Socio-economic research team

Dr. Thomas Höhne-Sparborth  
Director, Economics & Analytics  
Thomas completed a PhD at the London School of Economics focused on socio-economic spill-over effects and responsible for the management of Roskill's socio-economic consulting assignments assessments.

Dr. Nils Backeberg  
Senior Consultant  
Nils has extensive field experience as a geologist working in South Africa and Guatemala, is the author of numerous applications in his field, and provides input on technical and geological aspects of the study.

Jessica Roberts  
Division Manager  
Jess has a background in geology and manages Roskill's Technology Materials division, and is the editor of Roskill's latest titanium report. She has undertaken numerous consulting assignments in the titanium and other metal industries.

Nessa Zhang, MSc  
Senior Consultant  
Nessa graduated with an MSc in Operational Research and Management Studies. Prior to joining Roskill, she worked in an energy investment company and now closely supports Roskill's consulting assignments.

Jack Bedder, PhD Candidate  
Division Manager  
Jack has led consulting assignments on cobalt, nickel, vanadium, chromium, manganese, and others. He is an economist by training, and is completing a doctoral dissertation of critical raw materials at the University of Cambridge.
Four studies on nickel, chromium, cobalt and antimony ongoing, with broader implications for other metal industries.
Main purpose: To identify socio-economic benefits created throughout the value chain and product lifecycle

- **Production:** How many jobs depend directly on the mining and processing of cobalt, nickel or titanium?
- **Usage:** To what extent do downstream sectors depend on the use of these metals?
- **Indirect:** How much further activity is created among suppliers of energy, inputs, transport, and services?
- **Economic growth:** How do such metals and their usage contribute to research, investment, revenue, and tax income?
Socio-economic effects include those from the titanium value chain itself (**direct effects**), among supporting industries and those from consumer spending by employees in these sectors (**indirect effects**).

<table>
<thead>
<tr>
<th>Supporting industries</th>
<th>Energy</th>
<th>Transport</th>
<th>Legal/Financial</th>
<th>Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titanium value chain</td>
<td>Titanium minerals</td>
<td>Titanium production</td>
<td>First and end use</td>
<td>Recycling</td>
</tr>
<tr>
<td>Reinvested labour income</td>
<td>Consumer goods</td>
<td>Education</td>
<td>First and end use</td>
<td>Housing</td>
</tr>
</tbody>
</table>
Applications and motivations

**Sustainability reports**
Quantify direct and indirect impact on employment, including among suppliers and service providers
- Intuitive presentation
- Quantifiable data
- Indirect effects included

**Community acceptance**
Demonstrate contribution to local economies, businesses, job creation, and training opportunities.
- Focus on regional effects
- Emphasis on job creation
- Participatory approaches

**Feasibility studies**
Reassure investors, identify sourcing opportunities, drive local interest and and facilitate permitting
- Optimise sourcing strategies
- Demonstrate social awareness
- Pre-empt permitting concerns

**Industry assessment**
Ensure social credentials of the finished product and appreciation of industry's economic contribution
- Quantify indirect benefits
- Provincial/national levels
- Reputable methodology

**REACH authorisation**
Support socio-economic route to authorisation where risks of hazardous substances cannot be adequately controlled
- Route to REACH authorisation
- Following best-practices
- Covering multiple substances
TRUE EFFECTS OF METAL INDUSTRIES

Roskill
Mineral and metal processing industries contribute to local economies in a variety of ways, from generating employment, to R&D, and tax income.
**Indirect effects take into consideration the requirements of metal industries for inputs from supporting industries, as well as income effects**

- **Direct procurement**
  Goods, consumables and services purchased directly by the mining operation or project

- **Indirect procurement**
  Suppliers of steel, cement, etc. will themselves trigger further demand for energy, chemicals, transport, etc.

- **Income effect on workers’ spendings**
  Employment opportunities created by the operation mean increased earnings that are largely spent locally

Russian-American economist Wassily Leontief won a Nobel price in 1973 for his ground-breaking work on input-output analysis, which is still widely used today and forms the basis for Roskill's economic models used to assess indirect effects.
A metal processing plant is relatively capital intensive. But, its dependence on goods and services from other industries will often generate many more jobs in other sectors.
Indirect effects apply not only to employment, but also to value addition, research and investment, and generation of tax revenues.
SAMPLERESULTS

Roskill
Example from the nickel study: Over three-quarters of jobs resulting from indirect effects, and most jobs created in downstream industries.

Assessment of overall contribution of nickel to job creation in the EEA (number of jobs created)

- First Use: 125k
- Manufacturing: 190k
- End Use: 64k
- M-S-R: 40k
- Recycling: 17k

Total jobs generated: 437k

23.4% for Direct value chain: 102k
76.6% for Indirect: 334k

- Engineering
- Stainless
- Electro and electronic
- Structural products
- Construction and infrastructure
- Tubular products
- Repair and installation
- Security and defence
- Plating
- Automotive
- Mining, smelting and refining
- Non-ferrous alloys
- Social services
- Foundry
- Other services
- End use in primary sectors
- Other transport
- Transport and trade services
- Catering and entertainment
- Financial and real estate
- Battery
- Catalysts and chemicals
- Recovery and recycling
- Powder metallurgy
- Other
Attributing socio-economic effects among downstream industries depends on the calculation of **allocation factors** for metals such as titanium.

