White Paper

Creating an Innovation Pipeline for Europe

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Executive Summary

There is a need to provide support for innovation in both large industry and also SMEs which are the powerhouse of Europe. Innovation is led by industry pulling upon research that is performed both internally and also within academia. A problem is that there is currently a "valley of death" between academic research at TRL 1-3 and industry which tends to develop from TRL 6 onwards. Even within industry there is considerable "technology sensing and evaluation" but less activity in commercialisation of new ideas. An open innovation approach could well allow new ideas to be taken up and be exploited more fruitfully. There is need for strategic funding and actions to traverse the "valley of death" via creation of an "innovation pipeline" and supporting ecosystem to take new research outcomes and turn them into new products and processes.

Already a range of initiatives exist across Europe at a national and regional level to drive innovation, however, this results in fragmentation of effort and duplication. At a European level EU innovation initiatives such as ICT Innovation for Manufacturing SMEs (I4MS) and Smart Anything Everywhere (SAE) provide a good starting point for connecting together these fragmented national and regional initiatives. It I recommended that these should be extended to connect the different digital initiatives and to support platform building activities that will enable the adoption of emerging digital technologies. Strong links need to be created between competence, demonstration, and innovation centres at an EU scale. Here it is recommended that showcase experiments and large scale pilots are funded to bring together key actors and critical mass. There is also a need to engage with SMEs and support innovation and transfer of technology to SMEs. The most appropriate means for achieving this is via Competence Centres, clusters and regional initiatives.

Overall actions within Europe should foster co-ordination of national and regional initiatives to bring together all relevant constituencies from EU Member States. This could lead to an EU-wide network of Competence Centres.

Other issues that also need addressing are the need for a proper legislative framework as future systems would need to be "legal by design", e.g. as regards co-working of robots and humans and increased autonomy in systems. Liability issues have to be tackled with respect to potential accidents related to new ICT, but also as regards an innovative contract framework to deal with increasingly dynamic and flexible supply chains. Privacy needs to be addressed with clear guidelines on data ownership, management and exploitation to provide a level playing field across Europe. Finally, social acceptance of new technologies should be promoted in co-operation with trade unions as regards issues such as employment quality and quantity, welfare, health and privacy.

Introduction

There is a need to support both large industry and SMEs which are the powerhouse of Europe. Innovation is led by industry pulling upon research that is performed both within industry and also within academia. A problem is that there is currently a "valley of death" between academic research at TRL 1-3 and industry which tends to develop from TRL 6 onwards. Many innovative new ideas never get to market due to lack of support at the right time. There is need for strategic funding to traverse this "valley of death" via funding of an "innovation pipeline" and supporting ecosystem that brings new research outcomes to new products and processes.

This requires direct financial incentives for companies (e.g. tax relief for innovation activities at a national level) but also specific activities for research and knowledge transfer, education and training, entrepreneurship and growth. Europe is particularly strong in the ICT, Automotive and Aerospace markets and support is required for these vertical markets to maintain their position against global competition. There is also a need for action to address horizontal issues such as security and privacy which result in market uncertainty.

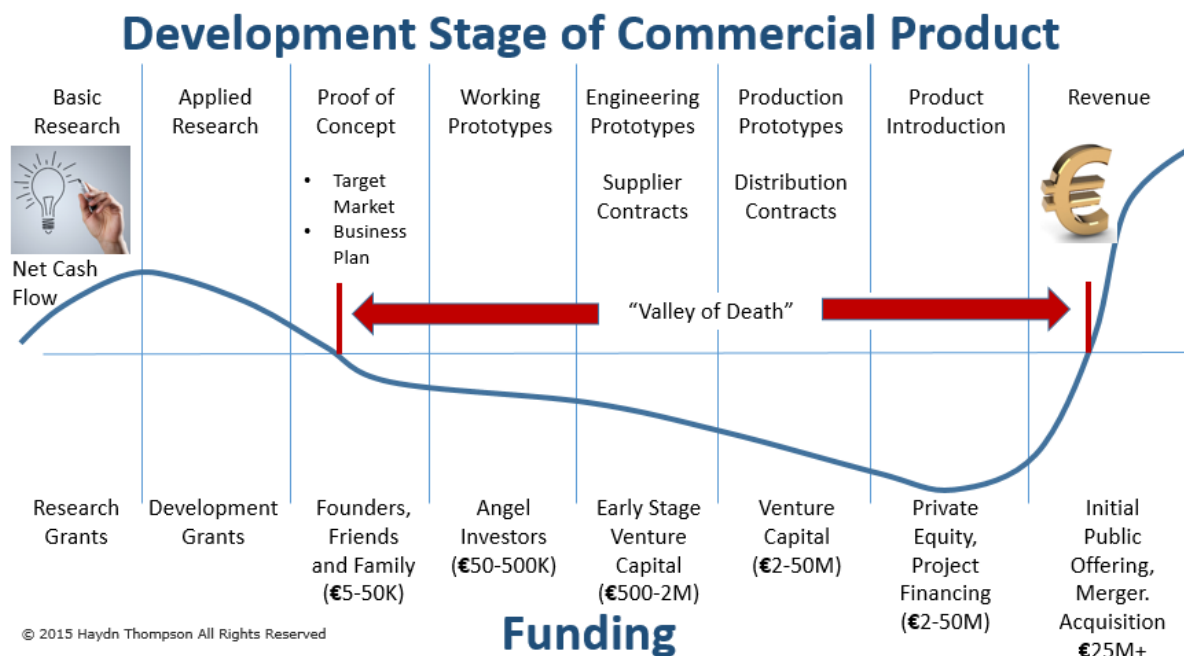# Challenge for Innovation – the "Valley of Death"

