Metals
2040
EMIL IMMONEN
Data Analytics Lead
BSc (Tech)
emil.immonen@aalto.fi
+35850529251

MIKAEL HONKANIEMI
Project Lead
BScBA (International Business Management)
mikael.honkaniemi@aalto.fi
+35850529251

SHUANG LIANG
Industrial Design Lead
BE (Industrial Design)
shuang.liang@aalto.fi
+358465492528

JULIA KEMMERLING
Research Lead
BA (Marketing)
julia.kemmerling@aalto.fi
+358402592691

SHANI ARMON
Creative Lead
BA (Visual communication)
shani.armon@aalto.fi
+358402143043
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In the year 2040, drastic shifts in society will be forcing companies to adapt to new industrial standards to tackle problems in the modern era. An industry that faces great pressure to transform from an environmental, political, and cultural perspective is the metals industry - and this pressure will continue until major action is taken. Companies in the industry face four key challenges leading up to 2040. The challenges include the sustainability crisis, rapid digitalisation and unlocking the potentials in data, shifts in consumer demands, and the attraction of top talents.
1.1 The sustainability crisis

The environmental impact of the steel and iron industries is massive - with the two industries alone accounting for 8% of global carbon emissions today, emitting 2.8 Gt of carbon per year. (Energy Transitions Commission, 2018) The carbon emissions for the industries will continuously increase with demand peaks in the next 20 years unless drastic industry-wide changes are made. If there would be any hope of meeting the Paris Agreement’s objective of keeping global temperatures below 2°C, all industries would have to cut carbon emissions from 36 Gt to 20 Gt by the year 2040, and continuously reduce emissions from going forward. (Energy Transitions Commission, 2018)

In the year 2040, the impact of the sustainability crisis will have on organisations in the metals industry will be significant, as actions taken towards a more sustainable future are continuously being enforced. Public policy against carbon emissions in the form of carbon taxes could impact the profitability of organisations drastically with current production methods in place. Material scarcity with the likes of iron ore will strongly push organisations to develop new production methods to offset high commodity pricing with processes that utilise abundant resources in scrap. Renewable energy solutions will be a global norm. The metals industry are a vital player in developing a greener, more sustainable future.
Harnessing the potential in digitalisation and data across industries will be a vital factor in the success operations in 2040. The distinction between the digital and physical worlds in the way we live and work will continue to blur. The development of smart factories for automated production to streamline production and support functions will be a giant step for players competing in the field for efficient practices. Investment in digital technologies will be a vital step in promoting effective virtual work to enhance actions across operations ranging from maintenance to customer support functions. The utilisation of data in the metals industry will be a disruptor in the valuation of the products and services provided by the industry. Digitally-integrated products and services will become the new norm. Skills in IT and digital technologies will become a vital requirement across industries in order to manage highly valuable IT infrastructures and digital functions.
1.3 Shifts in consumer demands

By the year 2040, consumer demands for product and service standards will be altered drastically by trends affecting everyday lives. The global population will grow by 25% by the year 2040, causing concerns in demand expectations for industries heavily involved in infrastructural developments such as construction and transportation. (Keller and Bhayani, 2018) More than 68% of people will be living in urban areas by the year 2050, therefore the metals industry must meet demands from rapid urbanisation. (United Nations, 2018) Metals will be vital players in the development of sustainable and smart infrastructures globally as investments in infrastructure are projected to increase along with the growing population and growing middle class. (Keller and Bhayani, 2018) Industrial and consumer shifts can influence the demand for sustainable materials such as “green steel” will be favoured in a joint effort to decrease global emissions.