- Around 30kt of titanium used in aerospace in the USA
- Back-of-the-envelope estimate of value of $1Bn in 2018 (based on Ti-6-4 prices)
- Total value of aerospace manufacturing of about US$277Bn in 2018
- Titanium representing 0.48% of total output (**first method**)
- Titanium representing 0.82% of total inputs, including labour (**second method**)
- What percentage of aerospace is **critically dependent on titanium?** (**third method**)
**The larger the downstream sector, the smaller the share of effects allocated to titanium may be, but owing to the size of these sectors the net result is significant.**

Example of allocation of socio-economic footprint of the US aerospace industry to titanium:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Aerospace sector</th>
<th>Method 1: Titanium as % of revenue</th>
<th>Method 2: Titanium as % of inputs</th>
<th>Method 3: % of sector critically dependent on Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation factor</td>
<td>%</td>
<td>100%</td>
<td>0.48%</td>
<td>0.82%</td>
<td>3%?</td>
</tr>
<tr>
<td>Output</td>
<td>US$Mn</td>
<td>276,741</td>
<td>1,331</td>
<td>2,260</td>
<td>8,302</td>
</tr>
<tr>
<td>Value added</td>
<td>US$Mn</td>
<td>155,731</td>
<td>749</td>
<td>1,272</td>
<td>4,672</td>
</tr>
<tr>
<td>Employees</td>
<td>#</td>
<td>438,600</td>
<td>2,110</td>
<td>3,582</td>
<td>13,158</td>
</tr>
<tr>
<td>Labour income</td>
<td>US$Mn</td>
<td>41,988</td>
<td>202</td>
<td>343</td>
<td>1,260</td>
</tr>
</tbody>
</table>
Downstream sectors, such as aerospace, depend on a lengthy supply chain, so that indirect effects can be dramatic.

USA: Estimated on-site and indirect job creation by the aerospace sector

- On-site: 16%
- Direct suppliers: 20%
- Indirect suppliers: 64%

USA: Jobs created through aerospace industry estimated to be attributed to titanium

Method 1: Titanium as % of revenue
Method 2: Titanium as % of inputs
Method 3: % critically dependent on titanium

- On-site
- Direct suppliers
- Indirect suppliers
This same analysis must be undertaken for each sector in the titanium value chain, and in its supporting industries – on a country-by-country basis

- In the case of nickel, separate studies are being undertaken for all major producing and consuming countries.

- Owing to differences in labour intensity, some sectors may account for more jobs than their consumption of a metal might lead one to expect.

- Building and construction, for instance, uses much less nickel than engineering applications, but accounts for more jobs.
NEXT STEPS

Roskill
Step 1: Material flow analysis – Available on a global basis, but would need to be produced for each country to assess socio-economic effects
Step 1: Material flow analysis - would include a historical assessment, is essential to determine “loadings” of titanium in different end use sectors.

Some Facts & Figures
- In 2014, the EEA mined/smelted/refined 271 kt of Ni.
- At year-end LME warehouses held 149 kt of finished nickel in stock.
- First use of nickel amounted to 561 kt.
- 43.6% originated from recycling (e.g., stainless scrap etc.).
- Ni was mostly used for melting stainless steel.
- Non-Fe Alloys was the largest non-stainless application.
- End use of nickel amounted to 731 kt.
- Higher use due to net-imports of Ni containing products.
- Nickel and related industries provide for around 846 k jobs (direct and indirect).
- Engineering is the largest direct employment sector (413 k jobs).
- Between 2010 and 2014, output of approx. EUR 189B was generated.
- “Value added” to society amounted to EUR 52B.
- The industry also spent approx. EUR 680 M on R&D.

The chart on the right illustrates the consumption of titanium mill products by application from 2012 to 2018.
Step 2: Industry assessment - Detailed company-by-company assessments provide detailed insights into employment, investment, etc.

Example: The example on the left shows Roskill’s estimates of the number of jobs created in the chromium mining sector in South Africa (not including indirect effects or employees in downstream sectors such as stainless steel). This data was assembled by meticulous data collection on every individual chromium producer in the country.
Step 2: Industry assessment – More detailed company data, gathered through surveys on a confidential basis, can also provide more detailed insights into procurement patterns and indirect effects

Example: The charts below provide an impression of the type of data that might be extracted from a company’s procurement data. Such data can be incorporated either on a confidential basis, or may be modelled by Roskill’s cost team, to provide an approximate but detailed insight into an industry’s cost and procurement patterns.
**Step 3: Economic modelling** – Material flow data and sectoral assessments are finally combined in economic models to estimate the net socio-economic benefits of the titanium value chain to society.

Example: A typical C$100M Canadian mining operation might only employ 114 employees directly. But, as mentioned on previous slides, such an operation will source materials and services from various suppliers around the region and beyond.
EXECUTIVE SUMMARY

- **Socio-economic studies** can be used to determine the contribution of the titanium industry to employment, value addition, research, tax generation, and investment.

- The great value of these studies is that they can take into account effects throughout the entire value chain, from mining and metal processing, through to end use in aerospace and other applications, and recycling.

- These studies can also map out **indirect effects**, resulting from the demand of the titanium value chain for various goods and services.

- In capital-intensive sectors such as mining, metal processing, and aerospace, **indirect effects often dramatically outweigh the “on-site” effects** on employment and other socio-economic indicators.

- Various similar studies already underway or completed, with **an existing methodology available**, suitable for use in a potential titanium study.