Fig. 1 The Innovation Pipeline

Innovation is led by industry pulling upon research that is performed both within industry and also within academia. New ideas tend to start as basic research or via integration of existing technologies in terms of applied research. Although many new ideas are developed and demonstrated there is a "Valley of Death" that exists in getting a new idea to a commercially successful product. This is shown in Fig. 1. Here it can be seen that there are a number of stages required in order to understand the market, define a business plan, engineer and then put into place production to deliver a new product to market. This requires financing and it is clear from Fig. 1 that the initial research and applied research are just the beginning of a long and expensive road. Also shown in Fig. 1 are the various financial sources that are typically used to fund different stages of development. This clearly shows

the numerous hurdles that an entrepreneur needs to address in order to successfully bring a product to market. Although funding bodies target specific stages of development, e.g. funding grants for basic research and applied research, there is a need to connect the various sources of funding and educate entrepreneurs to understand the full innovation cycle. Overall there is a need to create a strategic well connected "innovation pipeline" with funding at all stages.

Research and Innovation Ecosystem
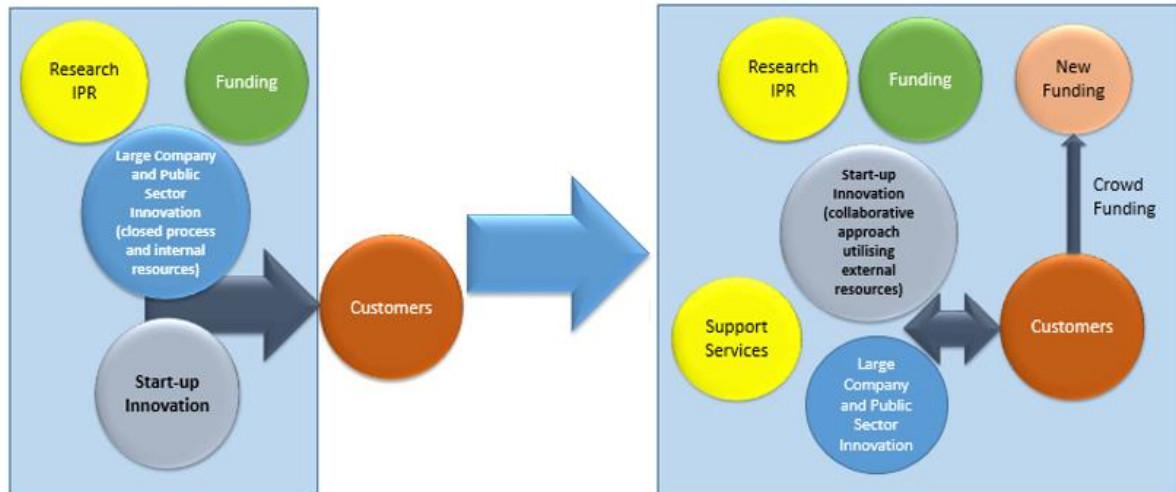
Fig. 2 The Changing Innovation Ecosystem

The innovation ecosystem is shown in Fig. 2. This shows that the ecosystem consists of many players and is moving away from the more traditional large companies and public bodies driving innovation on the left, to start-ups driving innovation with a much more connected and open approach to collaboration. With the move to product services and increased customisation of products there is a need to more strongly engage customers. Customers may also be a source of funding of new products via crowd funding. The interactions that are required need to be dynamic to flexibly allow different actors to engage rapidly to effectively and efficiently exploit new knowledge and ideas.

