Commercialisation of Nanotechnology – Key Challenges

Workshop organised by Nanoforum in Helsinki, Finland

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Prepared by:

Tom Crawley

Spinverse

tom.crawley@spinverse.com

Tel: +358 50 463 7149

About Nanoforum

This European Union sponsored (FP5) Thematic Network provides a comprehensive source of information on all areas of nanotechnology to the business, scientific and social communities. The main vehicle for the thematic network is the dedicated website www.nanoforum.org. Nanoforum encompasses partners from different disciplines, brings together existing national and regional networks, shares best practice on dissemination of national, EU-wide and Venture Capital funding to boost SME creation, provides a means for the EU to interface with networks, stimulates nanotechnology in underdeveloped countries, stimulates young scientists, publicises good research and forms a network of knowledge and expertise.

Nanoforum aims to provide a linking framework for all nanotechnology activity within the European Community. It serves as a central location, from which to gain access to and information about research programmes, technological developments, funding opportunities and future activities in nanotechnology within the community.

The Nanoforum consortium consists of:

The Institute of Nanotechnology (UK) www.nano.org.uk

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CEA-Leti (France) www-leti.cea.fr/uk/index-uk.htm

Malsch TechnoValuation (Netherlands) www.malsch.demon.nl/

METU (Turkey) www.physics.metu.edu.tr/

Monte Carlo Group (Bulgaria) http://cluster.phys.uni-sofia.bg:8080/

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For further information please contact the coordinator, Mark Morrison: mark.morrison@nano.org.uk

About Spinverse

Spinverse supplies consulting services to organisations ranging from start-ups to government institutions; provides seed capital and advises on later stage funding; and organises a range of events, including Nanotech Northern Europe, the largest congress and exhibition in the region. For more information about Spinverse, please contact Pekka Koponen, CEO, at pekka.koponen@spinverse.com.

Executive Summary

This is a report of the Nanoforum workshop on the commercialisation challenges of nanotechnology. The workshop took place in Helsinki, Finland on March 29th 2007.

Three areas of concern for Europe are identified. A very low proportion (only 3,5%) of global nanotechnology venture capital is invested in Europe. Despite public funding which is on a par with the US, Europe is lagging behind in the number of nanotechnology patents granted. Industrial investment in nanotechnology is also only half that of the US and Japan.

The low level of venture capital is largely due to a shortage of suitable investment targets. Companies lack focused business models, commercial experience, and exit strategies. Whilst public funding sources may take the place of venture capital, the concern is that companies then lose the other benefits that investors would bring, such as in-depth industry understanding and networks.

Low patent productivity is a consequence of the difficulty of identifying the commercial potential of research, partly because research is not aligned to industrial needs. There are specific questions of motivation (publications being more highly prized) and patenting capability.

The explanation for low industrial investment, despite the presence of nanotechnology 'global leaders' among European industry, is a failure to activate wider industrial interest. A company contemplating an investment in nanotechnology development will be dissuaded by the obvious challenges (production scale-up, health and safety concerns) if they do not understand the less obvious opportunities that nanotechnology brings.

The three challenges have a common solution. The investment of public funding in nanotechnology development needs to enable a greater amount of funding from private sources. In order for this to happen, there needs to be an understanding of the industrial or consumer problems which need to be solved, which then need to be fed back to development and research.

This can be done in several ways. Technology-led 'roadmapping' should be augmented by industry-led 'visions' which set out real industrial challenges. Funding priority should

be given to projects which meet those challenges, and which combine academic and industrial participants.

Researchers should be incentivised to product patents as well as publications, by sharing in the profits of licensing or other exploitation. Universities should be able to rapidly assess the value of a potential patent, which is enabled by understanding the needs that must be solved.

Individual firms should take their nanotechnology-based processes and rather than attempt to apply it in multiple applications and industries, focus on the area of greatest need. They should then understand with what or whom they need to integrate, in order to provide a whole solution. Investors should apply their industrial knowledge and networks to help nanotechnology companies develop, a contribution which may be as valuable as a financial investment.

