Innovation process

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Purpose of this report:
- This report was prepared for RISO team involved in design of the innovation system
- Report provides innovation methodology to establish common understanding of the process concepts and related terminology
- The report does not include RISO- or Denmark-specific cultural, economic, and political challenges, which will be considered in a separate report on implementation

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Executive summary

Purpose of this report

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Innovation process

- Innovation = Invention + Commercialization
- Invention: matching problems and solutions to create new products or processes
- Commercialization: turning inventions into widespread use
- Commercialization can take 10-100 times more time and resources than Invention

Commercialization strategies

- Inventions differ by their commercial potential and required commercialization resources
- Easy but small potential inventions can be licensed or sold as consulting expertise
- Large potential but resource-intensive inventions are foundations for partnerships
- Large potential and easy inventions can be accepted for spinout incubation
- Resource-intensive and small potential concepts should be not pursued

Innovation impediments

- Lack of financing
- Lack of experienced entrepreneurs
- Lack of researchers time
- Insufficient incentives and rewards
- Science/Business culture conflict
- Lack of process methodology and tools
- Legal and political constraints

Risk reduction

- Inventors face many uncertainties - risks
- Innovation is viewed by investors as risk reduction process
- Understanding risks and risk reduction process is critical for fundraising

Risk profile

- Risk curve at different innovation stages consists of different risks
- Combinations of the risks create unique invention risk profiles
- Inventions with different risk profiles should be processed differently

Funding gap

- For higher perceived risk investors demand higher returns and provide less capital
- Because of extreme risk, private money is not available at incubation stage
- Public money stops at invention stage, creating gap in funding - “Death Valley”
- Successful innovation system must provide funds to bridge the gap

Innovation system

- Innovation system consists of Matching, Incubation, and Value systems
- Matching system matches problems and solutions, creating new product concepts
- Incubation system reduces risks until they are acceptable to venture investors
- Value system supports spinouts until liquidity and then distributes profits

Matching system

- Matching system consists of Idea sourcing and Invention systems
- Ideas come from research (as new capabilities), or industry (as business problems)
- Capabilities matched with applications by diverse group of industry experts
- Problems are solved by diverse group of researchers
- Resulting product ideas pass feasibility study to become foundation of new companies
- Companies are seed-funded by innovation grants from Innovation Fund

Incubation system

- Incubation goal is to reduce risks until external funding is available
- Fundraising is “convincing business plan + investment offer + entrepreneur”
- Business plan is “opportunity + business model + execution strategy to exploit it”
- Opportunity is “potential for many profitable sales for as long as possible”
- Profitable sale is “Advantage translated into attractive customer offer”
- Advantage is “Superior value of new product over status-quo in targeted market”

Value system

- Value system goal is to manage portfolio of spinouts graduated from incubation system
- Researchers should provide continuous support to spinouts as consultants or employees
- Feedback from spinout failures should be used to improve methodology
- Success stories should be celebrated to promote cultural change and public awareness

Innovation concepts

Innovation process

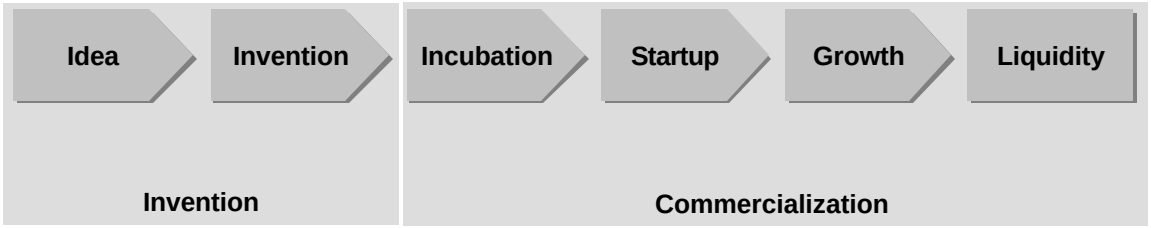
Words "Innovation" and "Invention" are often used interchangeably. While closely related, these notions are not the same:

Innovation = Invention + Commercialization

"Invention" is a creation of a new product or process. "Commercialization" is the conversion of the invention into widespread use. Examples of innovation:

- A new or improved product (Pentium chip)
- A new method of production (Henry Ford's production line)
- A new form of business organization (franchising, e-business)
- New uses for existing products (computers were first used only in military)
- New markets for existing products (donuts were invented in Germany and then spread throughout the world)

Innovation process can be presented as 6 distinct steps:



1. Idea: identifying interesting problem to solve, or discovering new technological capability
2. Invention: matching a problem and technical capabilities to create a new solution
3. Incubation: research and planning how to launch the invention into a marketplace
4. Start-up: establishing an organization and moving from the plan to the first sale
5. Growth: building organization and growing sales until company reaches profitability
6. Liquidity: receiving dividends from the company, or selling shares to other investors

The first two steps are part of the Invention process, the last four – Commercialization. Commercialization part typically takes 10 to 100 times more time and resources than Invention part to complete successfully. Inventors are often unaware of this fact, and mistakenly assume that after they make the invention work, most of the job is done and "the rest is easy". Moreover, researchers often perceive business expertise as inferior to scientific expertise, and completely underestimate the complexity of the commercialization process.

Commercialization strategies

Research institutions use several strategies to commercialize their knowledge and inventions: licensing, consulting, R&D partnerships and spinouts. These approaches have pros and cons, and managers are facing challenging decisions which strategy to employ in a particular case.

Licensing

Licensing is the most widely used commercialization strategy by research institutions. After an invention is made, it is patented, announced in the local business community, and licensed to the interested entrepreneurs or businesses. The licensees pay fees and royalties, in exchange for the rights to use the patent on exclusive or non-exclusive basis.

The key advantage of the licensing is that it is simple and requires little resources. After the invention is licensed, all risks, funding and work become responsibility of the licensees. This approach requires minimum effort from the institution, and even a small licensing office with minimal budget can issue a significant number of licenses per year. Unfortunately, the licensing approach has also numerous weaknesses: it is highly inefficient, it provides limited revenue potential and has high commercialization failure rate.

Research institutions have to make decisions which inventions to patent and how to find interested and capable licensees. Making such decisions requires strong business expertise, which research institutions don't possess. Often their licensing offices are run by people with strong legal expertise, who can ensure proper regulation compliance and legally sound contracts, but have little or no entrepreneurial experience. As a result, research institutions file many "dead" patents, which they can not license. Since patenting process is expensive, licensing revenues barely cover the costs of patenting and operating the licensing office.

Licensing also has perhaps the lowest revenue potential among other commercialization strategies. Since all commercialization risks are transferred to the licensees, as a compensation they assume most of the upside. As a result, license revenues typically range from a few thousand to a few tens of thousands of dollars per patent. For example, the Office of Technology Commercialization at the University of Maryland reported the following results of their 17 years of operation:

- recorded 1,300 technologies
- secured 270 patents
- licensed 750 technologies, generating $21.7 million in royalties

which shows the average revenue per license of $29,000.

Finally, a high proportion of the licensed patents remains inactive. After the patents are licensed, research institutions have little or no control over their fate. Licensees may choose not to pursue commercialization for internal political reasons, or run commercialization project poorly. If the licensees fail, it is often impossible for the research institution to regain control over the licensed technology.

Despite its weaknesses, licensing can be used successfully if the patenting and licensing decisions are made with sufficient quality. To increase success chances, research institutions can make several improvements of the existing licensing process:

- Licensing should be integrated into the innovation system
- Decisions should be made by the innovation committee with entrepreneurial expertise
- Prior to patenting, market and technology feasibility studies must be conducted
- License marketing should be extended globally to increase potential licensee pool

Consulting

Consulting is a way to commercialize research institute expertise and capabilities without filing and licensing patents. Over the years of research, scientists accumulate deep cross-disciplinary expertise and awareness of the technological developments in their fields. This expertise can be used to help businesses solve their R&D problems. Research institutions can market its competences and research facilities by soliciting consulting contracts from the business community. Large companies might be interested in such projects if they encounter research problems which are either too complex or require multi-disciplinary expertise outside of the company R&D scope. Smaller companies might be interested in outsourcing research to increase their R&D capacity or reduce costs.

In many ways, consulting is similar to licensing: it is also quite simple to setup and manage, it provides limited revenue potential, and there is little control over the innovation process after the knowledge is transferred to a customer. However, the key difference is that the projects are initiated by businesses, who provide strong connection to the market needs. As a result, consulting projects tend to have much higher rate of success than licensing.

Besides providing on-going revenues, consulting projects have significant indirect benefits, because they bring on board much needed access to industry information and expertise, broaden research institution business network, strengthen relationships with the potential commercialization partners, help change research culture, and can provide new ideas for both research and innovation.

Unfortunately, research institutions are underutilizing this strategy. Most of them accept consulting requests, but don't seek such projects proactively, and don't have proper incentives and interface for the companies. Moreover, the institutions gravitate towards dealing with the large industrial partners, often ignoring smaller, but more entrepreneurial and innovative businesses.

To increase the revenues from consulting, research institutions should:

- Develop proper incentive system and legal and operational interfaces with businesses
- Actively promote their consulting capabilities in business community

Research partnerships

Research partnerships are another popular vehicle for research institutions to monetize their expertise. In this approach, long-term partnerships with qualified companies are formed to

solve a particularly challenging research problem. Such projects are somewhat similar to consulting, except that they last much longer because the targeted problems require significant amount of long-term, fundamental research.

Research partnerships can be highly attractive because they provide predictable long-term source of research financing, direct access to deep industry expertise, and clear path to market in case the project is successful. However, the partnerships also have some weaknesses: such projects tend to be partner-biased (focused on specific partner needs and based on its specific market perceptions), and very high-risk (large companies tend to engage research institutions with heavy-duty issues that might take many years to solve and commercialize). Partnerships also have limited upside potential for the research institution, because such contracts usually assign resulting intellectual property to the paying partner – industrial company, and sometimes result in disputes over the IP ownership, because specific contributions are hard to separate.

Spin-outs

Research institutions can also take their inventions down the innovation process as far as possible themselves, using their own resources. In this approach, an invention is incubated in the institution facilities until a start-up company can be formed and funded from external sources and the project leadership can be transferred to a qualified entrepreneur.

Spin-out is by far the most profitable commercialization strategy. It has the highest possible upside potential, highest degree of control over the innovation process, the largest amount of learning and feedback, the deepest involvement of researchers (usually resulting in strong cultural change). Also, spin-out process is less sensitive to the external environment, and if done properly, results in higher innovation survival rates than any other approach.

Unfortunately, spin-out is also the most resource-intensive strategy. Until a company graduates from the program, the research institution is responsible for funding, staffing, managing risks, and providing infrastructure. An additional challenge is that, unlike licensing, spin-out process is much less developed conceptually. For example, a survey by the Association of University Technology Managers (AUTM) found that from $35 billion of research expenditures US institutions generated only 400 spinouts (one company for every $87 million). While plenty of case studies and examples of successful licensing programs are available, there is much less information about the spin-out programs. Incubation is still largely an art rather than science. As a result, research institutions are forced to develop their own methodologies and tools, which requires expertise they don't possess.

