**Sources of Innovation - revisited**

**Abstract**
In his groundbreaking work Sources of Innovation, Eric von Hippel discussed from where in (and out of) the value-chain innovations came in different industries, the customer, the manufacturer, the supplier or the third party innovator (universities, research laboratories, etc.). The world has changed and new phenomena have become apparent. This article is a conceptual paper, discussing these new phenomena and presenting a tentative updated pheno-typology of the sources of innovation. Except von Hippel (1988) it draws heavily on Kaulio (1998), Borrus & Zysman (1997) and Hart & Sangbae (2002) to build these phenotypes.

**Key words:** Innovation, Differentiation, monopoly rent, sources of Innovation.
Sources of Innovation - revisited

Introduction
Neo-classical Economists argue for perfect competition as the natural state of a capitalist economy. Business Administration and Entrepreneurship has as its very objective to show how firms can differentiate themselves to reap temporary monopoly rent, by establishing monopolistic competition where the firm has carved out a place in the market where it has a unique value or price. ¹

The forces behind the change
As the forces behind the increased complexity of innovation I propose shorter life-cycles, lower direct production costs, intellectual property, knowledge transfer, and network economics.

Shorter life cycles
Shorter life cycles is the result of increased competition. In the 19th century it was not unusual that a product existed for 100 years. After the WWII a typical product life cycle was 20 years. In the 1980s it has been reduced to 7-8 years and today it is typically 3-5 years, with individual products with life cycles of 3 - 6 months (e.g. mobile telephones). These individual products might reside within technology with longer life cycles (e.g. 7 - 10 years as the 4G mobile telephone systems) and the very concept of a technology as such (the mobile phone is 66 years old now).

¹ Although most researchers in business administration are unaware of this, the underpinning is Schumpeter’s discussion of monopoly rent, in its turn dependent on the classical discussions by Malthus (1798/1970), Ricardo (1817/1971), Marx (1867/1976, 1885/1978, 1894/19XX), (1857/1973), (1862/19XX) and Sraffa (1960).
**Lower direct production costs**

In early capitalism the cost of the production of a product or a service was 80-90% of the price, Piana (2003). After the Second World War supply has typically been higher than demand. Hence, resources where allocated to product development, adaptation and marketing. As a consequence, the cost of production sunk towards 50% of total price. Today the cost of production is in many industries less than 10%.

![Image 2: Lower variable production costs, own](image)

The lowering of variable costs was also the result of continuous efforts to decrease costs, to stay competitive. As different costs where “beaten down” by management efforts, new costs have come to focus. The foci of management has changed because of this changed cost structure. From direct labour in the 1950’s, direct material in the mid 1960’s, general Overhead costs in the mid 1980’s, I propose the costs of product development and marketing to increasingly smaller global target groups to be the most important today.
Intellectual Property

When von Hippel wrote Sources of Innovation he had the opinion that intellectual property in most cases gave limited possibility to exploit monopoly rent: ”...the observations presented above provide a very reasonable explanation for the typical ineffectiveness of the patent grant.”, von Hippel (1988:52).

Since then intellectual property rights have been strengthened as a result of the very militant action by the US in the WTO and because many industries have learned how to use intellectual property rights to defend their innovations. However in many industries this have forced co-opetition solutions of the type I described in the mobile telephone equipment industry as no single one of the competitors holds the rights necessary to realise the new technology.

Network economics

Network theory was preceded by mathematical graph theory and topology. Network theory focuses on social networks, but it is related to neural networks, which is used by neuroscience to explain some of the fundamentals of association in the human brain. This means that Knowledge theory and network theory can be seen as the same thing on different scientific levels. Kaufmann (1967:312-315) showed the importance of delimiting complexity by dis-associating networks into network islands, between which couplings are loose. Thompson (1967) brought this thought to organisation theory, in explicitly referring to von Neumann & Morgenstern (1944/2007) and Luce & Raiffa (1957). This is also the basis for
Wintelism, the phenomenon whereby loosed coupled product architecture components can be outsourced based on an explicit limited set (a brief) of knowledge.