Finally, the wide range of European industry that has not yet been ‘activated’ should also take responsibility for understanding the opportunities of nanotechnology, and identifying with whom they need to partner in order to meet those opportunities.

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Introduction

In order to better understand the challenges of commercialising nanotechnology, Nanoforum commissioned a series of three workshops to address this topic. The second of these workshops took place in Helsinki, Finland, on March 27th 2007 - the workshop schedule is contained in Appendix I. The workshop was also attended by a varying audience of well-over fifty from the adjoining Nanotech Northern Europe conference; an audience which included representatives from the media, science, industry and the investor community.

Rather than give a chronological description of each presentation, this report attempts to combine the themes that emerged during the day into a single synthesised whole. For the most part, the contents of this report do come directly from discussion and presentations at the workshop - these are identified in the text. This is supplemented by the use of other materials, from research papers and other public sources to information that Spinverse itself has developed.

One of the starting points was to understand whether nanotechnology presented distinct commercialisation challenges. The answer to this question is that some challenges are clearly exacerbated by the nature of nanotechnology and its present state of development. However, the fundamental commercialisation processes and challenges are common to all new technology, and care should be taken to note that nanotechnology does not 'rewrite the rules'

This report aims to cover the most important issues, to contribute at least a better understanding of the challenges, and at best to provide input to the solutions to these vitally important questions. The author and the Nanoforum project as a whole are very open to further discussion of the issues that are raised.

This report is just one part of an ongoing discussion which we hope will continue to animate the nanotechnology community in Europe and beyond.

Tom Crawley

tom.crawley@spinverse.com

Nanotechnology Commercialisation

The starting point of this report is that nanotechnology offers immense promise; promise which extends from specific business opportunities for individual firms to societal benefits for the world at large. Yet for these benefits to be realised, the products and processes that are renewed or made possible by nanotechnology will need to reach the supermarket shelf or the factory floor. This entails a process of commercialisation, moving from research though to technology development to productization and sale.

From a public funding perspective, it is critical to understand the challenges of nanotechnology commercialisation. Large amounts of public money (well over €4bn globally in 2005) are being used to support nanotechnology research and development. The calculation is that as the technology is commercialised, this funding will generate a return on the investment in the form of direct economic growth, and indirect social benefits (Exhibit 1).

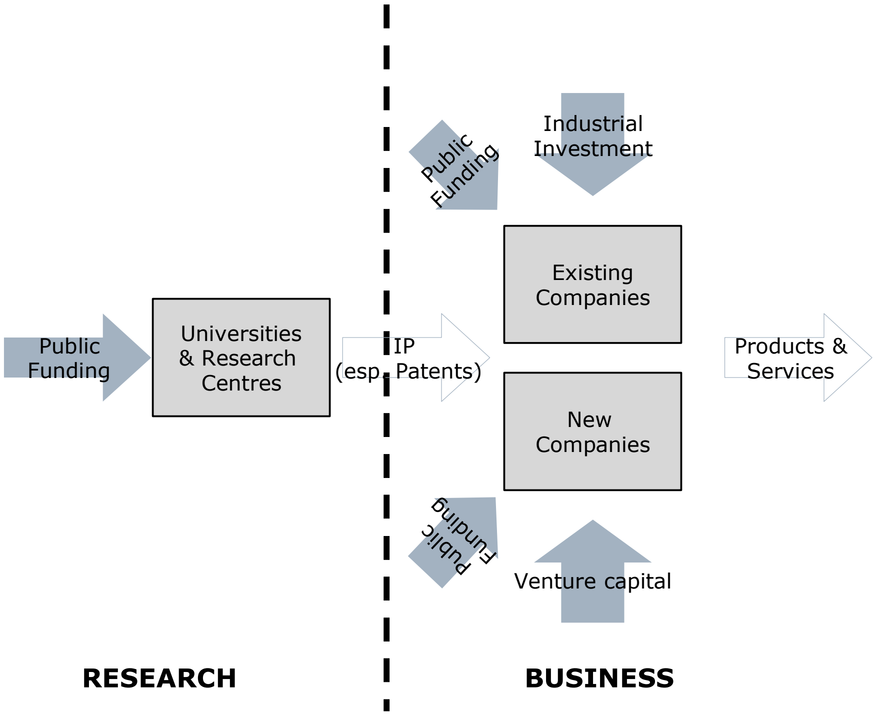
Exhibit 1: ROI of public nanotechnology funding

$$\frac{\text{Economic Benefits} + \text{Societal Benefits} - \text{Societal Costs}}{\text{Total Public Funding}}$$

