IMPACT OF INNOVATION TYPE IN NANOTECHNOLOGY
ON STRATEGY AND VALUE CREATION

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Abstract
Nanotechnology is often heralded to provide for technological advance that will cause radical innovation across many industries. Initially nanotechnology was expected to provide for product innovation, yet currently it is clear that most revenues will be created through components and process innovation within other industries. This type of innovation requires different strategies from more frequently studied product-based innovation. The paper refers to impact of type of innovation on strategy and value creation. The problem is vital in periods of limited financing and increasing costs of funding.

Key words: nanotechnology, innovation, strategy, value creation.

1. INTRODUCTION
Following initial interest in the media and attracting investors nanotechnology research and development is experiencing growing barriers. Early projects and financing deals showed that ideas with potentially promising commercial applications would take years or even decades to research and commercialize. It gradually becomes clear that, at least for some time nanotechnology companies will offer components rather then standalone products. New components will alter processes, enabling new products or changing their properties and production costs. In other words nanotechnology companies commercialize their results in process innovation rather than product innovation. Process innovation requires a different approach to value creation and management, changing the perspective of both managers and investors [1, 2].

While commercial use of nanotechnology creates uniquely valuable solutions [3], required competencies to develop such solutions are often outside the scope of any single firm [4]. Nanotechnology products (outside life sciences) are usually improving the characteristics (e.g. lowering energy consumption, increasing surface area) of existing products rather than creating new ones (at least from clients point of view). As components, nanotechnology products require substantial quantities of the final product sold to recover high initial investments. This requires economies of scale, which are difficult to achieve for start-ups. Berenbruch suggests that nanotechnology ventures should aim at establishing links with large-scale producers instead of building own production facilities based on financing from venture capital funds [5].

Cross industrial use of the technology creates the need to form networks and alliances, which are notoriously difficult to manage, especially in the process innovation management context.

Many nanotechnology alliances focused on knowledge creation and were not concerned with application [6]. Assessment of value creation in this setting is difficult, as financial metrics are not perceived to be of primary importance. Furthermore as the solutions offered by nanotechnology firms are being applied to a growing variety of fields, investors do not perceive nanotechnology as a separate class in itself, but one of technologies, that affect other classes such as healthcare and life sciences, electronics or alternative power solutions [7]. Lack of financial data and benchmarks discourages commercial funding but also has direct implications to identification of best practices in management of nanotechnology ventures.
To date, empirical studies on the emergence of the nanotechnology field have mainly focused on patents and scientific papers as an output measure. These studies, while identifying valuable trends and offering observation on firm formation and knowledge productivity strategies, do not offer guidance on commercialization strategies. Many nanotechnology research initiatives attempt to commercialize their results under the scheme “having the cure... looking for a disease” or “iterative process for matching technology and market” [8].

Currently nanotechnology research still benefits from favorable attitude in national or regional innovation strategies and from government funding, yet without creating the structures that are necessary to implement the technologies, even government interest may gradually fade. There is clearly a need for theoretical model for management of nanotechnology ventures that incorporates formal networks (consortia, alliances), open innovation systems and commercialization. A model that focuses not only on knowledge creation but also leads to generating cash flow for investors. Nanotechnology companies need to advance and become a viable partner for commercial funding sources.

I integrate literature on innovation types in nanotechnology, nanotechnology networks, open networks and innovation commercialization to develop a theoretical model for management of commercially oriented nanotechnology ventures.

2. NETWORKS, CONSORTIA AND ALLIANCES

Participants of modern technology development oriented networks (consortia, alliances) contribute tangible and intangible assets; manage research and commercialization initiatives in hope of sharing future rewards. Modern networks are not bounded by geographic distance [9]. They require advanced information and communication technology to communicate and store ideas and knowledge.

The access to networked resources (Fig. 1) usually means sharing equipment, tools and human capital. Sharing equipment and tools is essential, as nanotechnology requires equipment that is quickly depreciating (in technical terms). Creating a networked technology base enables sharing ideas that can guide to cross industrial applications. Nanotechnology advances require expertise of physicists, material scientists, chemists, biochemists, molecular biologists, toxicologists and medical scientists. They also require “T-shaped managers” that can connect knowledge from different sources and form new combinations [10].

Currently few nanotechnology research oriented firms have commercialization competence. Companies that have the commercialization capacities usually have limited nanotechnology research capacities. The match seems simple but nanotechnology research results can show potential in various products and processes, which means that value of the technology would be limited if applied only by the members of a particular network. Creating or joining open innovation systems may offer the solution to this problem.