**Knowledge production and knowledge transfer**

Knowledge creation and knowledge transfer theory are rather mechanistic compared to neurobiological and psychological theory of knowledge and creation.

Creativity is the result of associative synapsis in the brain, built on internalization\(^2\) of past experience and how this have been interpreted and given meaning. The child is essentially born autistic, with an information overload, overwhelming the small capacity of the brain. By experience the associations are built into a grid of pre-understanding that filters sensory information considered as redundant. Not until the grid is fine enough, can the brain start higher mental functions, built on a meta understanding on the child in itself, Vygotsky (1934; 1962).

Human experience is diverse and individual. Hence, the associations are not the same from one individual to another. Tacit knowledge could be said to be the mass of these associations. And with a rich network of unusual lose link associations the individual is considered creative by those that don't have the same associations.

Even though explicit knowledge is also harboured in the brain, it is associated with tacit knowledge that makes even the explicit knowledge intrinsically tacit!

Tacit knowledge can be transformed to explicit knowledge through externalisation. Externalisation is made in written or oral language, visualisation and behaviour. Even with odour, fragrance, scent, and aroma. The externalisation, the objectifying of the subject, makes it possible for the subject to "look at" her tacit knowledge and reflect on it. The "looking at" aspect is evident, as visualisation is a very powerful instrument for the designer, architect and product developer. The externalised knowledge is however not necessarily immediately understandable to others. It might need interpretation, a transformation into

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\(^2\) Vygotsky is sometimes seen as a forerunner of social constructivism, in that the child is formed by internalization of the cultural constructs embedded in language. However, this is not correct. As Freud, he did not see the child as a mere social construct; he viewed the internalization process (the superego) as moulding the inner potentials of the biological "sprout" (the id). Although criticising earlier primitive attempts to build a dialectical materialist psychology, Vygotsky was still a dialectical materialist.
more explicit knowledge, based on a - more - common frame of reference, a more explicit knowledge. This translation problem is the basic problem of knowledge transfer.

von Hippel differentiates between needs knowledge and solutions knowledge. I would add transformational knowledge, when the solutions knowledge is used to satisfy the needs. Of course it could be argued that this is the essence of solutions knowledge, but I would like to differentiate between the mere competence to find solutions to a needs problem generally and actually producing innovative knowledge that satisfies needs in a radically a new way.

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<th>Knowledge production</th>
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<td>Needs knowledge</td>
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von Hippel’s Sources of Innovation

In von Hippel’s ground breaking work The Sources of Innovation (1988), he showed that in different industries the innovations came either from customers, within the industry itself, its suppliers or from third
parties (independent inventors, research laboratories, universities, etc.), all depending who was most likely to earn and retain the temporary monopoly rent that the innovation permitted the innovator to reap.

Von Hippel’s proposal was the source of innovation depend on the possibility to displace the rent in the value-chain by the inventors exploitation of the innovation while preserving others from doing so or licensing it to others to use the innovation-related knowledge for a fee.

Phenotype\(^3\) 0: the default, in the firm

In von Hippel (1988) the firm itself was of course the innovator in many cases. I see this as the trivial default. For reasons explained above, this default is becoming less and less possible. In this default phenotype the firm has to get the knowledge about needs, the solutions and the transformation of the needs knowledge to products satisfying the needs. There is no knowledge transfer involved.

**Types of Customer involvement**

von Hippel identified customer involvement a a key issue in successful innovation because of the stickyness of customer information, von Hippel (1994).

Kaulio (1998) categorised customer in three types, for the customer, with the customer and by the customer.