From an individual perspective, whether as an entrepreneur, an employee, or an investor, it is also important to understand the process by which the opportunities of nanotechnology can be realised. Nanotechnology offers the possibility to transform existing products, and to enable entirely new products and manufacturing processes.

A simple model of the nanotechnology commercialisation process is given in Exhibit 2. Nanotechnology is science-based, requiring theoretical understanding and specialist equipment. This means that developments are made at universities, research centres and corporate laboratories. The ‘product’ of this stage is intellectual property, which may take the form of a patent; an exclusive right to exploit a technical innovation for a given period of time. The intellectual property is then developed by a company to become a saleable product.

Exhibit 2: Nanotechnology Commercialisation – funding flows and key actors



A new company may be established specifically to commercialise that technology; in which case it will require funding to support development before it can earn revenue. If the company is able to survive and grow, it may continue to be independent, or it may be acquired by a larger company.

An existing firm would typically acquire technology to develop its existing business. To a certain extent, depending on the resources and farsightedness of the company, it may also develop technologies that have the potential to offer completely new business opportunities.

Each of these mechanisms must function in order for the economic benefits of nanotechnology to be realised. Having identified the mechanisms, it is now possible to review the data available about each to diagnose where specific challenges lie.

Nanotechnology Commercialisation in Europe

New Firm Creation

The continuous creation of new companies is an indicator of the health and pace of technology commercialisation. This is often facilitated by venture capital, which provides funding and other support to new companies.

The best way to analyse the health of this area would be to see how many companies exist and are being created. However, there is a lack of reliable data covering the whole of Europe. Comprehensive studies by VDI in Germany have found around one thousand nanotechnology organisations, and over 140 have been identified in Finland. Beyond these very active countries, there may be a lack of new firm creation in nanotechnology. Certainly the number of nanotechnology companies that have achieved initial public offerings (IPOs) is very low; perhaps a handful in Europe in the last few years.

The level of venture capital in nanotechnology is one reliable measure that is available. This will be covered in more depth in a later section, but the headline figure is that only 3,5% of total global venture capital investments into nanotechnology in 2006 were made in Europe (Markku Maula).

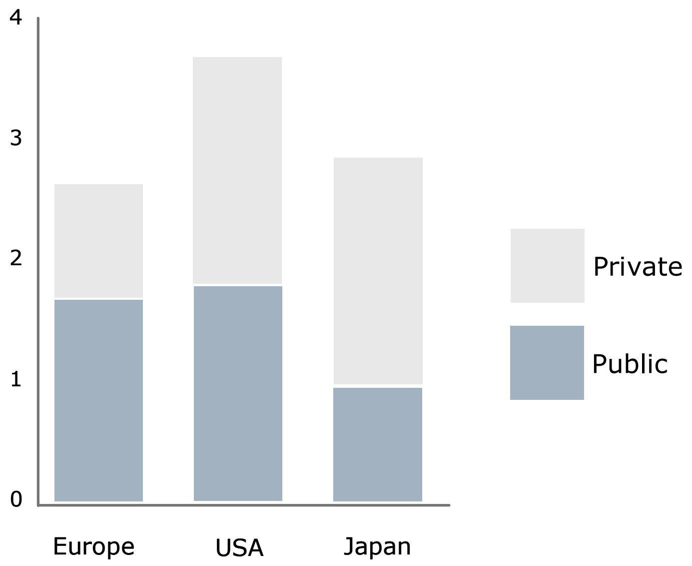
Nanotechnology development requires funding; this figure indicated either a lack of companies, a lack of development, or that funding is coming from other sources.