Shifts already impacting many industries today will increase their prominence over the years. A prominent trend today that is projected to grow is the sharing economy. (Tabcum Jr., 2019) People’s aspirations in owning less and accessing more will continue to trend through the year 2040, with industries such as the automotive industry and others to see dampened demand. The metals industry’s transformations in the future should accommodate for the shifts in economic behaviours.
1.4 Talent drought

With developing technologies and evolving working cultures, talent acquisition for top talents is a constant challenge in the eyes of employers. This is a current issue in the metals industry that will carry on into the future - especially with talent with modern technologies for functions such as plant management and maintenance. A challenge faced is the competition for engineers with backgrounds in IT and digital technologies, two expertise necessary for success in the development of digitally-integrated and automated metals plants. Difficulty attracting top talent globally also is factored through the combination of remote plant locations outside of urban areas, a collective desire to work towards something meaningful, and the pull-factor from trending industries such as IT and biotech. Industries like metals must make strong efforts in building reputable brands for employment that meet the desires of the potential talent for future generational challenges.
A joint project between Aalto University and ABB has been conducted to envision the metals industry in the year 2040 and to paint a picture of coming challenges and solutions. A massive shift in the industry’s operations and strategies must be made in order to tackle the challenges mentioned. Our vision of the metals industry in 2040 consists of plants and operations that will be community-oriented, digitally-driven, and constantly developing ecological solutions with the society around it.
2.1 The urbanisation of plant operations

Time will bring about many changes by the year 2040, including the optimal location for manufacturing facilities across industries. This is also the case with metals industries. With exponential urbanisation and the increasing propensity for communities to adopt circular systems into urban areas, actors the metals industry will have seized the opportunity to build manufacturing facilities near urban areas. These new urban manufacturing hubs will utilize the abundant scrap metal as a primary source for material, a result of a community-driven recycling systems coordinated between the municipality, customers, and the metals company. Consequences of global urbanisation can be utilised to benefit metals companies willing to embrace the shifts to a circular economy. Furthermore, employment opportunities in urban areas will be far more successful than in smaller municipalities, as millennials and younger generations are attracted to larger cities. (Florida, 2018) The talent pool in large urban areas will continue to grow, providing opportunities for companies looking to develop in a competitive, global era.

Organisations looking to revamp their current operations in remote locations must do so with close consideration to the strategy they wish to execute going forward. If the primary source of resources they will use is to be iron pellets, then accessibility to suppliers and trade routes will be necessary. Developing operations in urban areas will be vital nonetheless, as corporate and operational developments utilising modern technologies should be lead from urban areas with the talent pool to support it.
2.2 The evolution of raw materials

With new economic and environmental structures surrounding businesses in 2040, metals industry players will need to adopt new methods for how to utilise raw materials. A major change in the industry will be the use of scrap as the main resource for metal production - this shift will be down to several factors. Firstly, scrap metal production methods produce significantly less carbon dioxide emissions when comparing to traditional manufacturing methods, i.e. steel from iron ore pellets through a blast furnace. (European Commission, 2012) Secondly, due to trends of protectionism, raw material scarcity in regions like Europe will require companies to adjust their operations to use resources available. With adaptations to accommodate recycling and reuse, manufacturing companies are able to benefit from community-wide recycling efforts for their operations. A challenge to overcome is the energy requirements of using scrap as the main raw material for production. Metals companies must develop relationships and infrastructure with energy companies in order to build renewable energy solutions to comply with emissions regulations.

However, not all steel companies will have transitioned from iron ore pellets. Utilizing new methods of steel production must be implemented to lessen the effects on the environment. With scrap a primary source for raw materials, raw iron ore pellets processed with environmentally-friendly and sustainable methods will be a necessity to cover for inadequacies in scrap resources.
2.3 Two key methods for steel production

In principle, steelmaking recycled scrap steel will have similar processes in place in the year 2040 as it has today. More efficient and powerful electric arc furnaces will be utilised in the process to melt scrap metal into usable steel. A key difference in the process will be the energy input for the furnace, as renewable energy will be the primary source of energy by the year 2040, especially in regions such as Europe. (Vaughan, 2019) The major challenge when implementing scrap production will be effectively coordinating the recycling cooperation with nearby municipalities. Metals companies will need to utilize a community-based resourcing system in order to maintain competitive with this sustainable model.