The innovation ecosystem starts via the nurturing of the next generation of researchers. This is needed at many levels not just through post graduate training but also for more established researchers in academia and industry. Here there is a need for knowledge and skills not just in specific technologies but also in business and entrepreneurship. It is clear that there is a need for collaboration to exchange and transfer knowledge and technology between industry and researchers. There is thus a need for an ecosystem that brings together complementary strengths through collaboration and partnership. This allows existing capacity to be fully realised and also remove duplication and inefficiency. Connectivity, collaboration and openness are essential to the future of innovation. More and more it is teams of people, not individuals, which drive the advances of the modern technological age.

Universities are the power house of foundational research. Here the role of universities is to think a long way ahead considering new concepts and ideas at typically TRL levels of between 1-3. Many new discoveries and inventions start their life within a University Research Lab. but there is a need to improve the interface between Universities and Business and provide an environment for commercialising research that converts new ideas into real products.

Connecting the Pipeline - Creating Ecosystems

In order to create the ecosystem there is a need to provide support at all levels. Large companies are often co-funded by public initiatives with private investment being used to perform "technology sensing and evaluation" and to support lobbying of government for funds for larger scale, long term investment. There is also a culture of large companies co-working with innovative SME's to transfer new ideas into larger scale production. If this is successful quite often the large company buys out the SME to gain exclusive rights to the new technology and ownership of the IPR.

Individually SME's do not have significant lobbying power or "voice" within Europe unless supported via a trade association. A problem for many existing SME's is that they are not exploiting ICT technology to its full potential with the danger of introducing an "ICT gap" compared with other countries. There is a need to provide access to finance to help SMEs re-tool and adopt new ICT technologies and also access to knowledge to bridge the education gap raising the awareness within industry of the potential benefits of new technologies. Many initiatives targeted at SMEs concentrate on increasing innovation and market access. This can be by providing tax incentives for performing research, direct funding for innovation, e.g. innovation vouchers, streamlining intellectual property process or by connectivity to new ideas and research via competence centres.
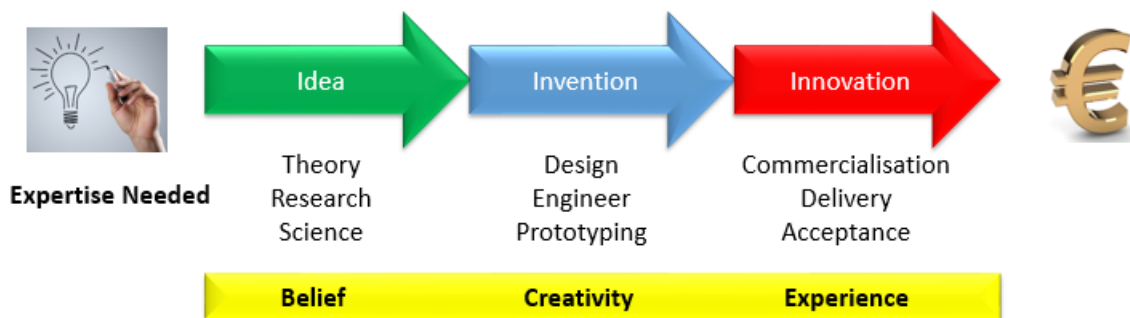
Fig. 3 Connecting the Expertise Value Chain

To connect the innovation pipeline it is necessary to put into place a "value chain" and supporting infrastructure that allows science-business co-operation on research and innovation as shown in Fig. 3. This needs to be accessible for individuals, businesses and the public sector to allow them to innovate alone or more likely in today's context in partnership. There is a need to both strengthen innovative capability, encourage greater investment in innovation and accelerate the commercialisation of emerging technologies.

Innovation Strategies for Europe

A problem within Europe is that there are a number of very good national and regional initiatives but these are fragmented and disconnected at a European level. As highlighted there is a need to create ecosystems of interrelated networks of companies and knowledge institutions across Europe and make it easier for individuals, businesses and the public sector to innovate alone, or in partnership, with the aim of strengthening innovative capability and encouraging greater investment in innovation in Europe as a whole.