Problem 1: The level of European venture capital investment in nanotechnology is only 3,5% of the global total, indicating either a significant shortage of funding, and/or a lack of viable investment candidate companies.

Patenting Activity

It was mentioned earlier that the public sector spends over €4bn annually on funding nanotechnology research. In comparison with the US and Japan, Europe is competitive in the area of public funding. In 2005, the EU member states and the European Commission contributed a combined €1,6bn to nanotechnology. This is only narrowly exceeded by a contribution of €1,7bn from the states and federal government of the United States (exhibit 3).

Exhibit 3: Comparison of Nanotechnology Funding (2005, €bn)



Source: European Commission (Hullmann, 2006)

It is assumed that the bulk of this funding goes to research centres and universities. In this case, one would expect to see parity between the US and Europe in the output of these organisations, whether as patents or publications. Unfortunately, this does not seem to be the case in patents. Figures from 2003 show that 1177 nanotechnology-tagged patents had US-based inventors. By contrast, the top 13 patenting countries in Europe (including Switzerland) only accounted for 440 patents (Kanama, 2006).

In publications, Europe is the equal of, and even exceeds the US. The 12 most prolific European countries produced 11 916 papers in the period 1991-2001. During the same timeframe, 9993 papers were published by the US, and only 4251 by Japan. Evidence indicates the quality of the output as well as its quantity; the two countries with the highest citations per paper count were Switzerland and the Netherlands (Thomson ISI database, via Hullmann, 2006). The problem is that publications are a contribution to the general level of knowledge; they aren't in themselves something which can lead to a protectable and exploitable technology. This poses a challenge.

Problem 2: Measured by funding and publications, European nanotechnology research is on par with the US, yet far less patents are granted to Europe-based inventors.

Industrial Investment

Nanotechnology is essentially an industrial technology, which particularly offers new possibilities for manufacturing firms. Industrial adoption of nanotechnology is where some of the greatest benefits will be realised, such as the renewal of traditional, threatened industries in Europe.

However, the level of industrial investment in nanotechnology is another area in which Europe is lagging behind other regions of the world. Whilst Japan and the US each saw over €1,8bn of investment in 2005, European industry contributed just half of that figure; €0,9bn.

These figures have one of two causes. It may be the case that industry has made an assessment of the potential return on investment in nanotechnology research, and concluded that because of various challenges, it would not be a worthwhile investment. It may equally be the case that no such process has gone on, and that the idea of investing in nanotechnology has just not been raised.

Problem 3: The level of industrial investment in nanotechnology in Europe is half that of the US or Japan. This threatens the adoption of nanotechnology as a large-scale industrial technology.

The next section of the report draws on the findings of the workshop to understand these problem areas in more detail.

