

Factories 4.0 Europe

A vision for the
future of
manufacturing in
Europe
as the result of the
4th industrial
revolution

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They come from existing EU projects.

Preface

This note describes a vision on the future of manufacturing in Europe. It set our goals for the European implementation of the Fourth Industrial Revolution.

Within EFFRA it can be used to guide the manufacturing programs in the second part of H2020 towards reaching the goals as described in this vision.

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This vision expresses the view of the author, it is not a EFFRA, or European vision, yet.

Introduction

All our manufactured goods are getting smarter. They have to be more sustainable and should be recycled by its owner/producer. Users change requirements and use patterns more often. Products will change into solutions where a piece of hardware is part of a service. Product companies become solution providers shifting their focus on their customers and their needs. Their solutions are leased and the cash flow changes from being paid after selling a manufactured good into continuous payments for lease contracts. In the meantime these original product companies loose their interest in their own manufacturing as they outsource it to their suppliers. These supplier manufacturers face the opportunities to offer a more complete part/assembly or even the complete products. Previous, they got the order if they offered the lowest price. Now they have to invest to become flexible manufacturers. Every week, any moment orders can change, product designs change with changing user demands and at the same time zero-defect quality becomes the norm. But above all, the series size goes down while the manufacturing costs have to be at the cost level of mass-produced goods. Welcome in the heart of the Fourth Industrial Revolution.

The challenge for European supplier manufacturers is to transform their factories into smarter, but above all more flexible and closer markets factories. All this is possible due to the wide spread implementation of Internet-of-Things, cheaper and smaller electronics, advanced manufacturing tools as smart robots, 3D printing, etc. and the trend of “doing more with less materials”. It is expected that ultimately these factories will be smaller factories, spread over multiple metropolitan area's/regions able to manufacture to large extent products or parts for products of several product companies where not economy of scale, but economy of networking becomes the rule of the game. In this document we describe our vision on the end-result of this revolution for European manufacturers. With such a vision in mind, one can select the best strategy to get there.

What is this Factories 4.0

Factories will become smaller, closer to the customer and more modular. Manufacturing equipment is modularized in units of the size of containers. Each unit contains a smart, Internet connected piece of manufacturing equipment as a 3D-multi-material printer, a CNC machine, assembly robots, test equipment, etc. With these units one can produce all kind of products in small or series of 1. Most important for the supplier manufacturer is that the whole assembly of these units can manufacture continuously different product orders from different product companies. Extension and changes imply more or different units. New product types imply the download of the production recipes from the original product companies, in general the solution provider or in the long run customers designing their own solutions. Different markets will use different solutions and follow different growth and evolution paths in this “metropolitan” manufacturing. The concept of a large, today often Chinese, classical factory will change. If the factory with the steam engine is called factory 1.0, the T-Ford type factory 2.0 and then today's highly efficient mass production factory can be called factory 3.0. Factories 4.0 is the concept of the

factory able to output hundreds to million different configurations of unique products for the lowest cost price. Not efficiency and economy of scale, but the best economy of networking in a value chain creates a competitive advantage. In this network of value creation from customer/solution provider/supplier manufacturer, the supplier manufacturer is located close to the customers, in smaller, flexible factories and able to adapt continuously. This change in business model in manufacturing is one of the paradigm shift of the Fourth Industrial Revolution.

In Europe, many H2020 projects, *Industrie 4.0* (Germany) projects, *Smart Industry* (NL) Field labs, Vanguard Initiative plan for High-Performance Additive Manufacturing pilot lines are all examples of this trend. We need a shared vision, a common European goal, for the European Factory of the Future. Factories 4.0 tries to be that vision.

Industry changes continuously, it is adapting to changing environments ..

Historically industrial manufacturing went through different paradigms. Initially it was about increasing efficiency (T-Ford factories, Taylor). Customers wanted affordable goods and efficient mass production was the answer. In parallel with higher Maslow's pyramid levels, customers wanted better and then more unique goods. So after efficiency, the quality drive became important. This was followed by the introduction of MRP (manufacturing resource planning) and we got the area of flexibility (and logistics). Today it's about sustainability and doing more with less. All the previous paradigms remained, but factories themselves improved continuously. In the meantime, factories and their environment continue to change and in Europe we face already the next challenge.

Present situation in Europe, facing a change in customer behavior ...

