, Lu, Nd, Pr and Tb)

This leads him to note as the "*central point*" that "*many of the metals so important to modern technology are available mostly or completely as companions.*" And that "[i]*n many cases, their most likely substitutes are elements with similar physical and chemical properties, elements that are companions as well.*"

And, as Dr Nassar pointed out to me subsequently, interestingly, the best substitutes are often elements that are co-produced with the elements of interest (e.g., Ni can substitute for Pd in multi-layer ceramic capacitors; Se and Te in pigments, rubber, and free-machining alloys; and the rare earth elements for each other in a number of applications). This, he said, is not surprising given that elements that are found in the same mineral deposits often have similar chemical and physical properties and are, thus, likely to substitute for one another in commercial applications.

As if to compound further these companion metals' dependence on their host metals – with all that implies regarding the speed and ease of meeting demand with supply, and pricing (in)elasticity – the results also show that "*although there are a few companion metals associated with multiple hosts, many more are primarily (that is, most of their primary production) associated with only one or two hosts. Similarly, although host metals may be hosts to multiple companions, they are often the principal host (that is, supply the majority of a companion's primary production) for only a few companions.*"

The wheel of companionality



Source: Nassar, Graedel, Harper Sci. Adv. 2015;1:e1400180 3 April 2015

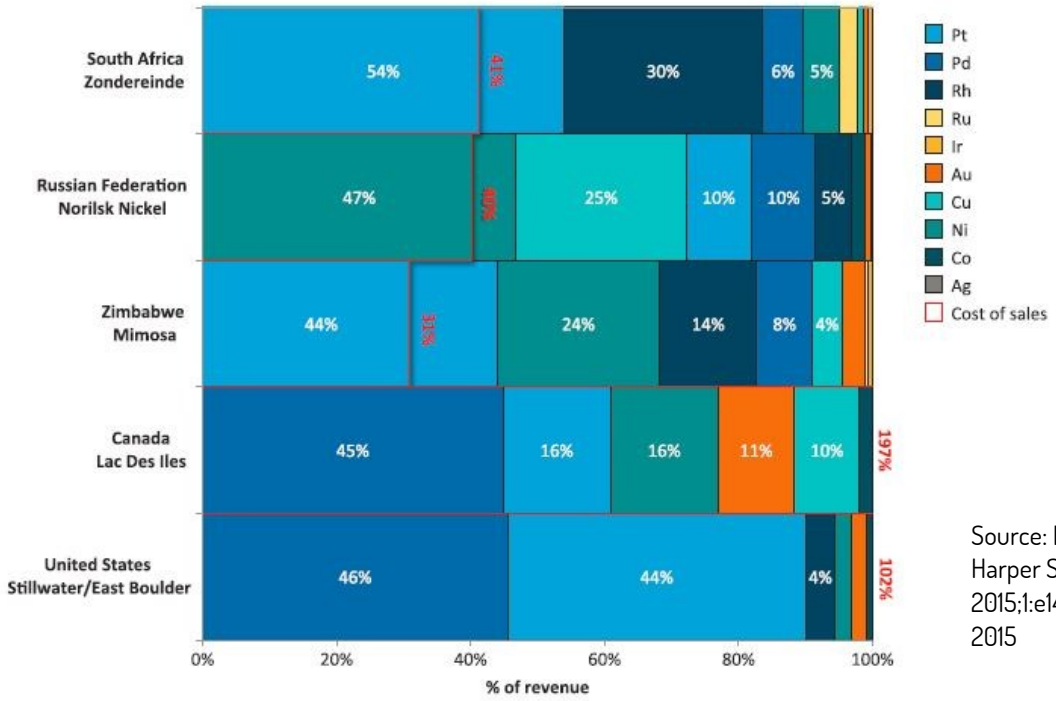
The principal host metals form the inner circle. Companion elements appear in the outer circle at distances proportional to the percentage of their primary production (from 100 to 0%) that originates with the host metal indicated. The companion elements in the white region of the outer circle are elements for which the percentage of their production that originates with the host metal indicated has not been determined.

Another Way to Measure Companionality

Whilst companionality can be measured using a model that addresses quantities produced, as Dr Nassar explained to us in his presentation, it can also, and may more precisely, be defined using an economic evaluation model. In such a model, companionality describes the degree to which the revenue contribution of a specific metal covers the cost of sales. Thus a metal that covers the entire cost of sales is "economically independent of the other metals," while a metal that covers only a small portion of the cost of sales is (proportionally) economically dependent on the other metals for profitable recovery.

This approach he illustrated very clearly and succinctly for us with an analysis of the economics of five different PGM-producing mines in five different countries that quantified the host-companion relationship.

Revenue contribution by metal (in descending order) for five mines producing platinum group elements.



Source: Nassar, Graedel, Harper Sci. Adv. 2015;1:e1400180 3 April 2015

In the above illustration, the red line marks the point at which revenues cover the cost of sales, thus defining dependency of the metals. For the Canadian and U.S. mines, costs of sales exceed revenues, as indicated by the red number at the right.