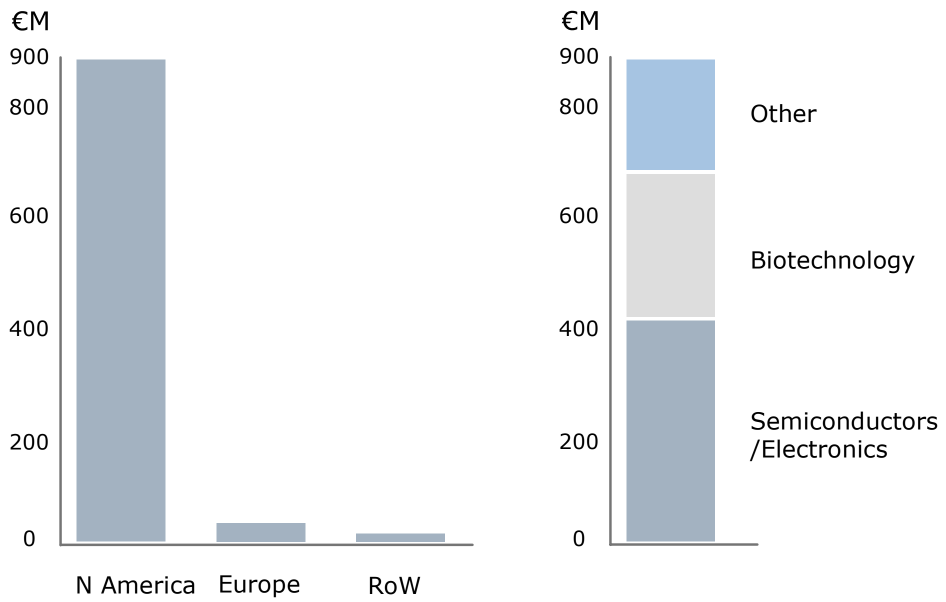
Venture Capital and Entrepreneurship

A key element for a successful nanotechnology commercialisation economy is the existence of a vibrant entrepreneurial and SME sector. New firms have a vitally important role to play in the development of any new technology, by meeting unmet needs and introducing disruptive technologies.

Most new companies require investment. Nanotechnology development requires skilled people and specialised equipment, so the capital requirements are higher than for businesses in other sectors. This would seem to indicate that if this sector were truly ‘vibrant’, a high level of venture capital investment would also be seen.

However, indications are that the level of venture capital investment in nanotechnology in Europe is just a fraction of that of the US (exhibit 4, Markku Maula). Of €940M of venture investment in nanotechnology in 2005, only €34M was spent in Europe. This indicates either a demand side issue – a lack of suitable companies requiring funding – or a supply-side issue, such as a lack of firms in the Europe with the capability or willingness to invest in nanotechnology.

Exhibit 4: Venture Capital investment in nanotechnology – 2006 global breakdown/2006 sector breakdown (source: TKK analysis of Thomson VentureXpert data, presented by Markku Maula)



A company that is attractive to an investor would combine a viable business model, an ability to execute that model (high-quality management), and a means of realising the investment (an exit strategy).

Platform versus product

The majority of nanotechnology companies have an offering which is either a process, or which is based on a use of that process to create a material. For example, a company may have developed a process for creating a certain type of nanoparticle, and then uses that to develop a specific type of functionalised nanoparticle.

This has two consequences. Firstly, the company's offering may have a huge variety of applications. A company which produces nanoscale titanium dioxide, for example, would see potential application as diverse as sunscreen and vehicle exhausts.

This 'platform' strategy, developing a technology with multiple applications, makes it much harder for all but the most exceptional companies to succeed. Whilst the addressable market size increases, the probability of success in each of the sectors appreciably reduces, as focus is split between multiple customers with multiple needs.

A platform company is also a less attractive investment target, because typically the exit strategy would need to be an initial public offering – a trade sale would be less likely because the company has customers in several sectors. Yet to achieve an IPO, revenue would need to be very significant (certainly larger than many current nanotechnology-based companies have been able to achieve) (Aymeric Sallin).

By contrast, a 'product' company can focus on a single industry, enabling them to identify a discrete set of key customers, and concentrating on winning their business. This also provides a more realisable exit strategy in the form of a trade sale (Aymeric Sallin).

The second consequence of an offering based on a process is that the company can only offer a really valuable solution when it is integrated within a larger system. To return to the titanium dioxide example, the company may have a process for producing the material, but it requires a process for dispersing it before it becomes valuable.

Business model validation

A business model choice can only be truly validated when it is proven that customers will buy what the company is selling. When it comes to when a company should release products for sale, the general rule is the quicker the better (Cathal Mahon). Selling validates the business model, affirming whether or not customers are willing to pay for the product (Brian Bilenberg). It also strengthens a relationship between the company and its customers, and provides an invaluable source of feedback for development.

Ability to implement

The success of a company is defined not only by its strategy, but its ability to implement that strategy. A company that has identified a particular customer need, and has developed an offering which meets that need, still needs to be able to sell, profitably. The chances of success are increased by having at least one person with commercial experience, even if their knowledge of nanotechnology is not so high (Cathal Mahon).

This is a specific issue in nanotechnology, because technology is often spun out of a research centre by its (academic) inventor. Whilst the product understanding is very high, a different skill set may be required to manage the business. Evidence from Technology for Industry (Malcolm Wilkinson) supports this contention; the presence of an entrepreneurial CEO (rather than an academic) was found to be the key success factor in a study of UK high-tech start-ups.