Our society is not growing anymore and has no new middle class that requires many goods as in the sixties & seventies or as is happening today in Asia, South America and parts of Africa. There you will find the need for large-scale, economy-of-scale, high-volume factories for low cost product as we have seen in the previous century in Europe and North America. In terms of Maslow's pyramid new products as desired by customers in Europe will be more unique, individualized, create a feel-good factor (low energy used, recycled or renewable materials) and are expected to be smarter. Smarter in the sense of interconnected as in Internet-of-(every)-Thing means that the "hardware" part of the product is complemented with services. It is the combination of hardware/services that solves a (unnamed) need or desire or create a unique experience. In extreme you don't want to own things, you want solutions and go on. Young people in city centers want to go from A to B, they don't want to own a car of their own anymore. Why do you want to own a drilling machine if you only want to have a hole in the wall? In other words, the world of consumers, both individuals, companies and even governments, is changing and industrial manufacturers and producers of solutions have to adapt.

Versus the present industry having a balance sheet crisis, and facing a great restructuring

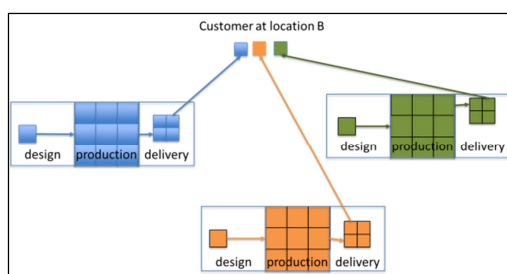
At the same time industrial producers as the original product companies are in an economic balance sheet crisis: low inflation, debts and hardly any growth. Restructuring in the sense of cost cutting and re-organizing implies less jobs and less growth. All surplus of the cash flow goes into restructuring the balance sheet, the transition to solution providing and financing lease contract. Currently there is also an under investment R&D as such.

Nevertheless technology continues to progress. Products are getting “smart”, they get connected to the Internet and producers can monitor their use. Instead of selling you a copier-printer, with the smarter products the printer company can also sell you a pay-by-use contract. If you print more, they replace the equipment, if it breaks down it is the supplier's interest to get it repaired as soon as possible, or even better to keep it maintained and serviced regular or with remote monitoring predicting the right service update. And at the end of its lifetime, the company knows exactly how the equipment was used. As the equipment is still property of the company, the company knows best what is in it and can refurbish it or recycle it as efficient as possible.

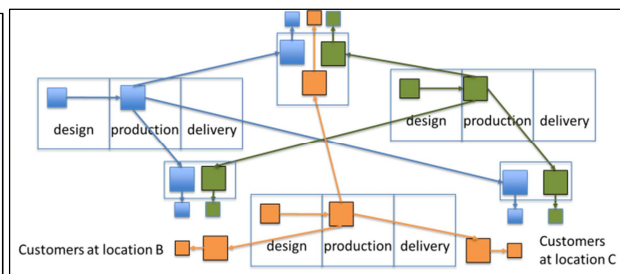
If you have a car, whether you own it or lease it, you would like to drive electrically, certainly in urban environments. But once you go on holiday or a long-distance trip, you would like to replace the electrical engine and batteries with a petrol engine. Cars are closed boxes, just like mainframe computers in the 80s before the PC entered the market. Soon cars will become more modular, just as personal computers. You will swap in and out components as batteries, the engine, or the whole car while still using e.g. your preferred software. Will you own by that time the whole car or do you lease an engine where the cost is determined by the (remotely) monitored use. Drive fast and wild and you pay more, drive smoothly and you pay less.

From manufacturer to solution supplier and from part supplier to supplier manufacturer

In industry we now face a situation that these “classical” goods manufacturing companies invest more in services close to their customers and request their suppliers to do more and more assembly. For example, in the automotive industry BMW does not produce their Mini's anymore, but has a supplier (the VDL company in Born, The Netherlands) do the manufacturing.



Pre-4.0 industries



Factories 4.0 with Metropolitan manufacturing

Suppliers at the same time become more the manufacturers and need to upgrade their factories. Some even have to engineering and design the requires parts themselves. As a result, suppliers have to invest heavily. However suppliers only got orders if they offered the lowest price. They do not have the cash position as large product companies. They face a balance sheet challenge too. Worse, they do not control the market of the end-user and are faced with smaller and smaller orders sizes. To cope with this situation, they want and need to serve more companies in different markets. But then they have to interface with coupling to different ICT systems where as the ordering companies today want direct control over the value chain to be able to change orders as the latest moment. With Internet-of-Thing and so-called cyber-physical systems (read intelligent, flexible, internet coupled machinery as robots and CNC equipment) and the proper standards this is possible.