With the host being the metal with the largest economic contribution and the companions those with smaller economic contributions, it can be seen that, in 2008, for the South African and Zimbabwean mines platinum was the largest revenue contributor and, hence, the host in both. In Norilsk's Russian mine, nickel was the host. And both the U.S. and Canadian mines ran a deficit that year!

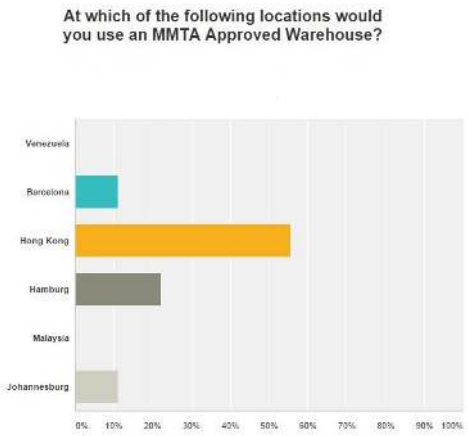
I believe, however, that it is particularly important to note, as pointed out by Dr Nassar subsequently, that when the economic companionality analysis was done for the platinum group metals, the data was obtained for the vast majority of operations, covering nearly all global production. However, such data are often absent for most minor metals. Indeed, data such as potential recovery rates and price elasticity of supply for most minor metals are often not known (at least to outsiders) and so the responsiveness of their supply to changes in demand is difficult to anticipate.

There were a number of other fascinating results discussed in the research paper, and which Dr Nassar also addressed in his presentation. Two such results which cannot be addressed here were: 1) the importance of understanding the dynamic nature of companionality – "*changes in production in different countries or in ore deposits within countries may change over time*" and, indeed, do; and 2) since 18 of these 38 elements having companionality greater than 50% ("*including such technologically essential elements such as germanium, terbium, and dysprosium*") can be "*further characterized as having geopolitically concentrated production and extremely low rates of end-of-life recycling*", the issue of supply constraints from these particular metals should not be overlooked.

I can only exhort you to Dr Nassar's paper (dated April 3, 2015) in Science Advances at http://advances.sciencemag.org/content/1/3/e1400180. It is excellent.

RESULTS OF THE RECENT MMTA MEMBER SURVEY

Thank you to Members who responded to the recent MMTA Member Survey. The result of the new Warehouse location question is below:



The Executive Team will work together with the Warehouse Committee to identify warehouses suitable for MMTA approval.

How to solve the problem of the shrinking kilo?

There is an international effort being currently undertaken to redefine the kilogram. This measure is currently based on a solid cylinder of platinum-iridium alloy locked in a vault at the International Bureau of Weights and Measures in France for over 125 years. This cylinder was then agreed to weigh exactly 1 kilogram, but inexplicably it has recently begun to lose weight, most likely due to the loss of gas locked inside the cylinder when it was made.

Mathematicians are currently working on replacing this solid metal block, known as the International Prototype Kilogram, with a mathematical constant (based on Planck's constant for those with a mathematical background).

"the standard kilo is literally losing weight"

In order to achieve this, however, they need to work out a way of estimating another mathematical constant called Avogadro's number (the number of discrete particles – molecules or atoms – in a 'mole' of substance. A mole of water, for example, is just a few teaspoons but it contains more molecules than there are grains of sand in the world.

The scientists at the heart of this research project have demonstrated their breakthrough by 'counting' the number of atoms in a kilogram sphere of pure silicon. They can estimate this because such pure silicon forms crystals of cubic cells each containing 8 atoms of silicon, and in this way, they can calculate the number of atoms in the sphere by calculating the volume occupied by each silicon atom.

Redefining the kilogram in such a fundamental manner will have an enormous impact on us all. It is the only one of the 7 base units on which all other units of measurement in science are derived that is based on a physical object rather than a fundamental physical constant.

Summarised from i, 15th July 2015 by Steve Connor

NEW MMTA MEMBER
Hickman, Williams & Company

Founded in 1890, Hickman, Williams & Company is 100% employee-owned and serves global metals producers and other industries with a wide range of materials including ferroalloys and specialty metals and alloys, such as Ni, Co, Ta, Hf, Re, Mo, W, Cr, Ti and Nb.

Consistent with our commitment to customer service, Hickman, Williams & Company maintains a network of strategically located sales offices, plants and warehouses to assure prompt delivery.

It is the Vision of Hickman, Williams & Company to be the premier supplier of high value products and services to the metals and other industries.

The Mission of Hickman, Williams & Company is to be the dependable source of high quality products and services for our customers, principals and employees. As an employee-owned company, we continually strive to improve these products with total customer satisfaction as our goal, while meeting statutory and regulatory requirements.