Commercialization strategy choice

The choice of the commercialization strategy for a particular invention depends on the combination of 2 factors: perceived commercial potential of the invention, and estimated resources (time and capital) required to commercialize it:

Incubation resources	Commercial potential: Small	Commercial potential: Large
Sufficient	**Licensing Consulting**	**Spin-outs**
Insufficient	**Don't pursue**	**Partnerships**

If commercial potential of the invention is large, managers should consider spinning it out. Spin-outs are the best option if they can be brought to the external funding within a reasonable incubation budget and time (for example, less than $200,000 and 1 year). If not, or if no reasonable judgment can be made, research partnerships might be a better option.

If perceived commercial potential of the invention is limited or unclear, but it can be brought to the "marketable" state within reasonable time frame and budget, the best strategy is to patent it and license (or use for consulting solutions). If the implementation challenges are high or can not be judged properly, the invention should not be pursued.

This decision process is general, and the actual choice depends on the perceived likelihood of success under different approaches. For example, even if the opportunity fits spin-out process requirements, licensing strategy might be selected if there is a highly-qualified licensee available, or if the incubation pipeline is filled to its capacity.

Environment of the research institution also has strong impact on the commercialization strategy choice, including factors such as availability of the entrepreneurial talent, size of local economy, legislation, availability and quality of local venture capital. Larger entrepreneurial, economic and capital pools favor licensing approach, because entrepreneurs and capital create "pull" for new technologies at the early stages. In environments with limited availability of entrepreneurs and capital, or small economies, research institutions have to incubate the inventions longer before they become attractive for the private sector.

In practice, most research institutions employ a mix of the commercialization strategies. For example, University of Michigan reports the following commercialization results:

2004 Data	5-Year Data
▪ 285 Disclosures	▪ 1,129 Disclosures
▪ 73 License Agreements	▪ 330 License Agreements
▪ 134 Patent Applications	▪ 609 Patent Applications
▪ 13 Start-ups	▪ 47 Start-ups
▪ $11.7 million in royalties	▪ $38.7 million in royalties

Innovation impediments

Innovations come from various sources; currently, there is a growing tendency in societies to assign this function to public research institutions and universities, who are perceived as key means to promote local economies. However, in practice the main challenges are yet to be addressed concerning how they can create, develop and finance innovations, while finding a balance between the maximization of private returns and social benefits. To fully realize the potential benefits and satisfy market demands requires significant human and financial resources beyond those available to the research institutions and universities. Specifically, research commercialization is facing the following key impediments:

1. Lack of financing
2. Lack of experienced entrepreneurs
3. Lack of researchers time
4. Insufficient incentives and rewards
5. Science/Business culture conflict
6. Lack of process methodology and tools
7. Legal and political constraints

Lack of seed financing is viewed as the greatest impediment to the creation of spin-out companies. Venture investors find it difficult to select spinout companies meeting their investment requirements. At the same time, because of lack of business experience, resources and capabilities, and because of their cultural environment, research institutions find interacting with investors problematic.

Another impediment is the lack of entrepreneurial leadership. Commercialization requires strong business skills and intuition researchers don't possess. However, research institutions do a poor job to identify, recruit and motivate experienced entrepreneurs. Most of them assume that entrepreneurs will come themselves and have no formal programs to develop relationships with entrepreneurs, and no clear and attractive terms of cooperation.

The amount of time researchers have available to help spin-out companies is another inhibitor. Research is often funded by various grants, and the researchers allocate most of their time to meet the obligations to the sponsors, which leaves little time for the innovation projects. Since initial stages of the innovation process can be very demanding, researchers have to make a difficult choice – unfortunately, often not in favor of the innovation.

Related issue is the clash of commercial and scientific cultures. Some researchers perceive innovation as distractions from their intellectual pursuits, and avoid them. However, even those researchers who are entrepreneurially-orientated and willing to actively participate in the innovation projects, often have problems doing so because most research institutions have policies that challenge and even discourage such involvements. Management should create more accommodating culture for the innovative researchers, such as offering 'innovation sabbaticals', allowing scientists to develop a spin-out full-time, and return to their research after the spinout successfully graduates from the incubation system.

The lack of incentives and rewards is ranked as the fourth most important impediment to the creation of spin-outs. Research institutions primarily reward scientists for their research efforts and this does not encourage an entrepreneurial spirit. To motivate innovations, the institutions should offer researchers significant and direct equity participation in their spin-outs, and attractive share of royalties. In addition, they should offer public recognition, by promoting successful innovator stories in both research community and society.

Another challenge is the lack of a clear innovation methodology and related tools. Most research institutions have no established spin-out procedures, usually getting a company with a patent out of the door as fast as possible and hoping that it would some how survive. Unfortunately, in most cases they don't, and the landscapes around research institutions are polluted with the "dead bodies" of the improperly spun-out companies. An efficient methodology should provide a process and tools (such as market research and product development methods) to carry an innovation from an idea to the moment when it has reasonable chances of survival and can be picked up by the professional private investors.

To complicate things more, there is often inadequate awareness amongst government policymakers that creating, developing and financing innovation is a highly complex and intensive process. As a result, many governments, instead of providing support through facilitating policies and substantial financial participation to bridge the gap between public research grants and venture capital, impose additional hurdles in a form of unreasonably restrictive regulations and rules.

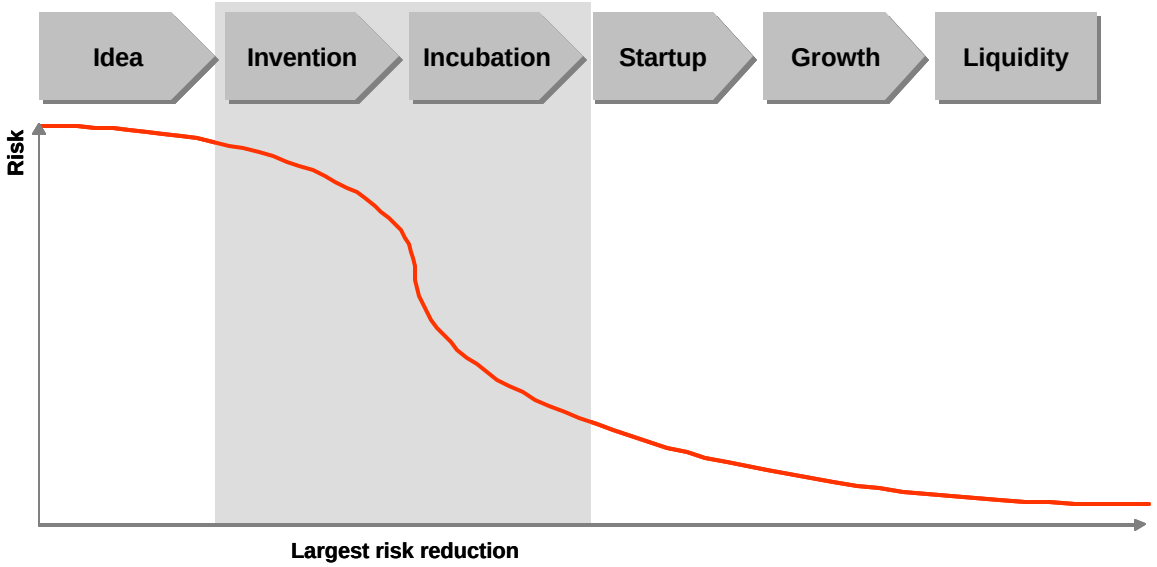
Risk reduction

Innovation process contains significant amount of uncertainties - risks. Risk is an uncertainty which might result in the innovation failure. There are many different types of risks:

- Market risks (will anybody buy our innovation?)
- Technology risks (will our solution work?)
- Competition risks (do we have enough advantage to sell our innovation?)
- Scalability risks (is market big enough? can we mass-produce?)
- Industry risks (can we enter the industry? can we access customers?)
- Execution risks (can we build a high-performing team? can we raise capital?), etc

At the beginning of the innovation process, we are facing the largest amount of risk, because too many things are unknown and can go wrong. At the end, when we have a profitable, successful company, the risks are approaching zero. From this point of view, innovation

process can be viewed as a "risk reduction process". This view corresponds to the perspective of venture investors, and since lack of funding is one of the top reasons why innovations don't reach markets, is essential for designing a successful innovation system.



Each innovation process step is dealing with the different types of risks, trying to reduce them to the acceptable levels before moving to the next stage. The largest risk reduction happens during the invention and incubation stages – when an idea first takes a tangible form, and when market and customer research bring critical information about the viability of the invention. This is the most challenging stage of the innovation process, where most ideas fail due to the lack of entrepreneurial expertise and funding. Unfortunately, these steps are the responsibility of the research institution: it has to reduce the risk before its innovations can be accepted by the external investors. Therefore, it is important for the success of the spin-out process to understand the nature of the risk at the different stages of innovation process, and to develop a set of effective tools to manage them.

Risk profile

Risk curve composition changes along the innovation process. Initially, it contains risks related to the invention itself. Later in the process, during the commercialization stage, the curve is composed of the risks related to the specific product and market, chosen for the commercialization. Therefore, we should distinguish between Invention risks and Commercialization risks.

Invention risks

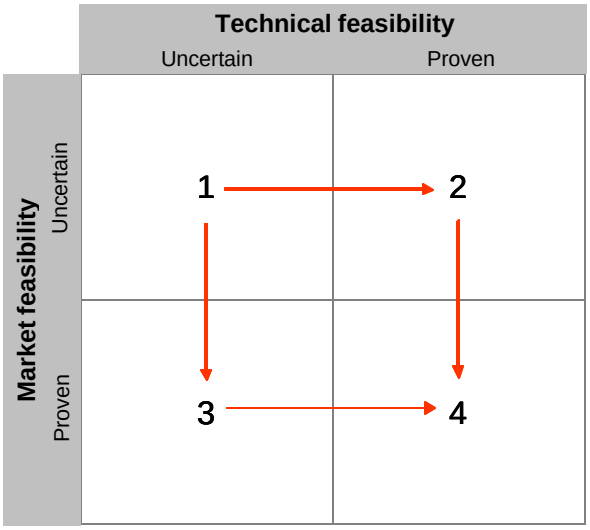
Invention risks are related to the fundamental uncertainties of new capabilities (technical feasibility of the invention) and new markets (commercial feasibility of the invention).

Technical feasibility is a risk that technology will not deliver core capabilities essential for the innovation to work. For example, if we try to build a high-capacity battery based on room-temperature superconductors, we will have a challenge because currently there is no feasible

technology to produce such materials. Technical feasibility risk does not exist if a technology is proven in other applications and available commercially.