In order to facilitate the carbon neutrality of the entire industry, processes to manufacture carbon-free steel from iron ore will be imperative. Although production entirely using scrap will become a leading force in the industry, the process does have its limitations. In order for iron ore steel production to remain a viable option among sustainable public policy and evolving consumer behaviours, production methods need to change in order to mitigate carbon emissions. (Olsson, 2018) The introduction of hydrogen-based steel production will be a major breakthrough in developing CO2-free steel production. The process radically changes the reduction process as it replaces the use of coke from coal to hydrogen gas - resulting in an offset of water instead of carbon dioxide.
2.4 Autonomous material transportation and production

In 2040, autonomous transportation will be a dominant development in the future of mobility of goods and people. In the case of the future metals industry, scrap metals and iron ore pellets will be transported utilising autonomous vehicles such as trucks, sea freight, and rail. The logistics operations will be managed semi-autonomously, as logistics managers will have the ability to supervise and control transport fleets from control rooms onsite.

Onsite transportation from loading docks to stock yards and onwards will be managed autonomously, as well. The transportation of people will be possible with electric, autonomous vehicles such as buses - transporting employees from point to point efficiently and swiftly. Raw material and finished goods will be transported throughout the plant autonomously, reducing risk of safety hazards and increasing production efficiency. Robotic operations and autonomous transport of materials will take the place of employees working on the floor on foot. Human labour will be a last resort for maintenance and operational tasks as digital monitoring of autonomous processes will be able manage the entire process from raw material shipments to customer deliveries. Digital control managers will all be located centrally in order to enhance communication, collaboration, and data flow between the different processes.
2.5 Additive manufacturing in production

Industrial additive manufacturing, or 3D printing, will be a vital but niche addition to the manufacturing capabilities of a metals plant. Additive manufacturing provides producers with the ability to design complex structures rapidly and with little waste. This production method can be seen as a additional niche value creator as it provides creative freedoms in smaller scale to mass steel production.
2.6 Predictive maintenance using artificial intelligence

Due to mass automation of the smart metals plant, physical access to the plant is mainly required in order to maintain equipment and machinery. Mobile and modular machinery throughout the production line that need to be serviced can be shipped to an onsite servicing area automatically for a predictive maintenance. Utilising artificial intelligence, maintenance can be scheduled according to the production schedules onsite, reducing lag time and delays. Immediate repairs that may cause halts to production can be communicated and coordinated between onsite engineers and digital control managers.

Onsite or offsite, maintenance can be assisted digitally from start to finish. For example, employees can receive real time assistance and guidance employing augmented reality and digitally connected tools. These tools provide step-by-step instructions and guidelines required in order to carry out maintenance operations - they will guide employees through what maintenance work needs to be done and in what order in order to ensure efficiency and prevent mistakes. As the maintenance is managed digitally, data will be collected on maintenance processes and improved automatically.

Additive manufacturing is a useful tool onsite for repairs and maintenance equipment. Equipment required for maintenance can be generated onsite utilising 3D printing, decreasing maintenance times.
2.7 Digitalisation and data-integration

With rapid digitalisation in the metals industry, the organisation must be able to manage a vast amount of data collected throughout the entire production process and ecosystem surrounding the plant. Integrating collaborative data management into the metals production cycle is imperative in managing production cycles, shipments, resource management, and maintenance of equipment and machinery in order to develop a streamlined production process. Creating a collaborative data structure is important for collective improvement between plant operations, and key partners. Close cooperation with the likes of suppliers, recycling units, customers down the value chain, and energy providers is vital.