But not only the business model changes, there is more to change, smaller, smarter,

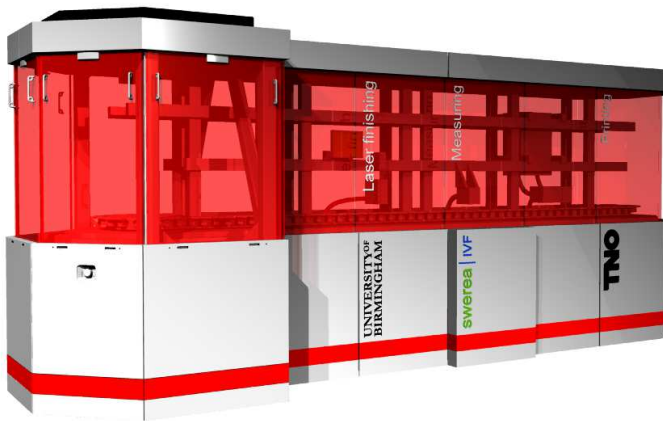
Products get smaller and more individualized. In the end the costs of a product is directly related to the amount of material. Cost of design can be written of after, say three years, costs of manufacturing equipment, say after seven years. The only costs, certainly in fully automated production processes, are the costs of the supplied components and in the end the costs of materials. In the continuous drive to lower costs, manufacturers will reduce the size and amount of material needed to manufacturing the product. They tend to build smaller and smaller or thinner products. One example of manufactured parts in the nearby future is printed electronics in flexible foils with a full computer in half a credit card to be embedded in all equipment and create the Internet-of(every)-Thing and all kind of services possibilities as individualized content services, remote monitoring, etc.

And finally in innovation you want to have a manufacturing capability close by. Manufacturing is an incubator for innovation. It is the place where new ideas are turned into real products. With all the possibilities of smarter and smaller products no one wants to depend on others far away. And you do not want to wait a long time for manufactured products in the initial phase when many small modifications are continuously needed. But you don't need a big factory, a flexible metropolitan manufacturing around the corner where all manufacturing recipes can be developed and tested is enough.

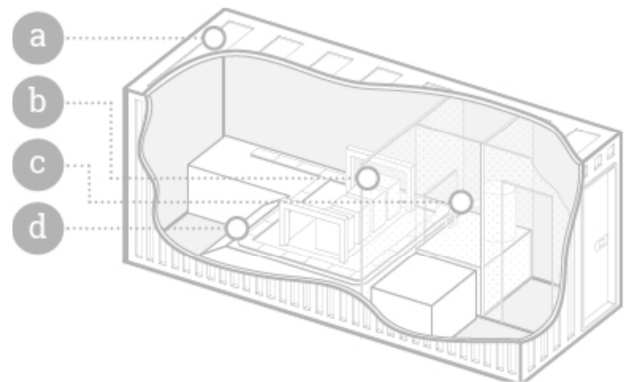
A vision of the Factory of the Future: Factories 4.0

Industrial Europe by 2020 and beyond will be around an evolved Factory of the Future concept of metropolitan manufacturing as already demonstrated in factories-in-a-container, factories-in-a-day and regional cloud manufacturing concepts. Here a group of skilled and disciplined workers run a flexible modular factory that can change and adept itself regularly, depending on the demands in their region. Consumers, professional users and solution providing companies will order through Internet. The closest by manufacturing capability with the best price offer and delivery time gets the order automatically. For larger volumes and more complex product assembly it might be a multiple-tier chain of orders, in a regional cloud-manufacturing manner with a network of sub-suppliers and assembly manufactures. Each factory unit will consist of a set of

“container” size equipment units with an automatic connection transport system between the units. A unit could be an automatic warehouse, a machining center, an additive manufacturing carousel, a flexible printed electronics unit, a robotic assembly cell, etc. And this mix of units can produce a wide range of products with design with manufacturing recipes from several different companies.