Market feasibility is a risk that invention will not be needed. For example, if we design a computer-controlled mouse trap, we might face a challenge selling it because there is no evidence of a profitable market for such product. Market feasibility risk does not exit if invention targets established markets.

The combination of these two risks creates four unique invention profiles:



Quadrant 4 inventions have both market and technical feasibility established. In this case, the innovation advantage comes from making products better – cheaper, faster, higher quality. An example of such innovation is Dell corporation. Personal computers were mass-produced long before Dell (technical feasibility proven), and PC markets were well developed (market feasibility proven). Dell succeeded because it developed more efficient business model, resulting in the industry's lowest costs and fastest delivery. Inventions in quadrant 4 don't have to address feasibility risks and can move to the next stage - product risks.

Quadrant 2 describes inventions with technical feasibility proven, but market feasibility uncertain. In this case, we have an established technology looking for new applications. An example of such innovation is Sony Walkman. This product was developed from a regular tape recorder by stripping its recording function. While the technology was trivial and proven, the need for such device was uncertain ("who would use a recorder which can not record?!"). Inventions in this quadrant must find evidence of the market demand, usually by conducting market and customer studies. After the market feasibility risk is addressed, the invention moves to the quadrant 4 and can graduate to the next level of risks.

Quadrant 3 inventions have market feasibility proven, but technical feasibility uncertain. This is the case of a new technology trying to improve existing products by providing new technical capabilities. An example of such innovation is fuel cell batteries. While it is obvious that a long-lasting portable source of power will be very welcomed by the laptop, cell phone

and other users, it's uncertain if scientists can make it work. In this quadrant, inventors must demonstrate a proof of technical capabilities before the project can move to the quadrant 4.

Quadrant 1 contains both technical and market feasibility risks. This is the most radical type of inventions, often with the highest commercial potential but also with the highest amount of risks. Such innovations are good candidates for the industrial partnerships, because their commercialization might require resources well beyond research institution capabilities. An example of this invention type is optical tweezers: it is based on a new phenomena and its immediate applications are unclear.

Research institutions generate most their inventions in quadrants 1 and 2. Quadrant 2 inventions - perhaps the most frequent case - are typically results of research breakthroughs, when scientists solve well-known difficult technical problems. Quadrant 1 inventions are made after researchers discover a phenomena promising new capabilities and new applications. Quadrant 3 is usually a result of consulting projects for the industry, when companies ask researchers for a solution of specific business issues. Finally, quadrant 4 inventions rarely appear in the research institution spin-out pipelines, because they don't require fundamental technical expertise and thus fall outside of the researchers scope.

Why is this matrix important? Because it can focus innovation efforts on the most critical areas, greatly increasing the efficiency of the process. Investors often complain about inventors' tendency to dwell on the obvious instead of addressing the real risks. For example, when presenting a plan to commercialize a fuel cell battery, inventors spent most time describing their benefits and market potential. However, these benefits are obvious, while the real challenge is to demonstrate the feasibility of the enabling technology. By focusing on the obvious and not addressing real investor concerns, inventors guarantee the rejection. The invention risk matrix helps inventors to allocate their time by highlighting key risks. If an invention falls into a Q3, the most research and presentation efforts should be allocated to prototyping, to establish and demonstrate technical feasibility. If the invention falls into Q2, the main focus should be on conducting market and customer research, to prove demand. In Q1, the inventors will have to address both issues.

In either case, the objective of the risk reduction process is to provide enough evidence to reduce investors perceptions of the feasibility risks to Q4. After this point, invention feasibility is established and the remaining risks belong to the commercialization stage.

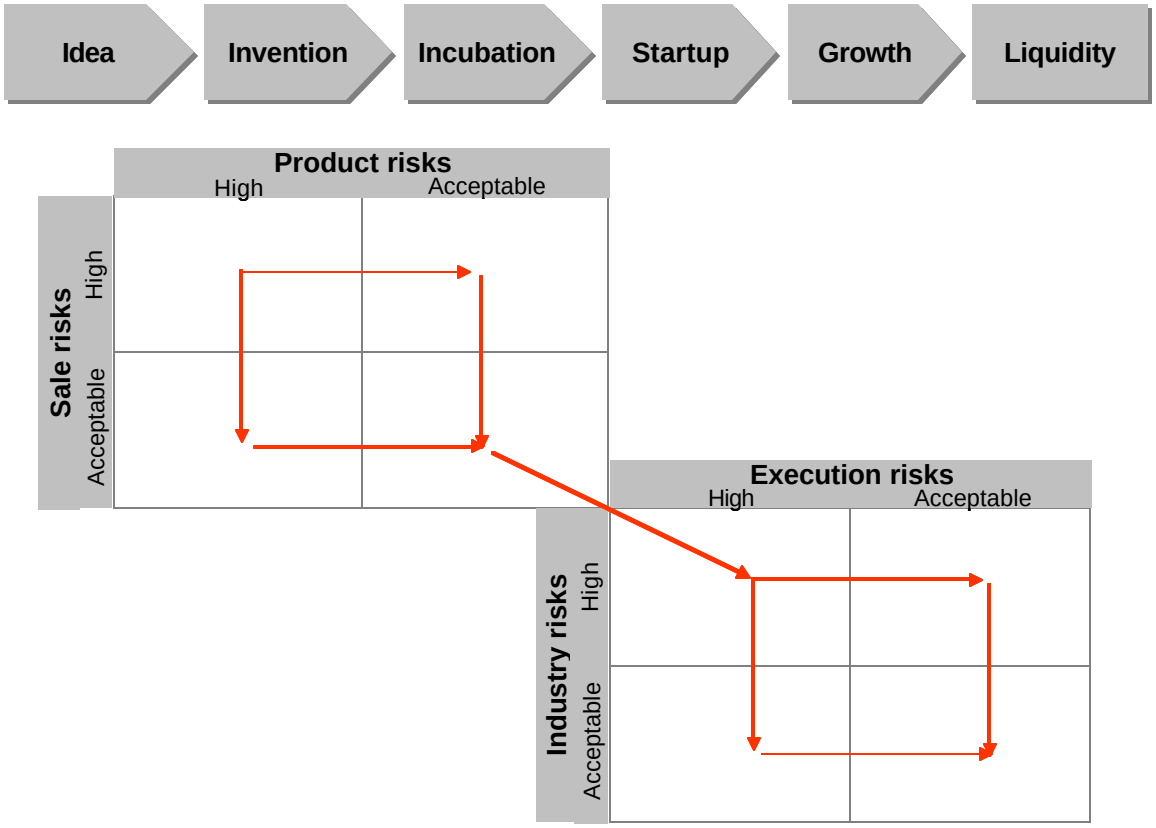
Commercialization risks

Commercialization risks can be split into 2 categories: Incubation risks and Start-up/Growth risks. Such division is important because incubation stage is the responsibility of the research institution, while start-up stage is handled by the entrepreneurial team and investors.

Like invention stage, incubation contains market and technology risks. However, there is a critical difference: incubation risks are now related to the specific product and market. For example, during the invention stage, technical risk is "is our core technology feasible?", while at the incubation stage it becomes "product risk" – "can our product performance meet

customer requirements"? Similarly, while invention market risk is "is there a need for this invention?", at the incubation it becomes "sale risk" – "can we sell our product"?

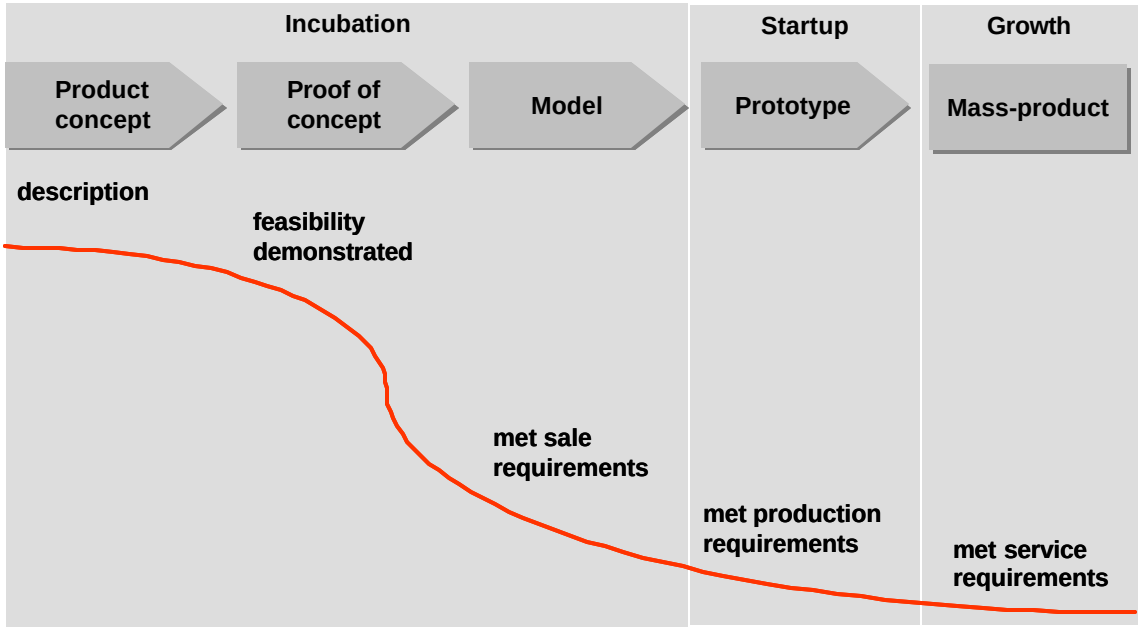
A risk matrix similar to the invention risk matrix can be used to profile these risks:



These matrixes can increase incubation efficiency by helping managers better allocate time and capital to address the higher risks first. However, at this stage both sale and product risks are always present (although in different proportions, depending on the type of invention), and are closely related - both risks have to be reduced in close coordination. Therefore, it is essential to develop tools to manage them both. The goal, as before, is to reduce perceived risks until the opportunity can graduate to the next level.

Product risk reduction

Product-related risk can be presented in 5 stages:



Product concept is a written description of the solution, which includes both a concept (in the form of vision, diagrams, drawings) and a path to the functional product. This is an important step in product risk reduction, because going from an idea to a formal written document forces inventors to think through the next level of details and highlights potential issues and challenges. Such written description helps to crystallize idea and share the vision with others.

Proof-of-Concept is a demonstration that we have all components required for the product to work and meet the basic requirements of the target market. POC is not concerned with the aesthetics, costs, size and other commercial parameters of the product. It can be a rough mock up, breadboard-based demonstration, etc. Proof-of-Concept is a huge risk reduction step, because going from intangible description to the working tangible system requires resolution of the key technical issues.