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\(^3\) “A unit of cultural inheritance, hypothesized as analogous to the particulate gene, and as naturally selected by virtue of its ‘phenotypic’ consequencies on its own survival and replication in the cultural environment.” Dawkin (1976:290)
Phenotype 1: For the customer

For the customer means that the company actually does not involve the customer in any active way. It thinks that it can appropriate the customer needs knowledge through market analysis, in a classic rationalistic Kotlerian sense. But it is of course possible to do it in a less rationalistic way, by guts feeling. When the Swedish manufacturer of design furniture, gives designers the task to design a new chair, it exposes ten chairs in its showroom and sees which one the customers take a liking to. Although I doubt that Apple do no market research, Steve Jobs has said that Apple is a company of nerds creating things they want themselves. They are confident that there are many other nerds out there. Hence they could be said be part of their own target group or rather being their own "lead-users" in a von Hippelian sense, Herstatt & von Hippel (1992). Essentially this is the same as the default phenotype.

Phenotype 2: With the customer

With the customer can be the typical approach of the small engineering firm designing "specials" for an individual customer. Or the "standard-special" of the mid-size engineering firm; meaning that they competed with products with a product architecture of standardised components that could be combined to give customers semi-unique solutions that where much less expensive than the "special" solutions and still rather price-worthy compared to the leaders standardised products. These standard-specials was look the strength of the Swedish engineering industry, like ASEA (now part of ABB), Volvo (not Volvo Car), Kalmar Industries and others, as their way to compete with their large US competitors, which due to a large inner market could produce standard products in large series. Of course with increased competition the targets groups have become smaller and standard-special has become the sign of all engineering industry.

The co-operation with the customer involves reflexive knowledge transfer. The customer transfer needs knowledge and the firm transfer solutions knowledge. They co-operate to in the production of transformational knowledge.

Phenotype 3: By the customer

By the customer is the same as identified by von Hippel (1988), when the customer invents and either proceeds as an industry start-up or license the innovation to its supplier. The first case is interesting on a societal level, but not for the firm, which is our perspective here. The latter can be the trivial case when an engineering company orders a "special" product from another, often smaller company, or if it is recurrent,
traditional outsourcing (see phenotype 5). A more interesting case is when the firm provides advance
users with “toolkits” to innovate, von Hippel (2005:147ff), nurturing user innovation. This is what I see as
phenotype 3. In this case the needs knowledge is not transferred to the firm, who packages it solutions
knowledge and transfers it to the customers in the toolkit and let’s the customer provide the
transformational knowledge.

Kaulio classified the customer involvement in 7 methods of product development: Quality Function
Deployment (QFD), User Oriented product development, Concept testing, Beta testing, Consumer
idealised design, Lead user method, and Participatory ergonomics.

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In Zineldin & Philipson (2007) we showed that business leaders in many cases just paid just lip service to
the adoption of relationship management. None of 5 studied Scandinavian firms exclusively relationship
marketing approaches, but still used the transaction oriented methods of Kotler and Borden.

Since von Hippel’s “lead-user” method, Herstatt, & von Hippel(1992), business leaders have also paid lip
service to customer involvement in product development.

My master students telephone interviewed 84 companies world-wide (out of 480 in a convenience
sample) in four clusters. Only 35% involved customers in their product development.
The results clearly shows that, as with relationship marketing, customer involvement in product development is not a widespread reality.

Phenotype 4: Third parties
von Hippel (1988) identified third parties, such as inventors, universities and independent research laboratories, as sources of innovation in some industries. An interesting development is that many of the big pharmaceutical companies no longer seem to be able to provide the right creative environment for innovation. In many cases independent research laboratories have been singled out. These companies owned by leading researchers or the employees at large invents new substances and patent these. The pharmaceutical companies buy these, take them through the FDA-tests and market them.

This phenotype implies that the firm must have needs knowledge to evaluate the proposals from third parties, but neither solutions knowledge, nor transformational knowledge. Knowledge transfer is limited to the final product, the embodiment of other knowledge.