Supply of venture capital

It is fair to assume that if there were a large number of investment opportunities, there would be funds which were able to exploit them, and therefore the lack of venture capital is primarily a consequence of a lack of investment targets.

However, there are some specific supply-side factors which lead to the current situation. These include a lack of VC partners with suitable experience (both in nanotechnology in general, and in some of the industries, such as chemicals and materials, where nanotechnology finds its earliest applications).

Role of public funding

Public sources of funding are also available for new companies; the EU has made specific efforts to make funding available for smaller companies, for example (Nicholas Deliyanakis). It may therefore be the case that public sources of funding are displacing private sources such as venture capital.

This may initially seem to be better for the founders of companies, enabling them to access funding without surrendering equity in their companies. However, what is then lost is the other benefits that venture capital can bring. VC partners with industrial experience and networks can help a company to design a strategy and to understand the dynamics of its target industry. They may also bring specific contacts to potential customers.

There is also an argument that venture funding provides greater discipline for entrepreneurs than public funding. A public body has less time to monitor an investment than a VC firm, and may be less demanding in insisting that the firm demonstrates results.

One solution could be to combine the best of both worlds, by investing public money into private venture capital funds. The money would then be more actively managed, and there would be a higher possibility of it being returned (with interest). This could also be done on a smaller scale with specific funding schemes or tax benefits for angel investors.

Conclusions

It should be noted that this is a dynamic situation, and that investors in Europe are already realising that nanotechnology does offer exciting firms for whom their investment and guidance can have a big impact. Encouraging recent developments include the closing of a €45M Venture Capital investment vehicle dedicated to nanotechnology advised by Swiss based NanoDimension AG.

Commercialisation Challenges: Patenting

The discrepancy between the level of patenting activity in the US and Europe was highlighted. The topic of patenting was discussed during the workshop by Jukka Korhonen and Markku Simmelvuo of law firm Papula Nevinpat, and briefly by Russell Cowburn of Imperial College. Additional information was provided during questioning of the speakers and the ensuring discussion.

The shortfall in the number of patents is primarily due to work either having little commercial value (and thus not worth being protected), or the difficulty of assessing its value.

Unsuitable for patent

One lesser cause is that research work does not lead to patents because it is derivative or insufficiently original. There are undoubtedly some isolated examples in which this is true, but for the most part citation data supports the contention that European science is of generally high quality. The Thompson data (Thompson ISI Database) shows that the two countries with the highest citation per article are the Netherland and Switzerland, with other European countries featuring prominently on the list.

Research work may also not be patented because it is in the realm of basic science. Remember that patents are designed to protect “solutions to technical problems” rather than scientific theories (Korhonen & Simmelvuo). This undoubtedly is one of the reasons why there are not more patents. The term ‘nanotechnology’ covers a huge range of research areas, from application orientated fields like material science to the theoretical frontiers of quantum computing. This is also not necessarily a problem; the role of universities is to develop the long-term future as well as the near-term, and ‘frontier’ research has an important role to play.

Not commercially valuable

A gap between academia and industry can account for a significant part of the answer. A recurring theme during the workshop was that of the challenges of bringing the two mindsets together (summarised by Professor Cowburn as being the difference between the academic motivation of proving that something can be done, and the entrepreneurial motivation of proving that something can be sold).

The workshop contributed a Nordic perspective to this question. Finland, and the region in general, is fortunate to have close links between universities and industry. This is due to wide variety of factors. Some are incidental, such as the fact that in a small country it is easy to identify and contact people. Others are a result of deliberate policies, such as a preference to allocate funding to research projects with industrial partners.

The effect of these links has been to ensure that application-orientated research projects have industrial input. This means that developments are more likely to address actual needs, rather than a guess of what a need might be (or even disregarding needs completely). Secondly, research will then take into account known factors, such as existing production processes. Thirdly, the research has a clear commercialisation path if it succeeds, as it will be taken into use by one of the participating companies.

This solves the difficult of assessing whether it is valuable to patent the result of research work; the industrial partners are able to offer an opinion as to the value of patenting the research work. On a broader level, the universities should be able to make an assessment of whether it is valuable to incur the costs of applying for a patent.