Chesbrough defines open innovation as the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation [11]. It is the antithesis
of closed innovation, in which internal innovation activities lead to internally developed products and services that are then distributed by the firm [12]. Many large-scale producers (potential clients) have created platforms and started to design and manage innovation communities (e.g. Procter and Gamble’s Connect + DevelopSM or General Electric’s Ecomagination Challenge).

Creating or gaining access to open innovation platforms (Fig. 1) enables use of external technology, cross industry opportunities and resources. The biggest potential is in creating own open innovation platforms that are designed to meet the needs of a particular company. Chesbrough observes that even small companies can create open systems [12]. Unfortunately this may be difficult for young nanotechnology companies especially in developing countries due to specialized knowledge and the necessity to attract attention of geographically dispersed communities of experts.

Participation in open innovation systems increases flexibility. Companies may adapt their technology to changing market conditions and obtain more value from innovation.

3. COMMERCIALIZATION

Participating in networks and open systems is also critical in commercialization (Fig 2). Networked technology and knowledge is crucial in devising revenue generating business models. The application of innovative technology in cross industrial settings (and process innovation) requires multidisciplinary expertise that can be provided by other members of the network. The participation in open innovation systems creates further opportunities that may increase the value of the innovation.

The access to networked and external resources is also essential in the assessment and choice of commercialization path. The choice between marketing own products, licensing and sale of the business depends on the access to resources and financing. Commercially successful innovators (e.g. Apple Inc.) often seek outsourcing opportunities to use external expertise and decrease the costs, capital involvement and risk in manufacturing.

![Fig 2. Closed innovation systems, consortia and alliances and open innovation systems in nanotechnology commercialization](image-url)
4. FINANCIAL PERSPECTIVE

Business ventures have to remain solvent. Although some (for a limited time) can operate without generating profits and positive cash flow from operations, ultimately managers have to come up with viable revenue generating business models. The ultimate goal for a business is to create value. A business needs to generate cash flows that will satisfy investors. Nanotechnology ventures have to participate in networks to increase their innovativeness but it is also essential in devising revenue generating business models and the assessment of resources and financial needs that determine commercialization paths.

Taking into consideration long research and development periods and capital requirements financing structures based on commercial financing are not fit for developing nanotechnology ventures. The key constraints to improved access to venture capital financing seem to be time (long development), capital expenditures related to equipment and economic scale (access to production capacities and distribution networks) [7]. Network participation may shorten development times and decrease capital expenditures through asset sharing and outsourcing. Focus on process innovation and cooperation with large-scale producers may further decrease the need for own resources.

Financial aspects should include complex issues related to protection and sharing of value of innovations created within networks. Intellectual property rights may be difficult to defend, both within and outside the network, especially in the case of process innovations where the use of particular technology in manufacturing may be difficult to identify in the final product. Innovations enabling manufacturing cost reductions are particularly prone to copying. This issue requires further research and legislative actions. It is important to note that early planning for commercialization provides for the possibility to discuss value sharing with network partners. Network participation enables the creation of shared intellectual property defense mechanisms.

Attracting the attention of commercial financing sources will take time even when nanotechnology companies apply commercial focus and resolve most legal and value sharing issues. Financial institutions need to develop expertise to assess the value creating potential and risk of nanotechnology ventures. Furthermore, unfortunately this needs to be done locally as venture capital funds are usually geographically restricted in their operations [13]. In perspective, focusing and generating cash flows by nanotechnology firms from a particular region should be seen as a step on the path to create an environment that stimulates new venture formation in that region.

5. CONCLUSIONS

Emerging process technologies are critical to economic growth since these process technologies are poorly understood and few firms have the required sophistication to use them. Consequently, any research that strengthens the ability to manage emergent process technologies has a strong and direct impact on the economy [14].

Although the notion that nanotechnology companies commercialize their results in process innovation rather than product innovation may be helpful in search for commercialization concepts and forming networks it’s important to remember that, from investors’ point of view, companies are supposed to generate cash flows. Creating networks is essential not only to support internal technology base and develop innovations but also to: identify and exploit revenue generating business models, supplement own resources and identify financing needs for commercialization.

The proposed model adds to literature by incorporating the stages of: devising revenue generating business models, assessment of resources and financing needs and commercialization to networked innovation models. The model targets cash flow generation instead of innovation and knowledge generation and may be helpful in increasing value from innovation and advancing nanotechnology companies to attract commercially oriented financing sources.
Further research is required to incorporate intellectual property issues and value sharing mechanisms within networks and open innovation systems. At this point however these attempts may be premature, as nanotechnology companies need to develop a sufficient number of cases to identify industry standards.

LITERATURE