Contact: John E. Porter
Email: JPorter@hicwilco.com
Phone: +1 724 772 3090
Website: www.hicwilco.com

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niobium
41
Nb
92.906

Niobium products supplied:

- Niobium Electron Beam Ingot, Niobium Vacuum Arc Ingot
- Niobium Electron Beam Chips, Niobium Plate, Niobium Wire
- Niobium Oxide, Niobium Strip, Niobium Foil

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Colin Williams, RIP P. 3 continued

In early 1971, Colin joined a Rudolf Wolff delegation led by Jack Wolff and Francois Robert. They were promoting their candidacy as world sales agents for Peruvian metals and minerals, at the time under the exclusive marketing of Minero Peru, a state organization. This was the start of another of Colin's long-standing friendships, in this case with Carlos Grana and Ronnie Gillespie, who were in charge of marketing at Minero Peru. While the various agencies offered were evaluated, and rejected by Minero Peru, there was a strike at the Cerro de Pasco Lead smelter, which had created a growing bottle neck and stock of untreated Pb Concs. Colin registered this and from Lima he went to Mexico, where he mentioned this fact to Wolff's agents Jose Barroso and Raul Estevez, who brought it to the attention of Penoles. Shortly after, a first contract with Penoles was signed for the toll treatment during one year of a total of 100,000mt of Pb Concs which was soon extended for an additional period of 9 years, at the rate of 100,000 mtpy, making the total tonnage of this deal 1,000,000 tons of Peruvian Pb Concs. This anecdote of an Englishman brokering an enormous deal between two Spanish speaking countries was one Colin used to explain to new recruits the importance of travel, serendipity and gumption.

Shortly thereafter, the partners of Rudolf Wolff sold their LME business to Noranda. Colin always wished to set up his own company and the catalyst of Rudolf Wolff's sale to Noranda led him in 1972 to team up with Bernard Buckman to establish Wogen Resources at 17 Devonshire Street, where the company was based for 15 years before moving to its current location at No.4, The Sanctuary, Westminster.

From the beginning the focus of the new business was China and one of the initial deals brokered was the start of sales of Iron Ore from the newly developed Hamersley Iron mines in the Pilbara, Western Australia to Minmetals in China. This was the beginning of a 30 year relationship with the CRA subsidiaries Hamersley Iron and Comalco, which only ended in the early 2000's, by which time Hamersley was selling many tens of millions of tons per year of Iron Ore to China and Comalco many hundreds of thousands of tons of Alumina.

By 1980 Wogen's star in China had risen so far as to qualify Colin and Bernard for an audience in the Great Hall of the People with Deputy Vice-Premier & Politburo member Wang Zhen. Wogen was at the forefront in developing a presence on the ground in China and opened one of the first wave of accredited representative offices in Beijing in 1980, following up with an office in Shanghai in 1984. Similarly Wogen was at the fore-front of opening a Wholly Foreign Owned Enterprise in 2004 as soon as that was allowed.

As a counterpoint to China, Colin thrived in doing business behind the iron curtain and made forays to Moscow, which involved trade in comparable proportions to those he undertook in the PRC.

From his time in California onwards, Colin had developed a keen interest in the materials being used in the developing aerospace industry, in particular Titanium. A fortuitous combination of British metallurgical processing capability combined with large-scale generation of Titanium turnings in US machine shops and the development of HSLA steel resulted in Sheffield becoming the Ferro Titanium production centre of the world from the 1970's through to the 1990's. Rudolf Wolff had teamed up with Geoffrey Willan and Jim Ingall to supply raw material from the USA for melting in Sheffield, with RW marketing the FeTi product. This was the basis of Willan-Wogen Alloys, formed in the mid 1970's in Rotherham, a JV company which Wogen later acquired in full, and which formed the core of Wogen's substantial Titanium business until the FeTi processing section was sold in 2000 to London & Scandinavian Alloys leaving Wogen Titanium Ltd trading and processing Titanium Sponge. In 1990 Willan-Wogen Alloys Ltd was awarded the Queen's Award for Export Achievement and in 2006 Wogen Titanium Ltd was awarded the Queen's Award for Enterprise, achievements of which Colin was rightfully proud.

In 2005 as the industrial revolution in China was taking off, Wogen became only the 2nd pure metal trading company to float on the London Stock Exchange, MG UK being the first in 1999. While the aim of the flotation was to facilitate succession planning and the further development of the company, the Company found itself out of sympathy with the expectations which the stock market had of a quoted company and when the stock market crashed in 2008/9 to a level where the shares were trading at a fraction of the net worth of the company, a number of employee shareholders decided to take the Company private. Wogen remains a private company owned solely by employees.

Colin had several interests outside of work which centred around providing support and guidance to communities close to his heart. He was appointed a Trustee of Uppingham School in 1991 and was Chairman from 1999-2008. He was instrumental in the creation of the Uppingham Foundation in 1999 and his great strength lay in encouraging others to help support the School too. He was an Active Honorary Steward of Westminster Abbey from 1992 until 2012 and served the YMCA as a Vice-President. Colin's hobbies and interests were listed as 'hymn singing, fly fishing, watercolours and beer drinking'. He was made a Freeman of the City of London in the 1960's and admitted as a Liveryman to the Worshipful Company of Broderers in 2002.

On the evening of Monday 20th July 2015, Colin's body rested overnight in St Faith's Chapel in Westminster Abbey, an honour afforded him as a former Honorary Steward, followed the next morning by a Requiem Mass.

On Wednesday 22nd July a Funeral Service was held for Colin in his Parish Church in Conington, Cambridgeshire. He is survived by his wife, son, daughter and grand-daughter.