Incentives

When a research breakthrough is made, a time pressure exists to publish the results of the work before other research groups. Yet once a development is published, it cannot be patented in Europe. This leads to a so-called ‘publish vs. patent’ dilemma. The view of an academic contributor to the workshop was clear; patent first, then publish (Russell Cowburn). That is a fair summary of the answer, though it is important to understand the issues involved.

Both sides need to have a little flexibility in this discussion. It is necessary to understand and accept that academic publication is highly competitive, and that every day counts when submitting work. Yet it is also important to acknowledge that whilst the primary goal of universities is to increase the stock of public knowledge, the best way of ensuring than an invention is able to be commercialised is to ensure that someone can profit from it; i.e. by patenting it.

The situation can also be eased by making it much quicker to assess whether research has merit as a patent. This requires having patent lawyers accessible or on call to provide a rapid assessment of whether a development is patentable at all, and whether it is valuable for the university to do so.

Finally, the motivation to patent can be stimulated by offering academic inventors a share in any revenue generated from the patent. The typical approach would be to offer revenue splits between the university, the inventor’s department, and the inventor themselves.

Nanotechnology in Industry

According to European Commission figures, industrial investment in nanotechnology in Europe lags behind that of the US and Japan. The economic and social benefits of nanotechnology will only be realised when it is incorporated in volume products. This requires its widespread utilisation in industry.

Despite this gloomy picture, leading companies from Europe, like BASF, Degussa, Nokia and Philips have visible nanotechnology activities, and the workshop heard from Peter Kruger of Bayer's nanotechnology working group. Bayer has been one of Europe's leaders in nanotechnology, with research areas in medicines, composite materials, and surfaces. The company has also started a new business segment which manufactures and sells carbon nanotubes (Baytubes).

This indicates that whilst there are 'global leaders' among European industry, there has not yet been the widespread activation of industry to the same extent as in the US or Japan. The panel discussion which concluded the workshop, which featured Nicolas Deliyanakis (European Commission), Peter Kruger (Bayer), Lars Gädda (M-Real), E James Prendergast (DuPont), and Matti Kleimola (formerly of Wärtsilä) addressed some of these issues.

Any decision involves a cost/benefit evaluation. For a company contemplating an investment in nanotechnology, the challenges of moving to production scale, and the potential health and safety risks are clear – the benefits require more explanation.

From prototype to production

Industrialisation of nanotechnology moves from the entrepreneurial mindset (can it be sold) to an industrial perspective (can it be reliably, safely, mass-produced whilst achieving economies of scale). Yet achieving reliable mass production is one of the biggest challenges facing nanotechnology. It is one of the most familiar problems of new technology adoption, yet also of the most intractable.

Producing larger quantities of a basic nanomaterial, such as carbon nanotubes, is currently possible. Bayer plan to be able to produce 60 tonnes per year by 2008 with high purity (Kruger). Methods still need to be developed to achieve truly large scale production (by way of comparison, over eight million tonnes of carbon black are produced annually). There is also a need for development of standards to enable comparison of nanomaterials, and to protect the buyer.

Having reliable production of material is just the start of a process to incorporate it into user processes and systems. For example, issues of dispersion still need to be solved before nanotubes can be incorporated into composite materials. New material ingredients can require new production processes to utilize them fully; ultimately the problem is one of taking complex materials, incorporating them in to complex systems, whilst still ensuring reliability and functionality.

The panel was keen to emphasis that this type of development, from prototype to production, was a familiar process in the chemical industry. The greatest need is time – it can take up to twenty years for a disruptive process to replace an incumbent (E James Prendergast). The time required can be reduced by incorporating an understanding of production processes at the research stage (which underlines the need for industry-academic cooperation).

Nanotechnology's complexity and novelty exacerbates these challenges, but also offers opportunity. Bottom-up production techniques (such as self-assembly) may come to replace current but less efficient top down processes, and by doing so encourage the renewal of traditional industries.