7th FP HyproLine



7th FP CassaMobile

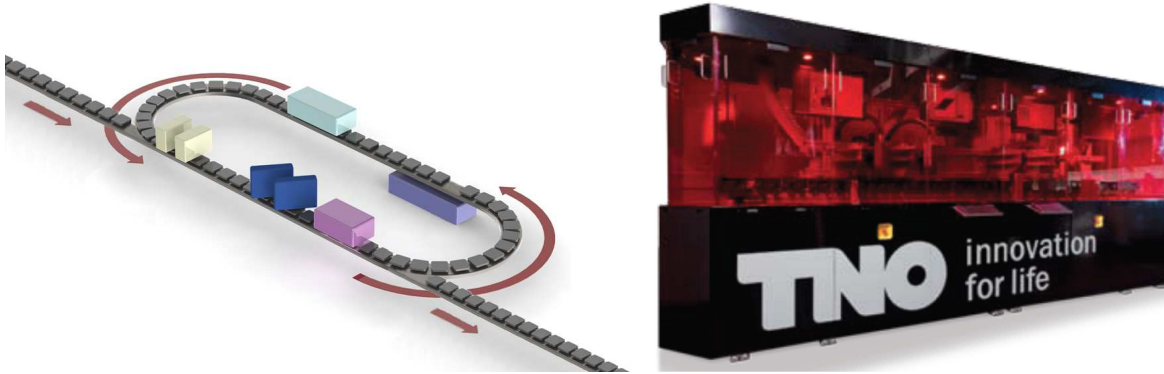
Manufacturing in due time will change in Europe from the large factories that companies once owned to Factories 4.0 regional/metropolitan “manufacturing (copy) shops”. The owner of the “product+service” will make use of these gradually emerging manufacturing shops of SME suppliers all over the world and located in regions close to the customers. They will protect their IPR by distributing key components only to “licensed” partners with modular fabs, will download embedded software and other means directly to the customer upon initial use. Although it might sound far away, it is already the situation with SME suppliers. They only miss the “smart” modular interconnected systems, but they do have a mix of equipment and skilled team of people. What they miss are the standards for all kind of units, for the interconnection between the units, interfacing to these almost automatic order executing modular metropolitan factories, a digital marketplace of manufacturers parts and goods and a more suited architectural design of the products.

Europe with its large machine tool business should take the lead in this concept of modular, container-type flexible factories as it requires a lot of (new) manufacturing equipment. In the long run this type of machine tool equipment will be installed world wide and be an export product. Finally, the concept of Factories 4.0 is not only for safeguard jobs in machine building, it is about creates and maintains value generating design and manufacturing jobs in metropolitan regions. Compared to the outsourcing trends of the last decade, this trend is also about getting manufacturing jobs back in town.

Every European metropole with a fab manufacturing Mercedes, Jaguar, Seat, ..

Majors with large plants will hate it, but the great company factories will disappear. Your new car of tomorrow will be produced at driving distance to pick it up the next day. Your

mobile phone of tomorrow is built and delivered in two hours after you order it. Ultimately, we will transport the bits & bytes for a product by Internet, and not the products. As weird and futuristic it may look, consider the following examples.



TNO PrintValley concept

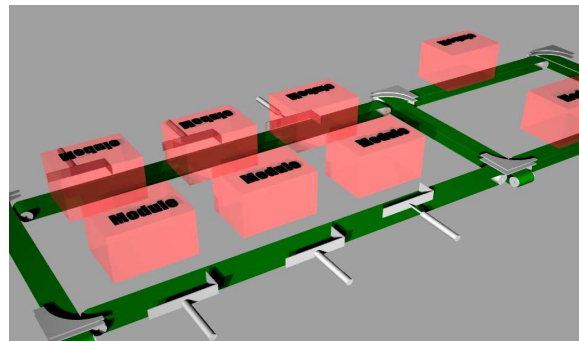
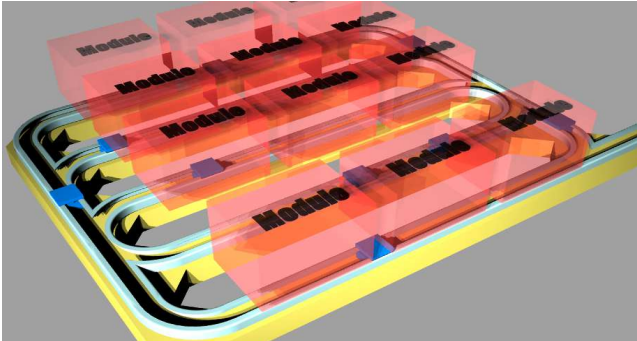
Your phone assembled with few standard components and printed around the corner ..