Innovation Catalyst	Useful For
Competence Centres	To promote interaction between researchers, industry, and the public sector, in research topics that promote economic growth
Regional initiatives	To improve competitiveness of SMEs both locally and internationally, help with qualification, upgrading and diversification, test solutions, and carry out early implementations
Innovation Clusters	To bring together industry and researchers to address specific topics or markets with the aim of creating critical mass in technological areas
National initiatives	National initiatives can be used to engage with larger companies accelerating research and technology in areas that are considered to be nationally important, develop a technological lead and provide a strategic vision of the future
Flagship Projects	Flagship research and development projects can be used to support strategically and scientifically defined objectives and engage with many project partners across Europe
Platform Building	Platforms can be used to create ecosystems or support specific sectors. They need to be interoperable, modular, and scalable with open and standardised interfaces. Critically for uptake they need to be affordable both from applications development and operation perspectives, with clear and easy understandable business cases
Demonstrators and Large Scale Pilots	Demonstrators and Large Scale Pilots are seen as essential to show potential adopters, both SMEs and large companies, that new technologies and solutions can be exploited in the real world.
Entrepreneurship	Education via an entrepreneurship programme eliminates the fear of failure and provides guidance and support for patenting, commercialisation of R&D results and business start-up.
Education and Skills	To promote holistic digital skills and training support at all levels, disseminating best practice and experience to re-skill and up-skill the workforce.

Table 1 Innovation Mechanisms (© 2015 Haydn Thompson All Rights Reserved)

A number of innovation mechanisms used around Europe are shown in Table 1. These target different types of engagement with individuals, SMEs and large companies with different aims to demonstrate technology, develop and transfer skills and knowledge and to engender collaboration.

In the following sections each approach is considered in more detail.

Competence Centres

Competence Centres driven by industry agendas should be used to encourage interaction between researchers, industry, and the public sector, in research topics that promote economic growth. They should enable research which might not otherwise take place, and facilitate interaction with industry that produces tangible economic benefits. Companies can also be exposed to, and benefit from, longer term, strategic research which would be too costly for them to support individually. Finally, Centres should provide an environment where companies can come together in a non-competitive manner to develop new business relationships and to learn from one another in an effective way.

Regional Initiatives

Regional initiatives should be used to allow greater direct engagement with SMEs. This is particularly important in some European countries, e.g. Italy (Regione Piemonte), where industry is organised regionally. Here a bottom up approach should be used to bring all market participants together to improve competitiveness both locally and internationally, help with qualification, upgrading and diversification, test solutions, and carry out early implementations.

Innovation Clusters

Innovation Clusters are at the heart of many innovation policies within Europe, e.g. Germany. Clusters should be used to bring together industry and researchers to address specific topics or markets with the aim of creating critical mass in technological areas. These should be supported with business incubators and innovation networks. Notably clusters form a concentration of interconnected companies that may well both compete and collaborate. Here Europe should support development of European-wide clusters and also linkage of existing clusters to further produce critical mass.

National Initiatives

National initiatives, e.g. Industrie 4.0 in Germany and the Catapult Centres in the UK, are being used very effectively to develop a technological lead and provide a strategic vision of the future. These well-funded public initiatives engage with larger companies accelerating research and technology in areas that are considered to be nationally important. The Catapult centres in the UK, for instance, directly address the gap between research outputs at TRL3 and implementation in industry at TRL7. Via collaboration between industry and the Catapults it is possible to access the necessary equipment and skills to allow prototyping and development of new innovations and transfer these to industry. Here it is recommended that European funding is used to provide linkage between these national initiatives to create a European Critical Mass.

Flagship Projects

In order to bring together key stakeholders, e.g. large industry and National Initiatives, it is recommended that substantial long-term Flagship research and development projects are supported that are strategically and scientifically defined and engage with many project partners across Europe.

Platforms

The future of Europe is digital. To support this Pan-European EU platform-building is needed. Platforms need to be interoperable, modular, and scalable with open and standardised interfaces. Critically for uptake they need to be affordable both from applications development and operation perspectives, with clear and easy understandable business cases. To achieve this industry commitment to European platforms is paramount. Here there is a need for relevant industry associations to lead and organise an industrial digital forum to identify the best approaches to platform-building activities. There are three types of platform:

- **Organisational** - across stakeholder groups;
- **Technological** - organised around industrial suppliers who agree to open up part of their commercial products. Here support for integration hubs is needed to test pre-commercial solutions and act as an experimental marketplace for new product-service or business models;
- **Operational** - organised in working groups to agree on essential issues, e.g. system specification, reference architectures, or semantic interoperability middleware.

To be successful there is a need to mobilise interest and commitment by large companies to work together and develop a supporting ecosystem of SMEs and mid-caps.