2.8 Renewable energy powering operations

With the electrification of a majority of the operations on the plant, a vast amount renewable energy is required in order to operate the production at a feasible level. Developments in wind, solar, and biogas will have taken place to the point at which they will be widely accessible to all, but the plant operations must create its own renewable energy in order to generate the massive amounts required for operations. Wind turbines and solar panels will surround the operations of the plant and multilateral agreements between the municipality and energy companies must be agreed for the development power solutions viable for production purposes.
2.9 Digitally-driven employees

A majority of plant operations will be controlled virtually and remotely in 2040. With the development and installations of wireless technologies in 5G, processes can be controlled and supervised in real time. Due to the exponential improvements in automation and the vast amounts of data collected, human interaction to these processes is mainly limited to maintenance, process development and attention to special, unpredictable situations. A majority of the work in day-to-day processes will be the development of the digital technologies and IT infrastructures controlling the automated processes in the plant. Employee knowledge of technologies in machine learning, data analysis, and artificial intelligence will be vital. The ability to program will not be a prerequisite though, as increased attention into UI and UX of digital interfaces will enhance intuitive control.

2.10 Continuous learning and development

Competence centres with an aim to encourage continuous growth and learning will be vital to the employee base for metals companies. Strong connections to universities, vocational schools and other talent clusters are key to attracting top talent and utilizing talent pools for development. Visibility to young professionals is important in building a brand around modern values and to attract up-and-coming talent. The competence centres should continuously research new opportunities for innovation as well as offer education to new employees and students. On site training is needed much less, as training can be completed through realistic, virtual environments.
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3.1 Sales processes throughout the value chain

With increased automated processes along the value chain and a connected network of suppliers and customers emerging in 2040, the metals industry can expect optimized ways of capacity and order planning. While currently most metal plants already operate on a made-to-order basis, the sales process will be further automated, involving less human coordination. Regular customers’ ERP systems will be able to connect to the supplying metal plant directly to give up orders, shortening the amount of time invested in manual order making. Demand forecasting improved through machine learning systems will additionally help the metal plants to manage their internal capacities earlier and therefore more effective, allowing them to react faster to customer demands (Gezgin, Huang, Samal & Silva, 2017).

This change in sales processes, as well as the increased focus on global markets and new products with added-value for targeted customer groups will also significantly impact current organizational structure, business models and skills required by the sales force of metal plants (Chalabyan, Mori & Vercammen, 2018).

By 2040, sales force employees will likely require higher expertise in data management and even software engineering. Cross-cultural communication skills and proficiency in modes of remote work will be inevitable. Additionally, customer relationship management will become increasingly complex, as diverse stakeholders and suppliers partake in the value network in tighter relations. Ideally, the salesforce will therefore be trained in the principles of ecosystem management, knowing how to navigate multilateral stakeholder relations - in person and through integrated digital platforms (Marr, 2019).
3.2 Smart Materials in the Internet of Materials

In 2040, smart materials will have been adapted to the market, changing the way in which customers and suppliers interact in after-sales process. By saving and generating data, smart materials will simplify the after-sales process, as the customer can receive all needed data directly from their purchased products. The main benefit, however, stems from the emerging supplier ecosystem, as connectivity increases by means of the internet of materials. Across production steps, smart materials will be able to communicate their attributes directly to the machinery in the supplying plant, as well as in the processing steps of the customer. This enables a lean production set-up, requiring less manual configurations. In turn, the data generated during the processing can be utilized to further optimize production processes on a continuous basis.
3.3 Circular Economy

Enabled through smart materials and an emerging ecosystem connecting stakeholders in extensive network of customers and suppliers, the metal industry will have taken first steps towards a circular economy by 2040. This means that the new trackability of smart materials will enable metal manufacturers to follow their products even after the sell, enabling them to more efficiently initiate recycling of a high percentage of their manufactured material (Sitra, 2018). With materials being trackable and the value chain becoming more transparent, metal plants can adapt their process planning to include more scrap metal and other refurbished metal resources in their manufacturing processes, pushing a 100% recycled raw material quota. With a circular economy business model, metal plants and their customers would soon see significant savings in production time and costs, producing less waste and emissions (Atasu, Agrawal, Rinaldi, Herb & Ulku, 2018).