Deep sea mining update

I admit that I sometimes choose topics for Crucible articles based on their 'wow' factor, but one topic that has cropped up repeatedly since I originally covered it is deep-sea mining. At each update the plans to exploit the resources at the bottom of the ocean seem to be getting more and more concrete.

As previously discussed, authorities at the little known Jamaica-based International Seabed Authority (ISA) (a UN body) are issuing exploration contracts. Understandably conservationists are very concerned that not enough is known about the fragile biodiversity of the ocean bed to even consider mining, as well as the lack of clear information on the risk of extracting minerals.

According to the ISA private sector interest in this untapped area has grown massively in the past 5 years, with very significant investments being made. I previously wrote about the sale of a British underwater machinery company to a Chinese firm.

In response to these developments a Deep Sea Conservation Coalition has been formed by international scientists. This group has urged ISA to temporarily halt authorization of new mining contracts until networks of "marine protected areas" are established around areas targeted for mining. This was published in a recent article in the journal *Science*, (July edition). However, in recent days ISA authorised its latest exploration contract, a 72,745 square kilometre (28,087 sq. mile) permit in the Pacific to China Minmetals Corp. China now has the most permits from the U.N. body, with a total of four.

So far, most of ISA's contracts have been issued for the deep abyssal plains of the Clarion-Clipperton Fracture Zone, the area of the Pacific Ocean off Mexico and the U.S. At depths of 4,000 to 6,000 metres, it is known to be rich in nodules containing copper, cobalt, manganese and significant concentrations of rare-earth elements. As part of an environmental plan, ISA has set aside nine areas in this zone, prohibiting them to contractors.

It seems incredible that there is high interest in deep sea mining, given that conventional mining companies are struggling to secure funding for far less complex on-land projects. It remains to be seen if any deep sea project becomes a real source of materials.

Tamara Alliot, MMTA

NEW MMTA MEMBER
Telex Metals LLC

Telex Metals is a minor metals supplier, manufacturer and recycler known for quality processes and products—and integrity of their people.

A respected source of tantalum, tungsten and niobium, Telex is a strategic business partner with the ability to meet customers' key business needs, providing security of supply, settlement transparency, and integrity to honor commitments despite changing market conditions.

Telex has experienced consistent positive growth since its founding. Telex's customer base and sources of supply are international. Telex has been certified as a Conflict Free Smelter (CFS) under the conflict-free sourcing initiative from EICC/GeSI since 2011. Their management team brings more than 150 years of combined metals industry experience.

The headquarters and manufacturing facility is based in the United States just outside of Philadelphia, Pennsylvania. They are compliant with all applicable US safety and environmental regulations and have the necessary permits to operate and support their customers' needs. The facility is a zero-discharge facility; all liquid and physical waste is neutralized and shipped to an approved treatment facility for processing.

Telex benefits are:

- Value-added recycling and processing of minor metals into premium products
- Guaranteed destruction of proprietary parts
- Customer-focused, flexible solutions
- Industry expertise
- Proven commitment to quality and the environment

Contact: Matt Danish

Email: matt@telexmetals.com

Phone: +1 215 781 6335

Website: www.telexmetals.com

IMPORTER COVERAGE THROUGH THE ONLY REPRESENTATIVE FACILITY

The EU's Chemical Regulation REACH has introduced a new area of chemicals management, not only in Europe, but globally. This legislation applies only to legal entities in the European Community, companies located outside but exporting products into the customs territory of the EU are not bound by the obligations. However, the Regulation allows for the Non-Community Manufacturer, to appoint someone established in the EU to act as his Only Representative (OR). This provides some advantages for the Non-Community Manufacturer (NCM), within the supply chain and for the EU-Importer. The OR has the right to act on behalf of a NCM to fulfil several obligations of REACH. In doing so, the OR prevents a distortion of competition between EU and non-EU manufacturer. REACH Article 8 outlines the Only Representative facility. The OR operates on behalf of an appointment by the NCM. The legal consequence of the appointment is that the OR has the right to act on behalf of the NCM and, thereby, must fulfil the „obligations on importers". Formally, he acts as the pre-/registrant of the particular substance, and he is legally responsible for the registration. Therefore, the OR has to fulfil the registration obligations and all other obligations of importers under REACH. At the same time, the importer within the same supply chain is relieved from his obligations under REACH: The importer is regarded as a downstream user.

Meanwhile, the OR-facility seems to be an attractive option within chemical control legislation in some non-EU countries that are implementing similar schemes. Turkey adopted an equivalent OR concept in its implementation of REACH-like legislation. South Korea has moved towards Korean REACH (or K-REACH) with its own version of an Only Representative. K-REACH is in force since 1st of January 2015 and exporters of chemicals to Korea can cover their importing customers through the OR Facility in Korea. ORs can submit the annual reporting to the authority on substance volumes & use, substance registrations or exemption applications and fully cover the Korean imports.

Through our offices in Europe and Korea, CHEMSERVICE can offer a comprehensive OR service package and global regulatory affairs support on International chemical control legislation.