Phenotype 5: To the supplier
In this phenotype the firm does all the inventions and just outsource its production to a supplier. This is traditional outsourcing and I include it as an innovation phenotype because of its knowledge management implications and as a contrast to phenotype 8 below. In this phenotype the firm designs the product or component in every detail. To get quotes it has to transfer all the knowledge necessary to produce it and the have to analyse these quotes in the same detail. This heavy load of knowledge transfer limits the number of suppliers the firm can invite to give quotes. The consequence is a limited difference between the quotes. The phenotype gives hence the company the same heavy knowledge production load as the default phenotype and above that a heavy knowledge transfer work load. Hence, this phenotype is abandoned for other phenotypes as companies are learning.
Phenotype 6: With the supplier

This is equivalent to phenotype 2, but here the firm is the instigator of the co-operation instead of the customer. By asking the supplier for a "special" or "standard-special" component the firm increases the value of its own product. The great advantage compared to the default is that the supplier provides genuine solutions knowledge. But apart from this it still means as with phenotype 7 that the knowledge transfer workload is heavy.

Phenotype 7: By the supplier/for the firm

This was one of von Hippel’s original sources, von Hippel (1988), where typically a material manufacturer invents new material characteristics which it proposes an important customer as a value-enhancing for its products. For the firm it means that the knowledge production and the transfer (in this case the embodiment in the component or material) is little. This is typical of innovative clusters, where the firm takes advantage of suppliers (including machine suppliers and designers, and other knowledge workers, on the cutting-edge), Porter (1990).

Phenotype 8: By the supplier/Wintelism.

Borrus & Zysman (1997) and Hart & Sangbae (2002) introduced "Wintelism" as a concept to describe a new phenomena that emerged after an antitrust decision against IBM in 1980. IBM was forced to outsource its component manufacturing in the hope of creating competition. Instead of traditional
outsourcing, IBM chose to only specify the input and output of the component, leaving the supplier to decide the necessary transformation.

**Less design work, faster design**

As a consequence the buying firm don’t need to "design" (innovate, product develop, construct) every detail of a product, only the "product architecture" on a "high" level of the product structure. This makes it is possible to develop in shorter time, which is very important with shorter and shorter life cycles.

**Increased competition among suppliers**

Since the firm only have to specify the function of the component (input - output), it is possible to transfer the information simple and inexpensively, e.g. by a web page, to many more suppliers, increasing the competition among suppliers. Often thousands of suppliers, rather than as before maybe some ten, can be invited. It also becomes less expensive to evaluate the offerings of the suppliers. And the firm don’t need to transfer detailed knowledge to the supplier that has gained the bid - the supplier knows best how the component shall be produced.

**The Unleashing of Creativity**

The prospective suppliers can use their creativity to invent radically new solutions that either gives a much lower price or higher performance or new features. Cf. the development in the computer industry since 1980.
To sum up, phenotype 8 is neutral to the default knowledge production of needs knowledge, taps heavily on the suppliers’ solutions and transformational knowledge and is much leaner in knowledge transfer than phenotype 7. This phenotype has become the preferential innovation model in the consumer electronics, mobile telephone terminal industries and other industries with a large part electronics and software content.

Phenotype 9: Virtual Enterprise with complementers
An alternative, and sometimes a complement, to open source software is middleware. This makes it possible to develop small software components that in themselves are of limited interest as stand-alone programs. By standardised middleware these components are able to seek up a multitude of complementary components to be able to execute more complex tasks for the user. At the forefront of such development has been Commercenet, www.commercenet.com. This is collaborative innovation between complementary businesses in the same industry in the form of a virtual enterprise. It limits the firms own knowledge production for needs knowledge, solutions knowledge as well as transformational knowledge. It might that the knowledge transfer has to be intensive sometimes, but on other occasions it might be possible to apply a ”wintelism”-type of architectural knowledge transfer with limited knowledge transfer on the component level.