Semiconductor devices are designed by their (fabless) owners, but manufactured in generic fabs. Still the costs of these fabs is prohibited large to morph into worldwide distributed micro-fabs. With maskless lithography equipment as shown by the Dutch Mapper, this will change. With maskless litho very specialized single-chip can be produced in series of 1. For bulk type chips this will not happen and smaller CD (critical dimension) as 10 nano and 3D-structures will required the economy of scale of large sized fabs. But the growth is in specialized single chips. With the smaller and smaller electronics products, the trend to evolve to flexible foil and printed electronics will change the demand for computing devices (as Internet-of-Things) to different electronics with the specialized single chips with several functional units. Today chips need to be put into a product with a kind of housing, energy supply, and interfaces as sensors/actuators and/or data channels. Soon they will be on single chips that can be in foil-based electronics, embedded in the housing of a product or placed during printing in a 3D product, saving all the extra costs of a PCB, a fixed, rigid housing, and volume. Flexible factories will use "container" units that can perform the tasks of manufacturing the electronics (sub) assemblies. And if a customer needs a different housing, they adapt to it or even personalize it. And your next phone will be foiled in your watch band, shoes and/or belt. Don't think in a linear shrinking extrapolation of yesterday Nokia into today smartphone. Manufacturing the phone of tomorrow will be different.

And why not design and dimension your own clothes and furniture and have it professionally manufactured

For clothes, shoes and other personal products we already know the job shops close to the market. Robotic, laser cutting and other automatic equipment will take over more and more of this work. The customer designs it or buys/gets the design from the Internet, adapts to her/his sizes and order it over the web. People now buy standard sized furniture. In several years, if you need a bookshelf of 109 cm, you just order it instead of selecting

today's 75, 100 or 150 options you pick from a warehouse rack. IKEA will become an iKEA with a hall of modular manufacturing containers. Not realistic? What about your CD manufactured music collection of 20 years ago and your digital MP3 play list today?



Goodbye car plant, hello my personal car plant

It will also happen with larger goods. The car will become a PC, a personal car, where you determine the outside, interior and software interface. It will be build upon a standard chassis and you then lease the engine part. For a 30.000 km service job, you drive to the service point, you engine is replaced and you continue. Oh, 20 years from now your car will do it self at night and pass the carwash on the way back. The standard chassis and engines might still be manufactured in a classical factory. The majority of the bodywork, partly with 3D printing, will be done close by, in our region. This might look today unthinkable as personal computers were unthinkable in the 70s with the mainframe and the first minicomputers entered the market. In 1980 the first personal computers were as limited as full-electrical cars today. But 10 years latter, in 1990, only one mainframe computer company was left over. Car manufacturing will see a similar change and Europe should, must and can lead.

Today modern car manufacturing plants can handle series of 1 in the sense of 1 model that can be delivered in 5 million different, unique configurations. It is an art of logistic capabilities to get every component right on time at the running belt. It requires an ICT infrastructure and the capabilities of advance manufacturing equipment to change their program for every new product. But over time, even the Factories 4.0 version of the car manufacturing plant will be come a modular, mixed car manufacturing plant in a metropolitan region with a close by network of Factories 4.0 suppliers. Sorry large automotive incumbents your prime era was the end of the 20th century. Who is the first to change. Look at how Tesla is rewriting the rules of the game. In several years the car platform might still be standard but each individual car will look different. Just image how many people would like to upgrade the internals of the car, but want to continue with the same outside body or others who would love to change outside color by season but keep the inside unchanged. Once the manufacturing capability is affordable the unmeet need will let it. And this capability is around the corner.