Model is a Proof-of-Concept with added considerations for end-user and selling: costs, user interface and controls, size, materials, etc. It should demonstrate that we can meet customer requirements, and do it better than competing products. Unlike POC, model should resemble the final product, and allow us to record its performance on the key purchasing criteria. Model can be also used for customer demonstrations and testing to facilitate customer feedback. However, at this stage models should not be perfected, polished and optimized because it is highly likely that the final market requirements will evolve and the model will have to be changed. Modeling provides the largest product risk reduction by matching technical capabilities with customer requirements.

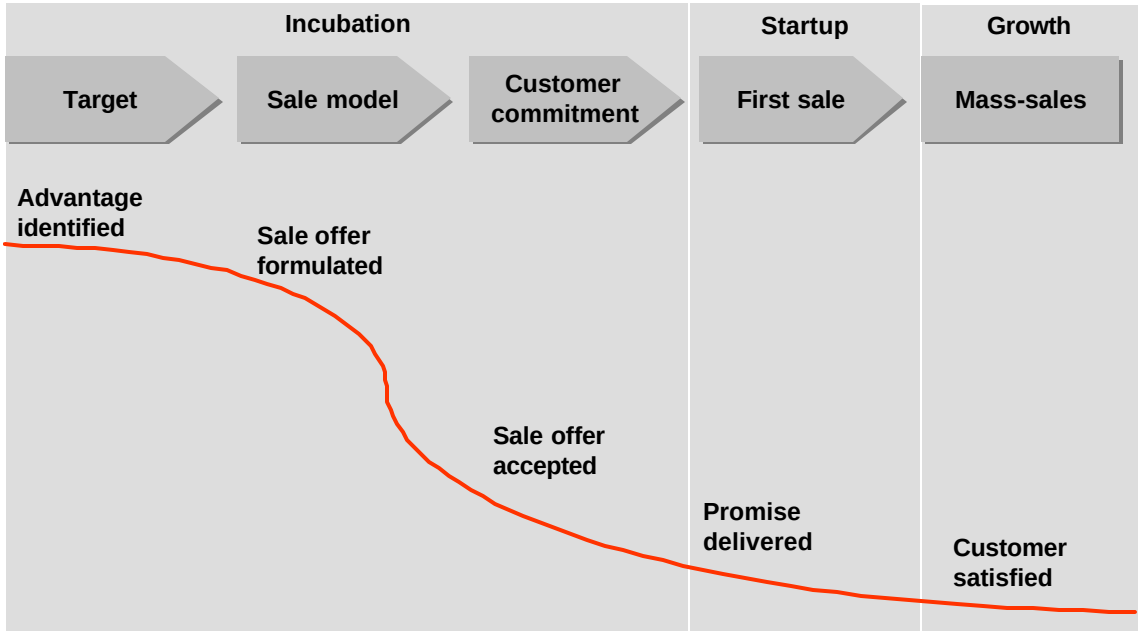
Prototype is a model with added considerations for mass-production. Prototype should be an almost exact copy of the final product, with the appropriate choice of materials, aesthetics,

and packaging. Prototyping should include considerations for supply chain efficiency, ease of assembly and manufacturing, servicing, etc. Prototyping is complete when a set of blue-prints is prepared for the manufacturing.

Finally, mass-product is a prototype which is mass-produced, widely distributed and used. At this stage, inventors will receive a direct feedback from the end-customers whether the product meets their requirements as planned. Upon receiving repeated confirmations of customer satisfaction, inventors can finally consider all product risks eliminated.

Sale risk reduction

Sale risk can also be presented as 5 separate stages:



Targeting identifies markets where our product might have the strongest advantage allowing us to win sales. It should result in a written market research report clearly defining target market segments as sets of key customer requirements we must meet to be considered as a viable purchasing alternative. The report must also provide a comparison of our product to other currently available options, and explain why customers will choose us over them. Until such advantage can be clearly identified and explained, the project should not proceed.

Once the target market is identified and our product advantage is explained, we must convert it into an attractive sale offer, by adding pricing, revenue model, marketing message, and other sale-related considerations. This offer should meet 2 key requirements: a) it should clearly convey our advantage so that potential customers get excited; b) it should efficiently explain to any qualified sale professional how to sell our product.

After the sale offer is formulated, it can be presented (along with the model demo) to the prospective customers to verify our advantage and sale assumptions. At this stage, sale risks drop dramatically if customers make a commitment. Such commitment might take many

forms: letter of intent to purchase, pilot project, preliminary order, promise to provide testimonials and endorsement if necessary (for example, answering VC due diligence calls). The key is to convert customer excitement into a real interest by asking them to allocate resources for us or to take risks on our behalf. Typically, customers go through a deep additional round of evaluation when they asked to pay, spend time, sign a legally binding document, or make a reputation-sensitive statement. Passing this stage dramatically reduces sale risks because it proves that customer excitement was not caused by our personal charm or a "gadget factor", but is based on solid business interest.

First sale is customer commitment converted into cash and delivered. Risk reduction comes from the facts that customers undergo yet another round of scrutiny of the purchase before making a cash payment, and that we are capable of delivering our promise. The first sale is a critical mile stone which provides enormous amount of insight and information for the business planning. It proves that our research was correct, and highlights bottlenecks and improvement opportunities. Ability to move from an idea to the first sale as quickly as possible and with minimal resources is a true measure of the entrepreneurial talent.

After the first sale is delivered, the remaining task is to prove that it was a typical sale, not a result of our unique personal relationships with the customer or his mistake, and thus can be repeated with other customers on mass-sale. Sale risk can be considered eliminated when sales to multiple unrelated customers are made, and existing customers show satisfaction (in a form of repeated sales, testimonials, etc).

Funding gap

Risk reduction is intense and expensive process, demanding substantial resources. Since most of the risks have to be addressed during the incubation stage and are responsibility of the research institution, obtaining adequate financing is key to successful innovation.

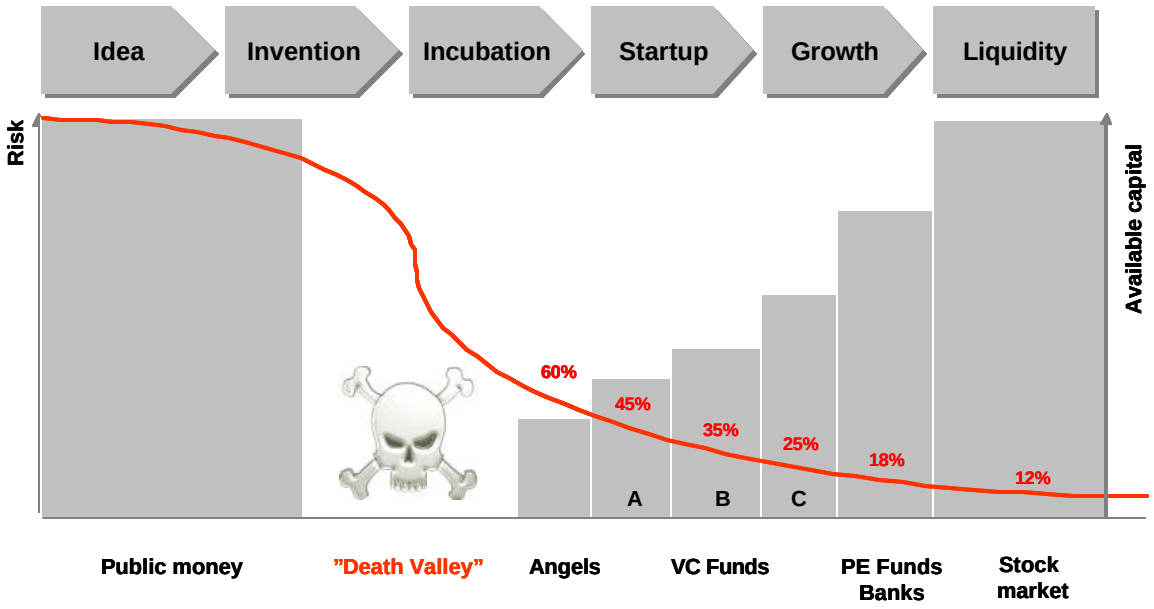
The bulk of innovation financing usually comes from the private sector. The available public funding is focused almost exclusively on technology development that is considered too risky for private investors, and is not intended to take a company all the way down the commercialization path. There is an assumption that at some point in the early innovation process, spin-outs will transition to the private-sector sources of financing.

Innovation risks are reflected in the cost of capital – for higher risks the large return is demanded by investors. For example, at the final stages of the innovation process, public market investors are satisfied with 10-12% return on their capital, while early-stage investors demand 60% returns and higher. To understand these numbers, consider a typical "round B" venture investment portfolio, which generates 34% return on capital:

	Company performance					
	Bad	Alive	Ok	Good	Great	Total
$ Invested	200	400	200	100	100	1000
5-year payout, times	0	1x	5x	10x	20x	3.4x
Gross return, $	0	400	1000	1000	2000	4400
Net Return, $	-200	0	800	900	1900	3400

50% of the net return came from only 10% of the investments, while 60% of the investment netted a zero or negative return. It is remarkable that such a large part of the portfolio is nonperforming given that the VCs are investment professionals. Although VCs are very careful and selective through deep due diligence of their investments (they fund only 1% of the deals they look at), their risks are still high.

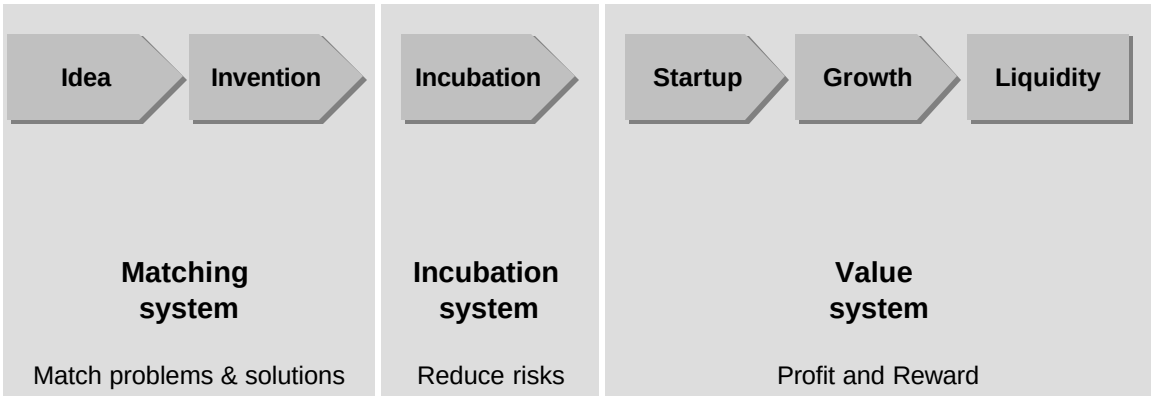
As a result, private sector financing availability is reversely proportional to the perceived risk. While there is an excess of capital at public stock markets, it amount gradually falls at the higher risk stages, and after the certain level it is simply unavailable. Even angel investors (wealthy individuals such as former entrepreneurs), who can assume the largest amount of risks because they have deep market expertise and focus on fewer investments, expect the major technical and market issues to be resolved prior to their consideration. Unfortunately, public money stops at the invention stage, long before angel money becomes available, thus creating a gap in funding. This gap is frequently called "Death Valley", because the largest number of inventions die at this stage:



Entrepreneurs cover the gap by raising so-called "FFF" money – from Family, Friends and Fools (unprofessional investors who don't understand risks properly). Research institutions don't have this option and must establish "Gap Funds" – pools of capital to carry innovations through the risk reduction process to the moment when investors can accept the remaining risks. Such fund can be set up as a budget category, or as a legal entity and funded from multiple capital sources: institution money, industrial partners, venture funds, government. Having a functional Gap Fund is a critical requirement for any innovation program.