Contact: Chemservice GmbH, Dr. Dieter Drohmann, Email: d.drohmann@chemservice-group.com

CRM ALLIANCE PRESENTS AT TTIP STAKEHOLDER MEETING

On 15 July, Maurits Bruggink, as Secretary General of the Critical Raw Materials Alliance, was given the opportunity to make a substantial presentation to the TTIP Stakeholder meeting. The meeting was split up into 4 separate sessions, and the CRM presentation was among 17 presentations in the session on "Issues related to agriculture, small and medium enterprises, sustainable development, energy and raw materials". On the EU side, Mr. Petros Sourmelis, Head of Unit Market Access, Industry, Energy and Raw Materials at DG Trade represented the European Commission, and for the US side Ms Jean Kemp, USTR Lead Negotiator for Energy and Raw Materials.

At the end of the presentation, both negotiators asked a question: for the EU, this was which trade barriers existed for CRMs, while the US negotiator wanted to understand what existing unfair trading practices there are. There was no indication given as to whether and when the negotiators would address the CRM issues during the trade talks.

Chief negotiators' briefing

At the official TTIP stakeholder briefing on 15 July 2015, the chief negotiators of the EU and the US, Ignacio Garcia Bercero and Dan Mullaney, briefed interested industry and civil society organisations about the 10th round of the TTIP negotiations taking place in Brussels from 13 to 17 July 2015.

Dan Mullaney specifically referred to the presentation on critical raw materials given to negotiators by the CRM Alliance earlier in the day. He stated that trade in critical raw materials, as they are used in high tech industries, would be discussed by EU and US counterparts during the course of the week's negotiations. This is of course a positive development, and shows that our efforts are bearing fruit.

On the subject of chemicals' regulation, it was underlined by Bercero that there will be no compromise on REACH or its implementation and no limitation to the power to regulate as a result of TTIP negotiations. The two sides are however continuing to discuss ways to cooperate on chemicals regulation. This can be read as a reference to the non-paper on chemicals regulation, which outlines the EU's proposals, inviting comments from and exchanges with US regulators, namely the Environmental Protection Agency, on the subject of various steps of the REACH regulation, such as the CoRAP substance evaluation, the Authorisation and Restriction procedures, and also on the CLP regulation.

Recommended action:

The CRM Alliance is to prepare a detailed paper on trade issues, including the main trade flows, barriers and practices. This paper, which could include recommendations to become a position paper, will help negotiators for TTIP and other bilateral or multilateral trade talks to orientate their negotiations and make improvements for trading of CRMs.

CRM Alliance, Brussels

Other Trade news: Vietnam EU Trade deal

On 4 August 2015, the EU and Vietnam reached an agreement in principle for a free trade deal. Negotiations for an ambitious and comprehensive FTA [Free Trade Agreement] were launched in June 2012 with a view to ensuring an effective environment for trade and investment relations. The EU and Vietnam still need to settle remaining technical issues and finalise the legal text. Once finalised, the agreement will need to be approved by the Council and the Parliament. The agreement will contain a legally binding link to the Partnership and Cooperation Agreement (PCA) that governs the overall relationship between the EU and Vietnam.

The agreement in principle reached on 4 August 2015 for a free trade deal includes the elimination of nearly all tariffs (over 99%). Vietnam will liberalise tariffs over a 10-year period and the EU will liberalise tariffs over a 7 year period. The agreement also covers non-tariff barriers to trade and other trade related aspects such as public procurement, regulatory issues, competition, services, investment, intellectual property rights, and sustainable development.

Trade picture

- EU exports to Vietnam are dominated by high tech products including electrical machinery and equipment, aircraft, vehicles, and pharmaceutical products. Vietnam's key export items to the EU include telephone sets, electronic products, footwear, textiles and clothing, coffee, rice, seafood, and furniture.
- The EU has a negative balance of trade in goods with Vietnam. In 2014, EU-Vietnam trade in goods was worth over €28.3 billion, with €22.1 billion in imports from Vietnam into the EU, €6.2 billion in exports from the EU to Vietnam.
- The EU is one of the largest foreign investors in Vietnam. In 2013, EU investors committed a total US$ 656 million in Foreign Direct Investment and thus remain Vietnam's sixth largest foreign investor's partner.

Update from the EU Commission

Managing Sustainability

Sustainability, a strategy employed to address risk and simultaneously create opportunity from that risk, is not a new concept. At a business level, it ensures that an entity can function profitably, including creating competitive advantages, fostering innovation and mitigating risk. The methodology fares best via a systematic approach, such as when it is ingrained into cultures that span every department within a business, and further beyond to its stakeholders. However sustainability might be defined, the concept is integrated daily. Today though, both markets and policy demand the concept move through its next evolution: defining its purpose composition.

Sustainability today involves long-term planning with heavy emphasis on environment and social welfare – an incredible leap from a hundred years ago. Given the advancement of technology and increasing knowledge of biology and social well being, sustainability as a whole attempts to ensure that decisions made today will mitigate long-term risk. It's a big shift in a society or company to plan well ahead into the future, but if your company plans on being in business for multiple generations, why not create a rough map for the long-term?