From bulk oil base chemical to process intensification and bio-based platform chemicals

In the process industry we also see changes toward more process intensification where in smaller units (bio) chemicals are processed. Here too the modular “plant-in-a-container” concept will become more common. Instead of building very large economy of scale installations for 30 to 40 years, the new developments will be more modular and easier to control smaller unit size plant. Initially these sites will be located close to the large chemical plant location in order to make optimally use of energy and material flows, but once distributed (solar) peak energy become cheap these container units might spread out closer to customers. Or in case of supply streams, they may be located close to the (seasonal) sources of supply as in case of bio-based chemicals. In some of the agro/food domains the product is immediately processed in the field and the intermediate product gets transported. This processing is done with container units that can be moved rapidly during the harvest time. You only transport the containers and the produced product, instead of the harvest with in general a large portion of water and leaves (foliage) you will throw away.

Print your energy neutral house or refurbish it with smart energy systems

The construction world “manufactured”, build the required product at the customer side. Components and raw materials are delivered and used immediately during the construction process. Only the building utilities are “prefabricated”. The energy systems as central heating, air conditioning units, solar PV, heat pumps, energy storage systems are manufacturing elsewhere. In general these products are manufacturing in standard series. However, the majority of construction in Europe will become more refurbishing existing building and not new constructions. Physical constraints of existing buildings in combination with more sustainable energy systems will create a market for more flexible energy products that will be different for every building. Here too exists a requirement for local, metropolitan manufacturing in flexible, preferable modular building units.

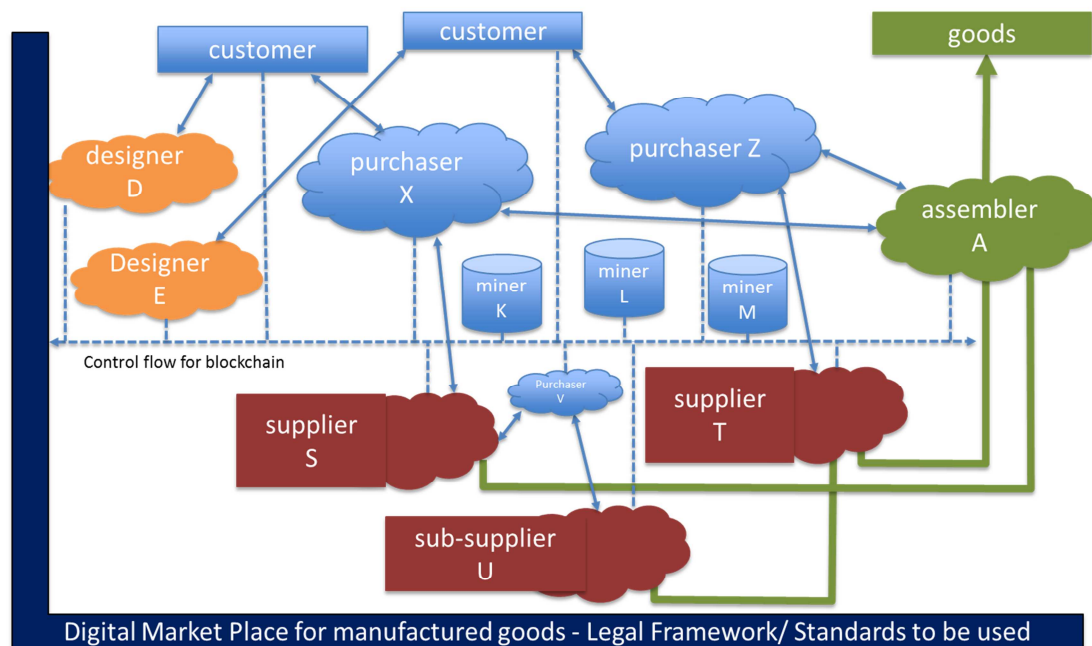
Existing fabs will not all change, they will get smarter upgrades

There are areas where manufacturing will change less. In capital transportation goods as trains, airplanes and ship not much will change at the final assembly stage. As electronics gets much smaller and more reliable it will be installed in more and more components and systems of a capital good. And such electronics can be just in time be supplied by a close by supplier manufacturer. Many of the existing fabs will continue to exist and will not be dismantled because of new markets. But in general even they will face the challenges of manufacturing of (smarter) goods in smaller series.