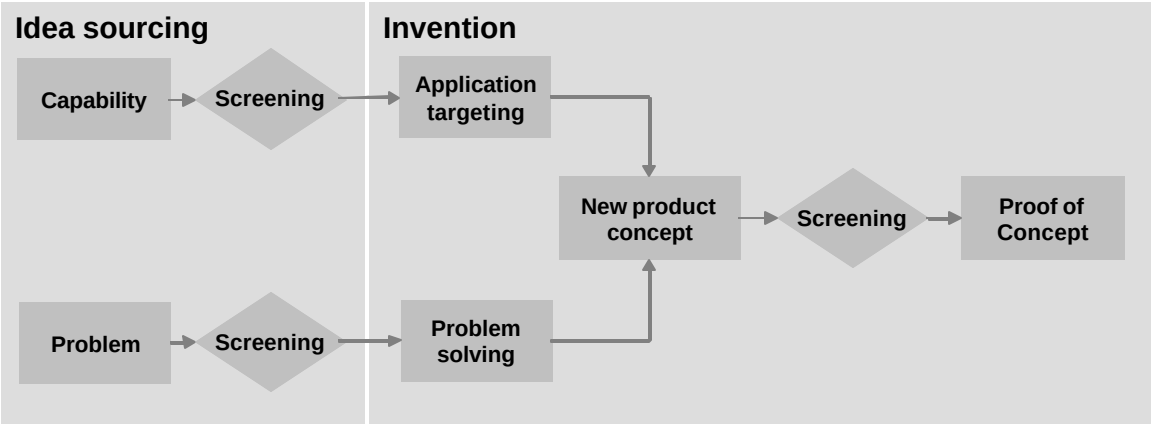
Innovation system

Innovation system can be implemented as three separate but connected systems: matching system, incubation system and value system:



Matching system goal is to match business problems with technological capabilities to generate new product concepts. Incubation system accepts new product concepts generated by the matching system, and reduces commercialization risks to the level private venture investors are comfortable with. Value engine provides continuing support to the spinouts graduated from the incubation system, monitors their progress, distributes proceeds from possible liquidity events, learns lessons from commercialization projects and promotes success among the researchers and local community.

Matching system



Idea sourcing

Whether innovation is mainly supply-pushed (based on new technological possibilities) or demand-led (based on social needs and market requirements) has been a hotly-debated topic. One point of view is that "recognition of demand is a more frequent factor in successful innovation than recognition of technical potential." Another view is that more radical innovations tend to stem from the discovery of new capabilities, while market requirements drive more incremental innovations. In my view, both types of innovation have equal chances for success, although require different tools to develop.

Supply-pushed approach happens when researchers discover new technological capabilities. To convert these new capabilities into an invention, we must find industry expertise to match them with the market needs and generate a new product concept. This approach results in the following path:

New technical capabilities ▶ Problem ▶ New product concept

Market-driven approach happens when industry asks researchers to find a solution for a business problem. To convert this request into an invention, we must find technical expertise to match the problem with a technology and generate new product concept. This approach results in the following path:

New problem ▶ Technical capabilities ▶ New product concept

Capability sourcing

New capabilities come from the research: discovery of a new phenomena, or resolution of a previously unsolved problem. Research institution should provide a clear interface for the researchers to submit their discoveries to the innovation system: a special form called “New technology disclosure”. The purpose of the form is to capture researchers knowledge about their discovery in a way that can help innovation team evaluate potential of the new technology. The disclosure form should contain the following information:

Category	Questions
Summary	▪ Brief description of new technology ▪ Significance of advance, key challenges solved ▪ The history of the project
Technical potential	▪ How it works ▪ Detailed capabilities and limitations of the new technology ▪ Technology status. What and when can be demonstrated? ▪ Known issues and estimated time to solve them
Commercial potential	▪ Known and potential applications ▪ Commercialization status (existing industry relations, demand evidence) ▪ Other research groups leading this area in the world ▪ How do we compare to competing technologies? ▪ IP (ownership, patents)
Research team	▪ Departments and researchers involved ▪ Possible time commitment to innovation project
Resources	▪ Names of technical and industry experts ▪ Technology education resources (books, tutorials) ▪ Information sources (research papers, articles, links, etc)

The form should be made easy for the researchers to fill out. Innovation team should train researchers to use the disclosures, provide examples, clear instructions and FAQ, and offer an easily accessible hot line to clarify possible questions. After the disclosure is submitted, innovation team should assign it to the project manager with the most relevant background.

Capability screening

The next step is to evaluate if new technology should be processed as a potential spin-out, or prepared for licensing or partnerships, or not pursued. Although at this stage insufficient information is available, managers have no choice but to make their best judgment, because innovation pipeline capacity is very limited (most likely, innovation team will be able to conduct matching sessions only 1 or 2 times a month).

Screening process involves 3 steps:
1. Background education
2. Due diligence
3. Decision

Background education goal is to train project manager in the basics of the technology, terminology and state-of-art enough to being able to formulate intelligent questions for the

due diligence. The manager should thoroughly study the disclosure, visit researcher labs and see technology demonstrations, interview the researchers, and explore education resources mentioned in the disclosure.

The objective of due diligence is to verify researchers' claims and collect information for the screening matrix: commercial potential of the technology, and estimated spin-out resources. There are 3 main sources of information for the due diligence: researchers, independent technical and business experts, and secondary research.

Commercial potential can be estimated reliably if there is an obvious application or a strong industry interest. Unfortunately, at this early stage such cases are exceptions rather than the rules, and the project manager has to use indirect clues about the commercial value of the technology. "Commercial potential" section of the disclosure provides a starting point for this investigation. Typically, the following factors improve the probability of commercial value:

- Technology is flexible (has many potential applications)
- It targets well established markets with an obvious promise of savings or improvements
- Researchers had to overcome very strong challenges to develop the technology
- Technology is one of the most advanced in the world
- Experts are impressed with the achievement and excited

Most of these clues can be gained from interviewing the researchers, reading research papers, patents, articles, and contacting experts such as professors, retired executives, etc.

Next, the project manager must estimate resources required to develop a proof of technology feasibility. If scientists already can show a working lab system or provide samples of the new material, the risk is obviously much smaller than if they only have a theoretical model. Required resources can also be estimated from the number and complexity of unresolved issues, technology limitations, and expert opinions about the time and capital required to bring such technologies to market. Project manager should also ask researchers to develop a detailed list of tasks to be completed before the technology feasibility can be demonstrated, and use his judgment to estimate time and budget required to complete them.

Due diligence findings should be presented as a written report, which might include a "score sheet" – a form where manager can assign numerical score to the market potential and resource requirements based on the formalized criteria. The report the should be presented to the innovation committee for screening.

The committee should consider several factors. First, how the technology can be classified on the screening matrix – spinout, licensing, partnership, or no-go. If it qualifies as a spin-out candidate, they should consider the capacity of the incubation pipeline. If it is underutilized, the technology should be added to the spin-out queue. If it is filled, they should benchmark new technology against the other technologies in the queue to decide if it should be added. If the committee decides that the technology should enter the invention process, it should form a dossier - "Innovation passport" - to capture all information and decisions related to the new technology. The innovation passport should be then put in a queue for application matching process, and a project manager and a small supporting budget should be assigned.

Problem sourcing

Starting innovation process from well-defined, acknowledged business problem significantly reduces commercialization risks. During the definition of such problems business experts provide significant input of industry expertise. To generate a high-quality invention, research institutions need to solve the problem using scientific expertise, which is easier for them because they can make much better judgment in technical domain than in business. Unfortunately, finding well-defined business problems requires marketing and entrepreneurial skills research institutions don't have, and this source of innovation is underutilized.

How do we define "an interesting problem"? High-potential problem should:
1. be well defined by business experts (ideally, potential customers)
2. have high social or economic importance and motivate researchers
3. be scalable and applicable to many markets
4. give strong competitive advantage if solved
5. fit institution competences
6. be solvable within acceptable time and budget

There are 2 ways to identify such problems – creating market "pull", and systematic analysis.

"Pull" approach means promoting research institution capabilities in the business community to generate in-flow of the business problems. Research institution must first identify the core capabilities it wants to use by inventorying its research expertise and capabilities. Then, it should establish interface for the industry – prepare a package which defines the terms of engagement. Such package should explain incentives, ownership of resulting IP, financing, project management, and application logistics. The next step is to create a market message which can catalyze business thinking. This message is a foundation of the networking pitch, sale brochure, press-releases, articles and advertisements. It should contain the following:
- Offer to submit problems for solving
- Description of the institution
- Description of the core capabilities, each with several examples of possible applications
- Benefits of working with the institution
- Example/case study of success
- Explanation of the process, problem acceptance criteria and terms of engagement
- Contact information (manager and web site)

The next step is to disseminate the message in the business community. It can be done through mass-media or direct contact with businesses. To use mass media, research institution must identify popular local channels allowing to reach corporate decision-makers and entrepreneurs, and either buy advertising space or publish articles and press-releases. In addition, it should publish the message on its web site.

Direct marketing can be done by presenting on the industry events, participating in trade-shows, mailing out brochures, creating technology show-room and organizing networking events on the institution premises, presenting to the large corporation management, creating research digest and allowing business to subscribe to receive it by email, creating on-line boards where businesses might post their questions, etc.

In addition, interesting problems might come from a network of business relationships such as entrepreneurs, consultants, bankers, industry analysts, venture investors, etc – from people who are directly or indirectly exposed to business problems in their lives and work. Institution must announce its interest in finding business problems to solve, and should consider establishing a referral program rewarding people who discover a good opportunity.

If done properly, these activities should generate a flow of interesting business problems for the institution to solve, and will result in large and high-quality business network. Another important side effect is increased visibility of the institution in the society.