Demonstrators and Large Scale Pilots

Demonstrators and Large Scale Pilots are seen as essential to show potential adopters, both SMEs and large companies, that new technologies and solutions can be exploited in the real world. It is recommended that Europe funds a range of demonstrator activities at different scales, e.g. small-scale and large-scale pilot demonstrators, Living labs, lighthouse projects and show cases to accelerate technology uptake, provide acceptance of new technologies and engage with the full value chain.

Entrepreneurs

A Smart Industry survey has shown that a significant number of entrepreneurs are still relatively uninformed about the upcoming digital revolution and its implications for their business. This is consistent with the figures from the World Economic Forum. It can also be noted that ICT is being used more by companies in their contacts with consumers than for business to business transactions. Two challenges can be singled out:

- How can companies collaborate effectively and organize themselves into chains and networks that make optimal use of data?

- How can companies develop new Smart business propositions based on state-of-the-art technology and knowledge?

Notably the digitalization of Europe opens up many opportunities for entrepreneurs. An entrepreneurial culture needs to be developed in Europe comparable to that in the USA. There is a need for education via an entrepreneurship programme to eliminate the fear of failure and provide guidance and support for patenting, commercialisation of R&D results and business start-up. In order to encourage innovation it is recommended that prizes and competitions are set up to stimulate innovation.

Education and Skills

Holistic digital skills and training support need to be promoted at all levels, disseminating best practice and experience to re-skill and up-skill the workforce. Supporting novel industrial training methods that allow adaptability of the workforce and faster knowledge transfer need to be developed. Lifelong learning approaches are needed to continually up-skill the workforce as technology rapidly changes. An awareness is also needed at the management and factory floor levels of societal issues such as green manufacturing which will become increasingly important in the future.

Recommendations for Connecting the Innovation Pipeline Across Europe

As highlighted already many initiatives exist for driving innovation:

- Competence Centres
- Clusters
- Regional Initiatives
- National Initiatives
- Flagship Projects
- Demonstrators
- Living labs
- Lighthouse Projects
- Large Scale Pilots

All of these have important roles to play in technology transfer, engaging with SME's bringing stakeholders and the value chain together, developing critical mass in areas and technologies, providing strategic vision and competitive advantage in key technologies, accelerating uptake and acceptance of technologies by large and small companies through demonstration in real world scenarios.

To connect the innovation pipeline together it is recommended that European Union funding is used to foster linkage between these fragmented initiatives to create a European Critical Mass and transfer technology and best practices from advanced industries, e.g. aerospace, automotive, where Europe is a leader to less advanced sectors. This could lead to an EU-wide network of Competence Centres. The ICT Innovation for Manufacturing SMEs (I4MS) and Smart Anything Everywhere (SAE) provide a good starting point and should be further developed and expanded. Additionally, showcase experiments and large scale pilots should be funded to bring together key actors and develop critical mass.

A large proportion of the value chain is generated by non-manufacturing companies, e.g. Google, Uber and Amazon. To be competitive there is a need for Pan-European platform-building that will enable the adoption of emerging digital technologies considering:

- Organisational Platforms
- Technological Platforms
- Operational Platforms

Additionally, for a platform to be successful, e.g. AUTOSAR, there is a need to mobilise interest and commitment by large companies to work together and develop supporting ecosystems of SMEs and mid-caps.

The digitalization of Europe opens up many opportunities for entrepreneurs and Europe needs to be ready to exploit this. Support for education in entrepreneurship is also recommended.

Similarly there is a need for digital skills and training support at all levels, disseminating best practice and experience to re-skill and up-skill the workforce to the digital world. The workforce will need a different skill set and be more adaptive to cope with the pace of ICT technology change. Education is also needed to raise awareness at the management and factory floor levels of societal issues such as green manufacturing which will become increasingly important in the future. Social acceptance of digital technologies should be promoted in co-operation with trade unions considering employment quality and quantity, welfare, health and privacy.

For new business opportunities to be exploited there is a need for an innovative contract framework to deal with increasingly dynamic and flexible supply chains. The legislation governing the IT sector and the internet has been built up around this sector and this may not be appropriate for specific sectors, e.g. manufacturing. There is thus a need for legal support for use of such technologies in different sectors. As an example, increased automation and co-working between robots and humans requires a "legal by design" framework and liability issues have to be tackled with respect to potential accidents related to new ICT. A barrier to many SME's from offering services to companies is the risk introduced from liability for lost revenue. Here a mechanism to provide insurance to remove some of this risk is also recommended.

Finally, in order to exploit new service ideas based on data privacy needs to be addressed with clear guidelines on data ownership, management and exploitation to provide a level playing field across Europe.