And we need a new manufacturing service network: the digital market place

To be able to produces series of 1 for the costs of mass-produced series we have the automatic change-over of program for the next product of advanced manufacturing equipment as robots, CNC machines, 3D printers etc. But if you produce in small series or

series of 1, you still face the transaction costs for a request for quotation, a quotation, a purchase order, an order confirmation, a manufacturing report, a delivery and a payment for each individual product. And in a network of suppliers these costs of transactions for each product again and again will explode. We need an automatic service for these transactions. Yesterdays solution was a company webportal where suppliers could look for request to bid on, but tomorrows solutions will be digital marketplaces. Today's AirBnB and Uber provide such webportals for hotel rooms and taxis without owning any room or taxi. One can call this webportals 3.0. In the manufacturing world no one want a single webportal company becoming the largest manufacturing without any factory.



A digital marketplace for manufactured goods using blockchain

The solution can be blockchain based. You can see this as a webportal 4.0. The blockchain principle, already proven in bitcoin, is a public, but encrypted, ordering ledger, a kind of shared, distributed database. With blockchain we can create a distributed internet platform where buyers and suppliers of manufactured goods can broadcast their requests for quotations and handle the subsequent transactions automatically without any third party involvement. In one sentence: it is a public database containing a chain of large blocks of transactions using encryption keys to authenticate participants. It eliminates the role of third parties and enables a transparent market where the best offers can be awarded automatically. And most important, due to the automation by blockchain robotic agents and elimination of office and intermediate bank clerks, the transaction costs of a series of 1 is not exploding. Parties on this digital marketplace for manufactured goods have to agree upon design, quality, and other standards. It is this new digital market platform that together with the advanced manufacturing equipment creates the regional network of smaller and smarter factories 4.0 that will produce manufactured good for the lowest total costs. Economy of networking makes the difference.

How to achieve Factories 4.0 ...

Paradigm shifts and architectural changes don't come overnight. Trends can become hyped, but existing infrastructure is not written off at once. As with every technology/product there is an initial period with a lot of experimentation before the most successful concepts gain more traction. Then follows a period of growth, mainly for new application/use, and finally existing, classical solutions are replaced by the new solutions. Implementing the Factories 4.0 vision as described will imply finding the first sensible applications and experimenting with them, learning what works and what not.

A sensible first application might be the area of suppliers that have to serve multiple solution providers or 2nd-tier suppliers that serve 1st-tier suppliers that face the challenge of smaller series of higher assembled products with a lot of changes. The first visible real life cases are suppliers that provide their customers with a web-interface on which they can draw or enter the precise product drawing/specification after which the order is sent directly to the shop floor. The ICT part of these systems are being implemented these days. More pilots and demonstrations can accelerate this evolution and should lead to more partners that can create a digital marketplace with the blockchain based platform as described above. Speed is needed here as blockchain solutions are creating a tsunami in the Fintech world impacting the legacy business model of banks and similar financial incumbents.

With our strength in manufacturing equipment, Europe should proactively invest in the form of H2020 projects, digital manufacturing hubs in the context of Digitizing European Industries and a IPCEI (important project of common European interest) in this new manufacturing services needed for Factories 4.0.

Next to the new ICT environments also the "hardware" part of modular manufacturing systems has to be extended. Today 3D/Additive Manufacturing service providers enter the market, similar to the copy shop seen birth 20-30 years ago when the printing-press was replaced by copy shops. Today books are individual printed. The 3D shops have to improve to become high-performance systems. After that, they can be "container-lized" in units that practically every SME metropolitan manufacturer can install in it's own plant. These additive manufacturing units can also be extended with different printing technologies, interconnecting variable transport lines to multiple container units etc. The Vanguard Initiative is an example of this ambition to install, probably as a distributed IPCEI (Important Project of Common European Interest, shortly called important project) program a set of high-performance additive manufacturing shops in regions specialized in manufacturing of smart products. Next to such a development in metal, plastic parts and electronic assembly has to be added. Similar concepts for personal goods and even personalized meal production (in hospitals and elderly house complexes) with 3D food printing units are in discussion.

This vision might be implemented in the form of Fieldlabs and pilot lines. A Fieldlab is an open/shared facility, commonly run by an public RTO or open organization. Pilot lines are close to commercial production and owned by a private company and might not be fully open. Today's European programs allow for funding of higher TRL projects, often with

mixed funding from H2020 and national/regional structural funds and/or EIB credits. The vision described here will not be implemented in lower TRL, academic laboratories. It has to be in shared facilities as Fieldlabs (TRL 5/6/7) and pilot lines (TRL 7/8/9) where actually manufacturing of goods takes place. Already today there are and have been EU 7FP and H2020 Framework projects in this field. For the second part of the H2020 program more projects can be expected, also because of the coupling to regional investments by structural innovation funds where such higher TRL can be realized.