What will your company be in 50 years? What are some major risks your company faces in the long-term? To make this a practical exercise, because of the many ideas one can have for the future but can only speculate what it may entail, we begin with where we want to be at the end. Envision 50 years in the future; what will the company and industry potentially look like, and what should your company look like? You then ask what would need to be achieved at the halfway point, 25 years, in order to be on track to the 50-year goal. Cut the 25 years in half, and then do it again and again, and you end up within a year or two from present day. This strategy of "backcasting", which is a tool of The Natural Step, a non-profit addressing sustainability for the last 25 years, allows a company to make big goals for the future, then break them into digestible segments and timeframes.

Every aspect of a sustainability strategy, or plan, should incorporate risks that will significantly impact the company's finances. As trends change in resource availability and regulations, externalities, many of which are not accounted for today, may need to be accounted for at great expense to those who do not plan in advance. It is also important to acknowledge that not everything can be easily quantified or translated into dollars. Goals and projects that do not distinctly appear in the bottom line can create tremendous value.

Direction for the plan can be taken from multiple resources, none maybe more important than the business itself. How well do you understand your business or department? What data are you collecting and how are you analyzing this data? Internal communication, organization and planning are essential components to successfully implementing long-term sustainability. It is also important to have leadership and assigned roles dedicated to the effort. Sustainability can be a daunting challenge and therefore its implementation requires ample resources. As these components fall into place – goals, roles, responsibilities and actions to be taken, the organization can produce, as most addressing sustainability do, a Sustainability Report, or Corporate Social Responsibility (CSR) report.

This report ensures monitoring of progress towards goals and continued focus on important issues in the present and future. It can be seen as half strategy map, and half measurement and verification tool. Additional value from this report is derived through its creation of engagement with stakeholders outside the company, a communication channel that can allow for proactive instead of reactive positioning. Sustainability reporting fosters industry evolution as well, as organizations use the data to benchmark against each other, in addition to leveraging data to create policy and guide industry innovation – benefits to all stakeholders.

One challenge to sustainability reporting involves standardization of measurement. There are multiple software companies offering sustainability tracking and reporting, all with slight variations of how data is manipulated. Different products also exist that are industry, process, or entity size, specific. To find what may be best for your organization, it is best to reach out to your industry associations engaged in sustainability. One place to start may be the MMTA's Thinking About Sustainability beginners' guide for SMEs.

For an understanding of what sustainability reporting generally entails, two established organizations that provide reporting frameworks include the Global Reporting Initiative (GRI), and B-Corp. For metals, numerous companies are tackling sustainability issues and reporting – some addressing the issue through CSR reports, and some including the subject in their annual reports. There you can find their goals and benchmarks, progress, certifications and qualitative endeavors. Especially with the recent downturn in metal commodities, organizations may want to look into what it would take to create a sustainability roadmap and reporting process.

Sabrina Dias, a CSR consultant in the mining and metals industry who, as one aspect of her job, travels across the globe to bridge the gap between mining companies and stakeholders at the mining site, spoke about her experiences in sustainability. She recently produced a sustainability report for precious metals company.

Her perception is that sustainability in the metals industry is going to expand, as it is a powerful framework for mitigating risk. Increasingly, she is seeing stakeholder engagement in business plans, and companies and organizations defining and implementing long-term sustainability. Her perspective is that companies with a systematic approach, as opposed to one that is linear, create the most value.

A 2015 study published by physicists at the University California, Berkeley, estimated that 1.6 million people in China die annually because of air pollution. In almost the entire eastern half of China, the small particulate matter is at higher concentrations than that of Madera, CA, the city in the United States with the highest concentrations. And recently in the news, there have been reports of factories in China almost fully automating their production facilities, with the exception of a few workers to monitor computers. Although this is nothing new, Mercedes and other top global manufacturers have had fully automated robotic assembly lines for some time, it reveals a little more about what the future may be, and asks what we want it to be.

A manufacturer, looking at this from a sustainability perspective, may think about the possibilities of fully automated facilities in the next 20 years in order to stay competitive. If so, where and how would they procure the energy for these types of operations? Would they have to pay for their carbon emissions? How would this impact their workforce of human labor and what would the adjustment look like? When should they begin investing and planning for these challenges? How will the community and government perceive these changes?

Benefits of Sustainability

⇒ Cost savings, long and short-term

⇒ Reduced market risk and volatility

⇒ Better defined and more apparent opportunities

⇒ Proactive instead of reactive market participant behavior

⇒ Shared best practices through standards and reporting

⇒ Long-term industry and business vitality

⇒ Branding / marketing opportunities

⇒ Financing opportunities

⇒ Increased competitiveness

Currently, industry is at a crossroads of embracing innovation and change. It's a push that will come internally, or will be forced at great expense, externally. The definition and criteria need to be broadened and cultural integration must increase.

Investments towards the allocation of resources into sustainability programs should be expanded. Companies that are proactive and execute long-term goals will have a better opportunity to create legacies.

Bryant Dulin, MMTA Sustainability Working Group

NEW MMTA MEMBER
Aminco Resources LLC

Established in 1986, Aminco Resources delivers financial and commercial solutions for the physical supply of carbon, minor metals, and rare earth products. With a combined experience of over 100 years, the principals of Aminco bring global expertise in both the supply and production of raw materials for the primary aluminum, steel, ceramic, chemical, and electronics sectors.