Phenotype 10: Virtual enterprise with competitors
This phenotype is based on Co-opetition. Zineldin (2004) identified that competitor’s in some situation co-operated and called it co-opetition. In most legal regimes this is not permitted under antitrust laws. However, western society has permitted such cooperation when it comes to building network economics, Westland (2008). This is necessary because network economies builds on standardised interfaces that permits networks to connect. There is also a societal interest that the interfaces are open, though not necessarily in public domain. A third reason is that in today’s complex technology a single supplier can often not realise a new technology because it does not own the necessary technology elements to built it. It has to co-operate with others that have necessary elements.

A typical, and perhaps best, example of this is mobile telephone technology. To build a new generation of mobile transmittance systems, the interested parties reunion in Geneva under the auspices of ISO, the International Standardisation Organisation, a United Nation’s body. Adhering to the rules of ISO about open standards and the open licensability of the resulting technology, they are protected from antitrust
prosecution. The signatories of the standard develop in co-operation the specification of the new standard, let’s say the 4G standard (the 4th generation mobile telephone system).

The owners of the intellectual property necessary to realise the new standard form a patent pool, a virtual enterprise that licence these patents from their owners and sub-license the patent bundle to the companies that want to compete in the market that will result. As the standard has been developed under the ISO treaty even firms that have no patents can license the bundle to create products for the new market. Companies like IBM, with no primary interest in the market will earn royalty on their technology.

The participating companies must on the market place, "platform", level have a good common understanding of the needs of the customers and also, on an architectural level of the solutions and
transformational knowledge. Hence the knowledge transfer on this level is intense. However on the component level it is limited to evaluating existent embodiments in patents, software, etc.

It can hence be said that this phenotype is equivalent to phenotype 8, wintelism, when technology has become so complex that it is not possible to produce a sustainable competitive position on the architectural level.

**The Phenotypes**
The above discussed default, phenotype 0, and the 10 phenotypes that present alternative strategies for the firm, can be summarised in the following image.

![Image 12. The Sources of Innovation Revisited. 10 phenotypes. Own.](image-url)

Two of my master students, Khan & Lodhi (2010), studied under my supervision the sources of innovation in the global wind-turbine industry. They identified 231 companies all over the world and made a convenience sample of the 31 companies from all over the world attending the European Wind Energy conference and exhibition in Warsaw, Poland. Hence, these represented 13.4% of the companies in the industry. Of these they interviewed representatives of 25 in person and the remaining 6 through an email-questionnaire. They found the following sources of innovation (multiple sources).
The phenotypes and knowledge production and knowledge transfer
The discussion above shows that the consequences for the firm when it comes to knowledge production and knowledge transfer are heavily affected by the choice of innovation phenotype.

<table>
<thead>
<tr>
<th>Sources of innovation phenotype</th>
<th>Number of companies</th>
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<tbody>
<tr>
<td>0. By the firm/in-house</td>
<td>25</td>
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<tr>
<td>1. For the customer</td>
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<tr>
<td>2. With the customer</td>
<td>19</td>
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<tr>
<td>3. By the customers</td>
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<tr>
<td>4. Licensing from third party</td>
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<tr>
<td>5. To the supplier/outsourcing</td>
<td>19</td>
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<tr>
<td>6. With the supplier/virtual enterprise</td>
<td>17</td>
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<tr>
<td>7. By the supplier/ for the firm</td>
<td>14</td>
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<tr>
<td>8. By the supplier/Wintelism</td>
<td>9</td>
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<tr>
<td>9. With complementors/virtual enterprise</td>
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<tr>
<td>10. With competitors/virtual enterprise</td>
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Table 2. Sources of Innovation in the Wind Turbine Industry, Kahn & Lodhi (2010).

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Knowledge production</th>
<th>Knowledge transfer</th>
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<td></td>
<td>Needs knowledge</td>
<td>Solutions knowledge</td>
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Table 3. The knowledge production and transfer in the phenotypes; Own.
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