EFFRA is the public-private partnership between industry and research organization with the European Commission for the Factory-of-the-Future H2020 research projects. EFFRA works with a vision on manufacturing and a roadmap. For the 2018-2020 timeframe this vision can serve as a starting point for updating the roadmap. This updated roadmap can be the starting point for the H2020 2018-2020 calls. The Factories 4.0 is broader as it should consist of the H2020 research projects of DG Research & Innovation & DG Connect, but also the regional implementations (DG Grow & DG region), the (new) training and businesses (EIT KIC Manufacturing). It will reach beyond 2020.

Turning a vision in reality

Sharing and communicating the Factories 4.0 vision is one step, defining concrete project proposals for H2020 calls, regional programs, EIT, will be next. To conclude this document, one example of a concrete target could be formulate:

- have in 2020 several supplier-manufacturers in 10 European metropolitan regions that can produce a mix of products from several vendors where close by customer order over the Internet, on a digital market place, their individualized product and get it delivered within 4 hours (TRL 9 in 2020).

Such an environment contains several different container-sized units with e.g. warehousing, 3D printing, CNC machines, post processing, assembly, vision inspections and testing, transport for a complete manufacturing site. It could be professional products or consumer products. Automation costs direct jobs, but manufacturing in metropolitan regions also creates new jobs: innovation and services jobs. If done successfully it might even enforce the creation of new types of jobs. This target should demonstrate the new business & job creation. Another example might be related to dual use. If suddenly needed not 1 factory can start producing a certain good, but 10 factories can start at once. Or the first demonstration implementation is for refurbishment or recycling where the supply is always in series of 1.

Conclusions

Europe is the largest consumer market with highly demanding customers. Europe is a type of market ahead of other world markets. Europe should be leading in capabilities to manufacture the goods and delivery the services for such a market. This will require **a Great Restructuring of our industry with classical manufacturer becoming solution providers and suppliers becoming flexible manufacturer**, all including the transition in financing and the cash flow changes. With a shared vision for the end goal of the Fourth Industrial Revolution within Europe, new products and corresponding manufacturing capabilities and ultimately exportable machine units will be realized on time.

The concept of modular, flexible and smart factories 4.0 using “container-size” type of units is challenging. Nevertheless, the world is changing, economy/financing is changing, customers are changing, products & systems are getting smarter and, in the case of electronics, getting smaller and smaller and popping up everywhere. Factories get smarter by using more electronics and automatic systems (cyber-physical) and change too.

From all these changes one can foresee Factories 4.0 where society continues to concentrate its repetitive value creation in factories, but this time it will be closer to the customer again. Reshoring is already a trend, not caused by the raising expenses of manufacturing in China, but because vendors, soon solution providers with their manufacturing outsourced to metropolitan supplier-manufacturers, want to be closer to their customers, want to be in the large urban concentration to order to be the first to supply the customers. And if demands growth rapidly, they do not want to own all manufacturing but still want to expand manufacturing capacity incremental, box-by-box. They do not want to concentrate production somewhere in the world with all the risk of single point of failure or trade politics. Certainly not if there is a more affordable, modular and flexible alternative ready in the form of supplier-manufacturing, the SME, in metropolitan areas that can produce the complete project too. Just as customers with their products as services, factories and manufacturing capability will become services that solution providers will lease or pay-by-use too.

In this document, in the middle of a crisis, a vision or goal is presented. It is now up to companies, large and small, solution providers or supplier manufacturers, government, European & regional, and knowledge institutions to act. The H2020 and regional funds are there. The ambition is to implement this vision also as an important project (or better program with many projects) of common European interest within the next 5 years and be ready for the next decade. It can even be a key part of the EIT KIC Manufacturing.

It might start with high-performance (additive) manufacturing, but need to be extended to electronic goods, personal goods, (electric, modular) car manufacturing, specialized (bio-) chemicals (and even food), but also to the supply chains of construction and high-capital goods (in machine tools, energy systems, etc.). It requires an investment into the billions of Euro's over the coming years, but it will create as a return the repetitive value creation we need to maintain our jobs and future European society's welfare for all of us.