Aminco's headquarters are in New York with offices in Zurich and Beijing. Additionally, we have an extensive network of agents worldwide to support product supply and customer service. Importantly, we work closely with our primary suppliers, often times establishing joint-ventures or partnerships, to ensure stability of product quality and availability as well as supply chain efficiency. From 1990 – 2001, the principals of Aminco owned equity in a large US based calciner, Venco, in a 50/50 joint venture with Conoco (now ConocoPhilips), where Aminco was responsible for marketing.

Aminco's rare earths and minor metals division focuses on the supply of critical raw materials to the master-alloy, magnetics, ceramics, glass, catalyst, phosphor, and medical imaging sectors. Aminco remains interested and prepared to invest in asset-based opportunities that complement our core trading activities.

Contact: Melvin Hill

Email: m.hill@aminco.biz

Business Phone: +1-914-949-4400

Website: www.amincoresources.com

The MMTA's 42nd Anniversary Dinner

Tuesday 13th October 2015

InterContinental London Park Lane, London, United Kingdom

The MMTA's flagship social event, the Anniversary Dinner, is returning to the InterContinental, Park Lane, London.

Join circa 250 expected guests for extensive networking drinks, this year kindly sponsored by RC Inspection, followed by an excellent 4-course dinner, including wine.

Ticket prices have been held at 2014 prices– Book online or contact the MMTA Executive for an invoice

£105 for MMTA Members and their guests

£150 for Non-Members

(+ VAT where applicable)

To book go to the MMTA's website or contact the Executive Team

Special offer - Pay for a table of 11, and you get the 12th place free - To take advantage of this offer, please contact the MMTA directly.

EVENING ITINERARY

6.45pm Networking Drinks Reception kindly sponsored by RC Inspection

8.15pm Dinner

10.30pm Music, Networking & Late Bar

1.30am Carriages

The Drinks Reception is kindly sponsored by RC Inspection

RC INSPECTION

VACANCY

PhD Studentship in Material Substitution, Resource Efficiency and Circular Economy

Applications are invited for a PhD studentship within the Sheffield University Management School (SUMS) and the Department of Materials Science and Engineering, at The University of Sheffield. This PhD will start in 2015/16, and is funded by the Engineering and Physical Sciences Research Council (EPSRC) in the area of material substitution and circular economy. This researcher will be part of the team in the Advanced Resource Efficiency Centre (AREC) and the Functional Materials Group; working closely with other researchers in the EPSRC funded materials substitution and sustainability programme.

Advancement in technology and product innovation for smarter and smaller products have led to increased supply chain complexity in ensuring security of materials supply especially, precious, critical and rare earth materials embedded. With volatility of materials price and control of their availability, these have driven many industries to explore and mine virgin materials from source. This practice is unsustainable given the impact of this process on the environment and climate change. Responding to this challenge, circular economy has been actively promoted as a new paradigm to address resources scarcity by reuse, recycling and recovery, in which second life of materials (or repurposing) are provided to feed into the economy. On the other hand, critical research has also focussed on materials substitution to reduce reliance on these materials. However, ensuring the shift from a linear economy to a resource efficient, substitution mindset and circular economy paradigm has not been well understood theoretically.

The circular economy approach is seen as a potential solution to the planet's emerging resource crunch. Reserves of critical materials such as rare earth elements and other important minerals are diminishing, with a corresponding rise in the costs of exploration and material extraction. The current linear economy, which adopts a 'take-make-dispose' approach results in massive waste. This level of waste together with potential supply risks are contributing to volatile commodity prices. In this research project, we will focus on the top-ten materials identified in Cucchiella, A'Adamo, Koh and Rosa (2015), namely gold, copper, palladium, plastics, silver, aluminium, tin, barium, platinum and cobalt. Some of these issues could be stabilised through the decoupling of economic growth from resource consumption.

To this end, this PhD research project will focus on developing new methods for quantifying the material flows and environmental trade-offs associated with these materials substitution and recycling within the resource efficient and circular economy framework. This will entail prediction of the environmental impact of recycling/substitution versus mining for the production of critical materials. It is intended that the current research work will contribute towards solidifying the economic and technical foundations for material substitution and recycling options in addressing materials supply chain sustainability.

Requirements:

Students with a First or Second High Upper Class Degree in Material Science and Engineering/Chemistry/Chemical Engineering, Environmental Science, Engineering Economics, or a closely related subject are invited to apply. Candidates should have a strong quantitative background including in life cycle assessment, input-output analysis and a deep understanding of recyclability of materials vis-a-vis circular economy. Experience with LCA modelling tools is preferred. Knowledge of separation techniques, process modelling and material substitution is desirable. Demonstrated ability of independent academic research and contribution to scientific publications will constitute an added advantage.

Under this funding scheme, UK citizens are eligible, as are EU citizens who have been resident in the UK for the 3 years preceding the date of application. The studentship is for three years starting in September 2015 and will provide full coverage of tuition fees and an annual tax-free stipend .

For further enquiries regarding the position and application procedure, please email your research proposal, CV and Cover Letter to Professor Lenny Koh (S.C.L.Koh@sheffield.ac.uk) or Professor I.M Reaney (I.M.Reaney@sheffield.ac.uk).