Alternative strategy is systematic analysis. In this approach, proactive search is conducted to identify the most important problems for local economy, society, or governments:

- Investigate the government largest budget expenditures for opportunities to reduce costs
- Look at the country's largest industries, exports, highest-growing segments
- Learn about high-pressure society challenges (such as environmental issues)

The advantage of the systematic analysis is the higher possibility of strong social, political and economic impact, because of the large size and importance the target areas. This information can be easily obtain from the official sources. For example, quick research of Danish economy provides the following possible areas of innovation focus:[1]

Denmark largest industries	Denmark world leadership
Pork: 25 B DKK	Pre-isolated pipes: 70% of the world market
Shipping: 13 B DKK	Windmills: 50%
Textiles: 7 B DKK	Hearing aids: 40%
Waste disposable: 6 B DKK	Seeds: 50%
Furniture: 4 B DKK	Mink fur: 40%

After the strategic focus is identified, the next step is to learn the target space. Invaluable tool for this task is Dialog, a gateway to the thousands of business research databases. Dialog can dramatically cut research expenses and time, providing easy access to the high-quality information such as news, trade articles and industry analysis reports. Managers should also use web, and materials from public sources such as local governments and industry associations, attend industry seminars to learn about its challenges, and study industry economics.

The next step is to narrow down target area issues to the specific technical problems. This can be done by interviewing industry experts, conducting (or purchasing) case studies, investigating industry "technology roadmaps" where they highlight problems they want to solve, etc. The end goal of the analysis is to identify problems which can be solved with the institution technology, and establish connection with the problem experts who can help define business requirements properly.

[1] *from www.workindenmark.dk/Business_in_DK/0/4/0*

Problem definition should be captured using "problem disclosure" form. It must contain the following information:

Category	Questions
Summary	▪ Description of problem ▪ Significance of the problem, why it is important to solve ▪ Who is affected by the problem?
Technical potential	▪ Known solutions, what is wrong with them? ▪ Why it is not solved yet? What are the challenges? ▪ Solution technical requirements and constraints
Commercial potential	▪ What are the purchasing criteria? ▪ Possible commercialization path ▪ Can case study be conducted? ▪ Can pilot project be conducted?
Business partner	▪ Experts who defined the problem ▪ Possible time commitment to innovation project ▪ Desired form of cooperation, constraints ▪ Possible help with resources: budget, facilities, etc.
Resources	▪ Names of independent technical and industry experts ▪ Education resources (books, tutorials) ▪ Information sources (studies, articles, links, etc)

The form should be made easy for the business experts to fill out. Innovation team should provide examples, clear instructions and FAQ, and offer an easily accessible hot line to clarify possible questions. If the problem comes from the systematic analysis, it can be filled out by the analyst, and then verified by the business experts. After the disclosure is submitted, innovation team should assign it to the project manager.

Problem screening

Problem screening is similar to the new capability screening. Innovation committee should evaluate its commercial potential versus resources required to bring it to market. These criteria can be assessed from the problem disclosure, which is designed to collect inputs for such analysis. Commercial potential in this case should be easier to estimate than in case of the capability screening, because properly defined problems have strong business input.

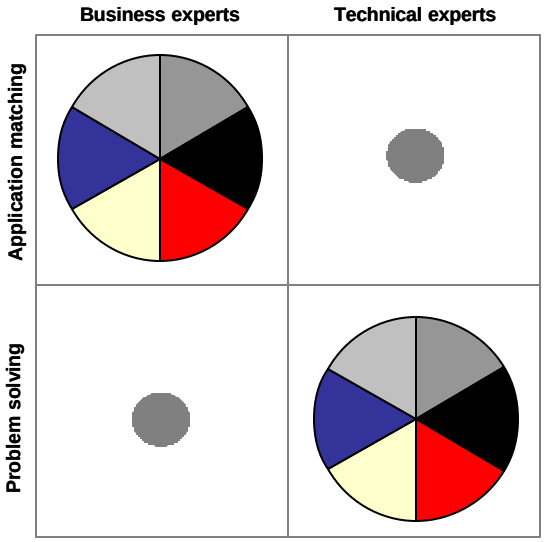
To evaluate the required resources and technical feasibility, managers should get feedback from the researchers: from "I have a solution!" or "doable", to "no idea", "very difficult", "no way". These opinions are perhaps best solicited by circulating a brief description of the

problem among researchers and asking for a feedback. The description should be a simplified extraction from the disclosure, motivating researchers and allowing them to make a judgment if they can help. The briefing should also ask researchers if they will be interested in attending problem-solving sessions if the problem is accepted. The problems then can be selected based on the researchers feedback and interest to participate.

Invention

The objective of the invention system is to match problems and solutions to generate feasible, high potential product concepts. Since ideas enter the invention system with the different risk profiles, the quality of the match depends on the innovation team ability to create balanced and relevant pools of expertise.

If an idea comes from a new capability, it is heavily loaded with market feasibility risk, and the matching process requires an large amount of diverse business expertise to identify possible applications. Otherwise, generated product concepts tend to be and commercially unrealistic. If an idea comes from a business problem, it is loaded with the technical feasibility risk, and thus the matching process requires a large amount of diverse technical expertise to identify possible solutions. Therefore, depending on the source of the idea, the matching process should be done differently and use different expert pools:



Application matching

Application matching is the process of exposing new technical capabilities to a diverse pool of business experts in a hope they will match new technology with the business problems they are aware of. In this process, innovation team, with support from scientists, presents new technology to the team of business experts from various industries, facilitates discussions, and captures generated product ideas.

The quality of the concepts generated by this process depends on the team ability to:

- bring together a large, motivated, diverse and relevant pool of business expertise
- articulate new capabilities properly to non-scientists
- facilitate discussion and brainstorming process
- capture ideas and information
- efficiently rate ideas at the end of the process

Ability to create an effective pool of business expertise is the critical skill innovation team must develop. The size of the pool should be large enough to ensure industry and functional diversity, but still be manageable, perhaps up to 20 people. Of those, 1 or 2 places should be reserved for the researchers who can answer deep technical questions. One place should be reserved for the project manager who should manage the process, and another for his assistant, designated to capture the meeting output. The remaining 16 places should be filled with business experts from different industries and functions.

Deciding on who might provide a valuable input is more art than science. The odds of finding relevant people can be increased by using secondary market research (I highly recommend an excellent guide on identifying, accessing and motivating experts: "Find it Fast", by Robert Berkman, ISBN: 00627374730), and by involving already identified experts in brainstorming a list of people, companies or organizations who might be valuable additions to the expert pool. Another approach is to announce a brief description of the new capabilities in the business network (by email), and solicit expert leads and interest to participate.

The expert panel should be diverse not only on industries, but also on functions. There are 2 categories of business experts - direct industry participants, and industry observers. The second category includes people who don't participate in the industries directly, but have significant exposure to the industry issues. This type of experts is important to have on-board: while direct industry participants might have deeper expertise, observers usually have more neutral and broader perspective.

Industry participants	Industry observers
▪ CEOs	▪ Business school professors
▪ Top managers (VP business development)	▪ Industry consultants
▪ Founders, entrepreneurs	▪ Commercial bankers
▪ Retired executives,	▪ Private investors
▪ Salespeople	▪ VCs and buyout funds
▪ Customer service managers	▪ Industry analysts
▪ Purchasing managers	▪ Investment bankers and business brokers
▪ Product development managers	▪ Journalists and editors of trade magazines
▪ Heads of R&D, ...	▪ Industry association employees, ...

The innovation team might also consider inviting participants whose involvement might have strategic value later in the process, such as entrepreneurs who might be interested in running the project, VCs who invest in related technologies or industries, government officials, and so on.

The project manager should compile the list of experts 2-4 weeks before the scheduled matching event. The list should be larger than intended audience, since some experts might not show up. The manager should contact experts personally and send them a teaser, which describes the purpose of the meeting, new technological capabilities, terms of engagement (including confidentiality and ownership of generated ideas). It should also provide incentives to participate: opportunity to see the new technology, networking with the other business experts, establishing relationships with the research institution, "innovation participation" publicity, priority options to invest, acquire license or start pilot projects, and so on. The invitation should also include logistics – location, time and duration of the meeting. The location should be convenient for most participants, and might not be located at the research institution. In this case, project manager must ensure that the location is properly equipped – it should have chairs, computer projector, writing paper, snacks and drinks, etc. For some experts, institute should offer to cover their travel expenses.

Project manager must also ensure that participants have an opportunity to network. It will be helpful to prepare a list of participants with brief bios and share it in advance. Also, project manager should prepare badges with names/companies, and have everyone introduce themselves for 1-2 minutes at the beginning of the meeting.

After the introductions are made, project manager should make a 10-15 minute presentation, which should include the following:

- Objectives of the meeting
- Description of the new technology, its capabilities and limitations
- If possible, technology demo
- Overview of the meeting process
- Basic rules of brainstorming

To make this introduction productive, more detailed descriptions should be sent to the participants in advance, so that they had a chance to read and think about the possibilities. In addition, the presentation should be done by the project manager, not by the scientists, because researchers tend to be too technical and detailed for business audience. Rather, the scientists should help handle technical questions and make demonstrations.

Then project manager should use a classic brainstorming process to facilitate the generation of new ideas. This process is well-known; I will not go into the details in this report and only give 2 recommendations: first, add to the participants' badges bright, easily visible numbers so that the assistant can capture who was the source of a particular idea. This information might be valuable for the idea evaluation session later on. Second, to improve the efficiency, at least one of the project manager should be professionally trained as a group facilitator. I recommend these companies for such training:

Interaction Associates (trains facilitators for problem-solving groups)
www.interactionassociates.com

JPB group (provides training and tools for brainstorming)
www.jpb.com

After the brainstorming session is completed, the participants should receive 5-7 sticker notes, and post them on ideas they think are most practical and interesting. I recommend to put participant numbers on the stickers, so that they can be identified later. After the voting, the participants should have free time for snacks and networking. The project manager should close the meeting by thanking everyone, mentioning that the list of ideas will be compiled and shared by email, and that if anyone has additional ideas or want to initiate a project, they should contact the manager any time. Finally, it might be helpful to get a 1-page questionnaire to capture a feedback on how to improve the process and if participants will be willing to become a part of the innovation network and participate in similar events in the future. It is helpful to ask if they can recommend other experts who might be valuable for applying this new technology.

After the meeting, project manager should compile a written list of ideas, rank them by the number of votes, email the summary to the participants and allow several days to capture the follow-up feedback. The ideas then should proceed to the analysis and screening stage.

Problem solving

Problem solving process is used when the idea comes in a form of well defined business problem. The process is similar to the application matching, with several distinctions:

- Expert pool consists mainly of researchers, not business experts
- Most experts can be sourced internally
- Meeting is usually held in the research institution facilities
- More efficient techniques can be used instead of brainstorming

The quality of the product concepts generated by this process depends on the project manager's abilities to:

1. create motivated and diverse pool of the relevant technical expertise
2. articulate business problem properly to scientists
3. facilitate discussion and brainstorming process
4. efficiently capture ideas and information

Expert pool should be about the same size as for the application matching process. Besides the project manager and his assistant, it should include 1-2 industry experts who posses deep knowledge of the problem from a business side, and can help answer researchers questions about the requirements for the possible solutions. The remaining spots should be filled with the scientific and technical experts with diverse and relevant backgrounds. This group can include the researchers from the institute, other partner institutions, and technical experts from non-competing industries, such as heads of R&D units.