Risk

Industrial adoption of nanotechnology will not succeed without customer acceptance of nanotechnology. The debate about nanotechnology safety is covered heavily in other sources, but for the purpose of this report it is important to note that the panel agreed that responsible development of nanotechnology was critical to its success. The European Union role was characterised as creating a legislative framework which ensured that the consumer is protected. This may require new law, but may equally be a matter of utilising existing legislation (Nicolas Deliyanakis).

Failure to activate

The risks of nanotechnology need to be balanced with an understanding of the benefits that it may generate. In countries where specific steps have been taken to activate industry, investment and involvement has increased. This has been the case in Finland, where the national nanotechnology programme has resulted in a doubling of the number of companies with nanotechnology strategies or research activities.

Activation has taken a couple of forms. Firstly, it has involved the establishment of ‘visions’ for key industries. These are need- rather than technology-led analyses, performed by companies themselves, which set out the challenges facing an industry, and begin to understand where nanotechnology can play a role.

These are then combined with funding instruments for development projects which may involve companies or companies and universities together.

Conclusions and Recommendations

From a policymaker or public funding body perspective, the challenge of nanotechnology commercialisation does not lie in the overall amount of funding, but in deploying it in such a way that it will create a multiplier effect, increasing the amount of private investment. In order for this to happen, there will need to be a move towards a more problem- or need-focused approach. This needs to take place at every level, from the European Commission down to individual organisations.

These remedies are also heavily interlinked. Greater industrial investment may lead to acquisition of new companies, providing an exit strategy which makes them more attractive to investors.

At a **national and EU level**, technology-led ‘roadmapping’ should be augmented by industry-led ‘visions’ which set out real industrial challenges. Funding priority should be given to projects which meet those challenges, and which combine academic and industrial participants.

To improve patent productivity, develop a single European patent, as soon as technically feasible.

Public funding bodies should also consider whether funding is displacing other sources (such as venture capital), and if so whether to combine the two, by investing into funds.

Researchers should be incentivised to product patents as well as publications, by sharing in the profits of licensing or other exploitation.

Universities should be able to rapidly assess the value of a potential patent, which is enabled by understanding the needs that must be solved.

Individual firms should take their nanotechnology-based processes and rather than attempt to apply them in multiple applications and industries, focus on the area of greatest need. They should then understand with what or whom they need to integrate, in order to provide a whole solution. Firms should use public funding but not become dependent on it, or allow it to deflect from the need to validate the business by achieving sales.

Investors should apply their industrial knowledge and networks to help nanotechnology companies develop, a contribution which may be as valuable as a financial investment.

Finally, the wide range of European **industry** that has not yet been ‘activated’ should also take responsibility for understanding the opportunities of nanotechnology, and identifying with whom they need to partner in order to meet those opportunities.

Appendix I: Workshop Agenda

The Nanoforum workshop took place at the Helsinki Fair Centre on March 29th 2007, during Nanotech Northern Europe.

10.30 Global Trends and Perspectives

Success Factors for Building a Nanotech Business
J Malcolm Wilkinson, Technology for Industry

Immaterial Rights in Fledgling SMEs
Markku Simmelvuo & Jukka Korhonen, Papula Nevinpat

Entrepreneurship and Venture Capital: A Global Overview
Markku Maula, Professor, Helsinki University of Technology

March forward to the industrialisation of nanotechnology
Shicheng Mu, China National Academy of Nanotechnology

14.00 Entrepreneur and Venture Capital Perspectives

Russell Cowburn, Imperial College London & Ingenia Technology Ltd.

Aymeric Sallin, NanoDimension AG

Cathal Mahon, CAT Science

Brian Bilenberg, NIL Technology

16.00 Industrial Perspectives

Bayer’s Experiences of Commercialising Nanotechnology

Peter Kruger, Bayer MaterialScience AG

Panel Discussion with:

Nicolas Deliyanakis, European Commission

Peter Kruger, Bayer MaterialScience AG

Lars Gädda, M-Real

E James Prendergast, DuPont Electronic and Communication Technologies.

Matti Kleimola, Professor, formerly of Wärtsilä

Appendix II: References

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