NEW MMTA MEMBER
Titan International Inc LLC

Titan International, Inc. is a world-class manufacturer, trader and recycler of high-value specialty metal products. For over 25 years, we have built our reputation on expertise, reliability and service – providing a broad line of quality products and custom solutions based upon our clients' unique requirements. Titan's technical staff of metallurgists, chemists and engineers work hand-in-hand with clients to provide product consulting, market research and custom material development.

Operating from our 200,000 square foot state-of-the-art production facility, Titan produces products of the highest quality and purity at competitive prices. Titan's products are approved for use in the most demanding applications and industries, including aerospace, automotive, energy and defense.

Titan's products include pure rhenium pellets, ammonium perrhenate (APR), tungsten carbide grits and powders, ferro-alloys and other metal powders (including ferro-niobium, ferro-vanadium, and ferro- tungsten powders), as well as aluminum, tin and copper powders.

Titan maintains strategic global partnerships that allow us to provide our clients with a wide array of quality products including hafnium, tantalum, niobium, rare earths, chromium, cobalt, copper, molybdenum, nickel, silver, tungsten, and zinc to name a few, along with chemicals for the plating industry.

Over the years, we have expanded to include industry-leading and environmentally responsible metal recycling and recovery processes. We recover high-value constituent metals such as rhenium, nickel and tantalum from a variety of scrap sources. Titan also provides clients with "closed loop" toll processing services, enabling clients to reclaim valuable constituent metals from their scrap sources, for re-use in their own production.

Contact: Christopher Devone

Email: devone@titanintl.com

Phone: +1 856 735 2220

Website: www.titanintl.com

Cobalt and Horse Doping

This past year, horse racing regulators worldwide, most recently in Australia, have turned their attention to an unexpected substance: cobalt. Every horse needs this important element to survive, but some horsemen believe that supplementing the substance will help their horses gain a competitive advantage on the race track.

Cobalt is a trace mineral found in B vitamins that horses require in tiny amounts for correct functioning of their physiology. As a result, all horses will have trace amounts of the substance in their systems. (Humans also need cobalt in B vitamins with dietary sources including meat, liver, kidney, clams, oysters, milk, ocean fish and sea vegetables such as seaweed.)

Doctors have used cobalt to treat anaemia (essentially by increasing the blood's oxygen-carrying capacity) in humans for decades. However, it was associated with a variety of adverse effects, including gastrointestinal, neurologic, cardiovascular, and thyroid problems. As a result, doctors have largely ceased using it. Some athletes, however, continue using it as a doping agent.

Until recently, researchers had not evaluated cobalt supplements' beneficial or adverse effects in horses. Nevertheless, as racing regulators' interest in the element has increased, so has the amount of research.

Last October, Indiana set a race-day cobalt threshold of 25 ppb for horses in that state. Doctors stated that prior to the threshold's

implementation, 6 to 7% of horses tested had increased cobalt levels. Since implementation, less than 1% of horses tested have had increased cobalt levels.

Kentucky is currently doing cobalt surveillance. The Racing Medication and Testing Consortium had not yet recommended a threshold value at the time of this presentation, but should soon.

Several additional studies assessing cobalt's adverse effects, the administration of cobalt-containing supplements and blood samples from non-racing Standardbreds are underway. Thus, there is work underway evaluating different cobalt testing methods, which can result in different test outcomes.

In closing, doctors stress that while illicit cobalt use appears to be prevalent, it's effects— whether these are negative *or* positive—aren't currently well-understood with no one having documented any beneficial effects scientifically yet in horses.

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08.30—09.30 Registration & Coffee	**Speaker**
The German political approach to the importance of CRMs	**Dr. Christian Kühne** Ministry for Environment, Climate & Energy, Baden-Württemberg
What is EU policy towards critical raw materials (CRMs)?	**Alexis Van Maercke** Policy Officer – Raw Materials, DG GROW
Supply risk and economic importance — what makes a material 'critical'?	**Dr. Frank Marscheider-Weidemann** Fraunhofer Institute
The role of the CRM Alliance in promoting and defending CRMs in Brussels	**Heleen Vollers**, CRM Alliance
Q & A and Wrap Up From Morning Session	**Christian Payn**, IMA

LUNCH & NETWORKING

Panel Discussion—What is the risk? Case studies looking at different elements of supply risk and economic importance for Europe • New European primary production of Mg in Turkey • Difficulty of developing primary production in Europe (REEs) • The trader view on supply risks • Trade issues and restrictions including new exchanges • Candidates for substitution (In)	Moderator: **Martin, Tauber**, President CRM Alliance **Ilhan Goknel** Eczacibasi Esan **Mark Saxon** Tasman Metals **Armin Buschhausen**, MD, Cellmark Metals Germany **Claire Mikolajczak** Indium Corp
The Way Forward	**Maria Cox**, MMTA

16.00 SHOWCASING OF DLR PROJECTS & NETWORKING DRINKS

International Magnesium Association

www.intlmag.org

mmta Minor Metals trade association

www.mmta.co.uk

When?

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Where?

German Aerospace Center (DLR)

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