The selection of relevant technical expertise is unfortunately also more art than science. Conducting preliminary research and brainstorming with experts might be very helpful in identifying valuable areas of technical expertise. I also recommend "self-selection" process. Project manager should send out a brief, 1-2 page description of the business problem and the importance of solving it. The memo should allow researchers to make a clear judgment if their input might be valuable, and motivate them to participate. Self-selection not only

guarantees motivation and relevance, but also demonstrates the probability of finding solution (the more researchers sign-up, the higher the chances of finding a solution). Since most experts can be sourced internally, preparation of the problem-solving meetings is much simpler than preparation of the application matching events.

During the meeting, an introductory presentation should be made by the product manager, to ensure that researchers understand the issue properly. The presentation should explain the problem, the criteria a good solution must meet, and what has been already tried. Participating business experts can help answer these questions in depth. The introduction should be followed by a traditional brainstorming process. Problem-solving process might also be greatly enhanced by using certain techniques such as TRIZ, the theory of inventive problem solving (visit www.triz.org for more information). TRIZ allows to distill problems to specific technical challenges, and suggests tools to resolve them. I recommend that at least one member of the innovation team receives professional TRIZ training.

The rest of the process is similar to the application matching. The resulting list of ideas should be voted for, ranked, distributed among the participants, and submitted for screening.

Product concept screening

Results of the matching should be analyzed to select the most interesting ideas. The project manager should categorize them as A (highly possible and interesting), B (maybe possible but require deeper assessment), and C (unlikely to be practical). To make this judgment, the manager should conduct follow-up interviews with the authors of ideas and experts who voted for them, to understand why they consider these ideas interesting and practical.

The "A" type ideas then should be formalized for the deeper evaluation by filling our a "New product concept" disclosure. The disclosure should be prepared jointly by the project manager and the participants who expressed desire to participate in the idea evaluation. It is also highly desirable to get potential entrepreneurs and venture investors involved in the preparation of this document: not only their input is valuable, but in the process they become well-positioned to support the spin-out if it is initiated.

The disclosure should include the new product concept, history of the idea development, and the assessment of the market and technology feasibility of the product. Technical feasibility can be assessed with the help of the researchers, who should roughly outline the tasks required to build the simplest functional model of the product. If possible, they should try quick-and-dirty modeling, drawings and mock-ups, to gain stronger insight into the feasibility of the new concept. Similarly, market feasibility can be assessed with the help from the industry experts or perspective customers, who can recommend the best market segments to explore, and help gather initial evidence to support these choices.

The filled disclosures are then reviewed by the innovation committee, to decide if the opportunity should be pursued at all, and if yes, which route it should take. If spinout seems possible, the committee should also decide if the new product concept is feasible and can proceed to the incubation, or a proof-of-concept study is required.

Proof of Concept

The purpose of the feasibility (also called "Proof-of-Concept") study is to remove as much of the Invention risks as possible. Since the study might require substantial time and effort, the innovation committee should be able to provide a "feasibility grant". The grant, typically $20-50,000, is used to pay for the market studies and conceptual technology development. It should allow researchers and managers to provide defensible results within 6 months. If feasibility can not be reliably assessed within this budget and time frame, the project should not be pursued, unless an external party is willing to co-sponsor it.

Feasibility study might include proof-of-capability, proof-of-market, or both. Proof of capability study should determine that the product key components are available, or at least lay out a clear way to make them. For example, if a magnetic cooling element is required for the new product, and it is critical that it can lower temperature to -30 C, the proof-of-capability must provide either demonstration of the working element, or develop a clear R&D roadmap which would convince a qualified expert that such element can be made. The demonstrations can be made on the breadboards using lab equipment, and should not be concerned with the product costs, aesthetics, manufacturability, etc.

Proof-of-market must confirm that the target market acknowledges the business problem and is willing to pay for the right solution. The evidence usually comes as testimonials of the perspective customers, industry expert endorsements, industry analyst reports. To collect it, manager should conduct both secondary and primary market research. Secondary market research involves gathering information about the market others already collected and stored on the web, in databases, analytical reports, articles, etc. Primary market research involves gathering new data directly from the industry participants – customers, suppliers, investors. Both secondary and primary market research require skills and experience, and whenever possible should be outsourced to the qualified consultants familiar with the target markets.

After the feasibility study is completed, the results should be added to the "Product disclosure" and re-submitted to the innovation committee.

Company formation

After the innovation committee approves the spinout, it is time to form a company. To complete this task, a manager has to answer several questions:

1. Who should participate in the company equity, and how shares should be allocated?
2. How to recruit and motivate an experienced entrepreneur?
3. How to ensure researchers commitment to the project?
4. How to recruit advisors who can help with expertise and resources?
5. How to fund the company?
6. How to transfer intellectual property to the company?

Equity allocation

Commercialization process requires contributions from the multiple parties, such as:

- Business team (entrepreneur + company managers + employees)
- Researcher team (inventors + other contributing researchers)
- Institute (central office + department(s) originating the invention)
- Innovation team (innovation office employees + project manager)
- Advisors (consultants, industry experts, legal counsels, etc)
- Seed investors (Innovation fund investors + syndicating partners (i.e., CAT))
- Venture investors

All of them should receive incentives in the form of equity participation. It is important that researchers, innovation team, and innovation fund investors receive their equity shares directly, not as a part of the institution share. Such direct link provides much stronger sense of involvement and ownership, resulting in higher motivation. The shares don't have to be granted immediately in full - they can be transferred as options according to a vesting schedule connected to the project milestones. Obviously, initial equity shares will change along the innovation process as new contributors come on board. For example, a typical equity evolution scenario might look like this:

	Formation	Incubation	Startup
Business team	30%	24%	17%
Research team	30%	24%	17%
Institute	30%	24%	17%
Innovation team	5%	4%	2.5%
Advisors	5%	4%	2.5%
Seed investors	0%	20%	14%
Venture investors	0%	0%	30%
Total	100%	100%	100%

The initial participants can be diluted further, if more capital has to be raised. However, while the percentages are falling, the value of the shares is usually increasing with each financing round, reflecting reduced risks. For example, if seed investors contribute $200,000, and round A investors add $1,500,000, the resulting value of the shares will look like this:

	Formation	Incubation	Startup
Business team	$0	$240,000	$840,000
Research team	$0	$240,000	$840,000
Institute	$0	$240,000	$840,000
Innovation team	$0	$40,000	$140,000
Advisors	$0	$40,000	$140,000
Seed investors	$0	$200,000	$700,000
Venture investors	$0	$0	$1,500,000
Company value	$0	$1,000,000	$5,000,000

The institute should let the entrepreneur, researchers and innovation team decide themselves how to allocate shares among their team members. It should also decide in advance how to split its share with the department(s).

Recruiting entrepreneurs

Another challenge for the innovation team is to find and recruit a qualified entrepreneur. This step is critical for the success of the project, because proper incubation requires strong entrepreneurial skills research institutions don't have, and because the lack of an experienced CEO is the overwhelming reason for the investor rejection. What are the key qualities investors are looking for in entrepreneurs? Here is a summary of a venture investor survey:

- "Entrepreneur who has been there, done that"
- "Entrepreneur who knows why customers in this industry will part with their money"
- "A CEO with a success or two and at least one failure"

There are many ways to identify qualified entrepreneurs. Short-term options include hiring headhunters or advertising project opportunity in the entrepreneurial and executive venues. Long-term options include cultivation of the relationships with the network of experienced entrepreneurs ("BENs"), involving potential entrepreneurs early in the innovation process as innovation committee advisors and brainstorming experts, inviting them to serve on the innovation fund board or incubated company boards, working with the affiliated venture investors who usually have their own network of trusted entrepreneurs. Obviously, short term options are more expensive, and should be used only if no other options are available.

To recruit an entrepreneur, the innovation team should "sell" an opportunity and offer an attractive equity package. Key selling points include Proof-of-Concept demonstrations, market analysis and expert feedback, customer interest evidence, and a possibility to receive an innovation grant. Managers should prepare a presentation which explains the excitement, validates the concept, lists qualifications, and offers the incentive package. Obviously, selling the opportunity is much easier if the entrepreneur has been involved in its formation early on. The recruiting should result in signing a formal agreement, after which the project manager can transfer the control of the project to the entrepreneur.

Researchers commitment

Having sufficient researchers time to support product development is also critical for the spinout success. Prior to granting the researchers their share of equity, innovation manager should sign a contract with them which guarantees a certain number of hours per week to be devoted to the project. The contract should be signed by both the researchers and their department managers. In some cases, the researchers should be required to take a sabbatical, which the institution should provide with the right to return to the research as soon as the project is completed. The contract also might contain time schedule with the slots designated to the spinout, so that the entrepreneur can plan the project properly.

Recruiting advisors

Advisors' pool of equity can be used to recruit advisors who might contribute as experts, or whose early involvement might be strategically important - potential investors, customers, partners, executives, etc. Advisor pool shares can also be used instead of cash whenever

possible to acquire professional services of industry consultants, market researchers, product development companies, etc. Using equity this way can reduce funding needs.

Funding

Initial funding for the spinout comes as an innovation grant from the Innovation Fund. The grant usually comes in trenches (for example, 3 disbursements of $50,000 each), connected to the project milestones.

Innovation fund can be set up either as a separate entity managed by the research institute (similar to a typical venture fund), or as a designated category in the institute budget. The first approach is preferable, because it allows to create a larger and more diverse pool of investors, and provides greater financial transparency and incentives for the innovation team. The money for the innovation fund can come from the institute budget, government grants, venture funds interested in being involved early on, industry partners, etc. The size of the fund is typically $2-4 million. Given the average size of the innovation grants of $100,000, the fund can finance 20-40 spin-outs, which should be sufficient to support incubation pipeline for 2-3 years. Since average payback period for such investments is 5 years, at least 2 funds will have to be raised before the proceeds from the investments are sufficient to sustain innovation rate of 10-15 spinouts per year.

Patents

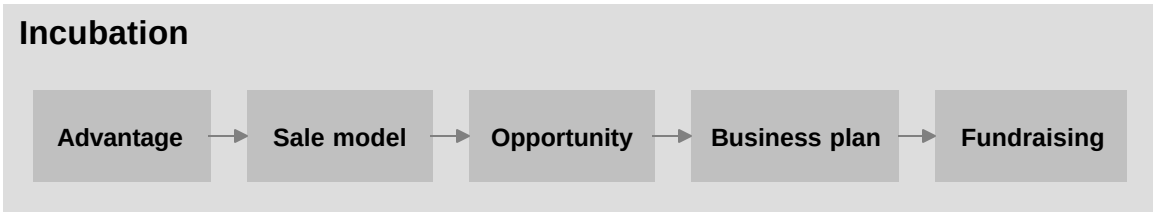
Patents serve several important functions in the innovation process. First, they protect research institution rights for the invention, allowing to disclose proprietary information to the participants of the innovation process (experts, entrepreneurs, investors). Second, they serve as a knowledge depository – they capture researchers knowledge in a written form, allowing it to be transferable and making it a fundable asset. Third, patents become a part of the business strategy, by protecting key elements of the competitive advantage.

The important questions are what to patent and when, and how to transfer the patents to the spinout? On the one hand, the patents should be filed as early as possible, to ensure that the proprietary information is protected during the innovation process. On the other, early in the process little information is available about the viability of the invention and required competitive strategy. Typically, institutions and companies resolve this contradiction by filing many patents with the broadest claims possible, as early as they can. This approach might work, but it is costly, and it increases chances of the patent being rejected.

One way to resolve the conflict is to use provisional patents. Filing for a provisional patent establishes inventors priority and gives them an option to file a full patent within a year. This year should be sufficient time to move the opportunity far enough in the innovation process. Another solution is to file an umbrella patent, license it to the company with exclusivity for its target markets, and then help the company file a set of the derivative, product-related patents, focused on the protection of the strategic advantages.

Incubation system

The purpose of the incubation system is to reduce the commercialization risks to the level acceptable for the external investors. The end goal is to raise private sector financing and transfer the project under the control and responsibility of professional investors and entrepreneurs:



To understand the incubation system, it is necessary to understand the requirements of successful fundraising. Fundraising success depends on providing investors with a convincing business plan, attractive investment offer, and an experienced entrepreneur. Business plan, in turn, can be described as an attractive business opportunity plus efficient business model and implementation strategy to exploit it. But what is "an attractive opportunity"?

While there are many ways to describe the opportunity, I use a notion of a "typical sale transaction" as its foundation. An ability to make profitable sales is the building block of any business (as entrepreneurs put it, "nothing happens until somebody sells something"). An opportunity then can be described as a chance to make as many such sales as possible (scalability), for as long as possible (sustainability):

Therefore, to understand and estimate an opportunity, we must develop a model of a typical sale transaction. This model should explain who are our customers, what is our offer to them, and why they will choose our offer over other alternatives they have.

Customers will choose our offer over competition only if we can demonstrate a significant advantage over other purchasing options. Thus, the first step in the incubation process should be the development of clear understanding of our product advantage – what will compel our customers to choose us and enable a profitable sale?

The first two steps - understanding advantage and modeling sale transaction – are the most critical stages of the spin-out process, because they serve as the foundation of the business plan and largely define the success of the fundraising and the future growth of the company. Unfortunately, these steps require strong entrepreneurial skills, creativity and resilience, and they are costly - they consume most of the incubation time and budget.

Inexperienced entrepreneurs often skip these steps and rush to writing business plans. However, it is impossible to conduct proper market size estimates and competitive analysis without first understanding market requirements, competitive advantage and the act of sale. As a result, such business plans are filled with vague generalities, irrelevant multi-billion dollar market size estimates, and non-defensible financial projections. Professional investors recognize the lack of opportunity understanding and reject such business plans. To avoid this trap, innovation team should pay special attention to developing a methodology for the first two steps, and coach entrepreneurs to use it efficiently.

Advantage

Many innovations fail because inventors focus on the technical benefits and the strength of their ideas, rather than on customer needs. They find it difficult to translate technical characteristics into the benefits their products can provide to the customers, and to compare these benefits with the competition. However, this step is critical for the success. To understand why, consider how customers are making their purchasing decisions.

When customers are looking for a solution for their needs, they explore their options, qualify them using a number of business and technical requirements, and create a set of several most viable alternatives. Then they evaluate them using their purchasing preferences, and choose an option with the largest perceived value. If we are interested in selling our inventions, we must therefore make sure that a) we get into the set of the purchasing alternatives; b) customers choose us over other options.

To get into the set, we must first meet one or several mandatory requirements, to show that our product can serve the core needs of the customer. For example, if we have a new disinfection technology, it must demonstrate at least the minimal bacteria killing rates acceptable in this market. I call these requirements “segment qualification criteria”, because they define if a solution will be considered at all in a specific market segment (segment is a group of customers with similar purchasing requirements).

Besides the segment qualifications, customers also use purchasing preferences – such as price, color, warranties - to choose from the available options. To win, we must demonstrate advantage (better value) over these alternatives, either by showing superior performance, or by better matching our product benefits with the key requirements of the market segment.

To understand our possible advantage, we must select a qualified market segment and learn the purchasing criteria, competitive alternatives, and our product capabilities and limitations. Developing such understanding is perhaps the most challenging step in the innovation

process. It is also the least understood step, which most entrepreneurs do intuitively, relying on a chance and luck. This step is for entrepreneurs what invention step is for the scientists.

It is difficult to develop a methodology which improves the odds and increases the efficiency of the advantage search. However, I believe it is possible - just like TRIZ method was developed for inventors despite all skepticism. I propose two tools for such methodology: "Advantage matrix" – analytical framework to organize and present advantage-related data, and "Advantage cycle" – an algorithm for collecting it.

Advantage matrix

Advantage matrix is an analytical framework allowing to collect and analyze market data to identify a possible competitive advantage. The advantage matrix consists of three sections:

1. Segment definition section
2. Market requirements section
3. Product section

Segment definition
Requirement 1 Requirement 2

	Market levels			**Our product levels**		
Buying criteria	**Low**	**Mid**	**High**	**Current**	**Target**	**Gap**
Criteria 1 Criteria 2 Criteria 3 Criteria 4 Criteria 5						

The first section, "Segment definition", contains qualification criteria a product must meet to be included in the competitive set. This section includes the list of qualification requirements, measurement units for the requirements (such as kWh), and acceptable parameter ranges (such as 1 – 5 kWh). The qualification requirements are often also called "Factors", and specific numbers are called "Levels". In addition, this section should contain qualitative requirements for the segment (requirements which can not be quantified), and detailed description of standard tests used by the customers to measure the factors.

Segment definition allows us to focus market research by quickly eliminating segments with requirements our product can not meet. Such focus is important because finding the right target market is a trial and error process, and by focusing we make it more manageable, faster and less expensive. Later in the process, this section becomes a foundation for market size estimation, industry analysis, and entry and growth strategies. Unless segment definition is done properly, this analysis is useless.

The second section, “Market requirements”, contains information about customer purchasing preferences and currently available options. It consists of:

- purchasing criteria (such as price, size, energy efficiency)
- measurement units for the criteria
- market levels for each criteria

Market levels can be presented in several ways. In the simples form, market can be split into a low end, mid-market, and high-end sub-segments. The objective then is to record each criteria levels for each sub-segment. For example, the price criteria can be described as low end: <$10,000, mid-market: $15,000, high-market: >20,000. Quantitative criteria should also be supplemented with the qualitative parameters important for the customers. This information allows us to “see” what customers can currently buy. The low end levels show the minimal acceptable performance, the average levels, if matched, will keep our product market-neutral, and matching or exceeding the high-end levels gives advantage.

This section of the matrix can be substantially expanded. First, the list of purchasing criteria can be weighted by their contribution into the purchasing decisions. In a simple form, they can be just ranked or categorized by the perceived importance (1 – critical, 2 – substantial, 3 – nice-to-have). In a more advanced form, we can measure their % contributions into the customer decision-making process. This information though is very hard to obtain in practice, because customers usually understand these weights only intuitively. Fortunately, there are analytical tools, such as “Conjoint Analysis”, allowing to convert these intuitive judgments into explicit numbers. Conjoint analysis also has another benefit. It estimates customer preference functions – how much customers are willing to trade one preference for another.

Second, “low end” – “high-end” categories can be converted into the specific competitive offerings. These offerings can be represented as distinctive platforms, and each platform can then be represented by specific products. Each product can contain information about its market share, as a percentage of all sales, and 3-year growth rates.

Third, market levels can be converted into relative scores. I use a simple but efficient scoring system: [-2, -1, 0, +1, +2]. The first number means that a product is the worst on the market, +2 the best, 0 - market average, -1 below average, +1 above average. Using these ratings, we can quantify each competing offer, and then use the numbers to calculate their relative value by multiplying the scores and criteria weights and summing up the results. If analysis is done properly, these advantage score should correlate with the market shares and growth rates of the products, and allow to predict who will win the market in the long-run.

Expanded version of this section of the matrix later becomes the foundation of the competitive analysis and competitive strategy. It also provides input for competitive differentiation in sale documents and presentations.

The third section, “Product requirements”, allows us to record how customers perceive our product on the purchasing criteria, benchmark our performance against the market or other products, and define a clear path for our product development. This section consists of the following information:

- Target levels - what do we have to offer to win this segment?
- Current levels - what levels does our product have currently?
- Gap – how far is our current performance from the goals?

Target levels reflect the following strategy: before building a product, we can formulate a hypothetical offer, based on our analysis of the "Market requirement" section. We then can verify with the customers that the offer is indeed attractive, and use it to drive our research and product development. Customer-confirmed performance goals provide strong focus and creativity stimulation for the inventors and speed up product development.

There are multiple ways to formulate attractive offers. Typically, market preferences have fundamental trade-offs: when we improve one parameter, we worsen another. For example, we might offer the best disinfection rates, but at the expense of large energy consumption. Usually it is impossible to have +2 score on all criteria, unless we have a breakthrough technology which opens new performance frontier. However, we still can gain significant advantage by better matching customer preferences (+2 on the most critical parameters), developing more balanced offer (eliminating -2 and -1 scores), offering new performance level for one or several key parameters (such as industry lowest price, smallest size), etc.

Next, we must learn how far is our current performance from the winning offer we want to make. The current levels are measured using a model of our product. Therefore, we should focus initial product development to build a model, however simple, just enough for us to record our current levels – as soon as possible. This requirement greatly reduces the costs and development time for the first model. When planning expenses and research tasks, we should ask: "do we need this to record our first measures?".

After the first model is built and we can record our levels, we can use this section to calculate the gap between our and target performance. This section can be further elaborated by adding costs and time required to bridge the gap. This data becomes the foundation for the product development roadmap. It allows us to see how realistic our expectations about developing a winning product are, and to record our progress.

Advantage cycle

While the advantage matrix itself is fairly straightforward, filling it with a reliable, relevant data is a challenge. It requires not only significant time and money (which can reach 80-90% of the innovation process budget!), but also advanced tools and expertise in areas such as secondary and primary market research, market segmentation, customer research, and product development. Most of this expertise is not available at the research institutions, and this stage should be completed by the qualified and motivated entrepreneur.

First, since the product disclosure contains industry experts recommendation of the target markets, entrepreneur should use this input to explore the target space (usually using secondary market research and calling his personal contacts). The purpose of this step is to understand how the target market is segmented.

The next step is to formulate a hypothesis: in what segment our product might have the highest advantage? This hypothesis can be based on the secondary market research and brainstorming with the industry experts. The result of this step is a decision to investigate a particular segment for a possible advantage, and a completed segment definition.

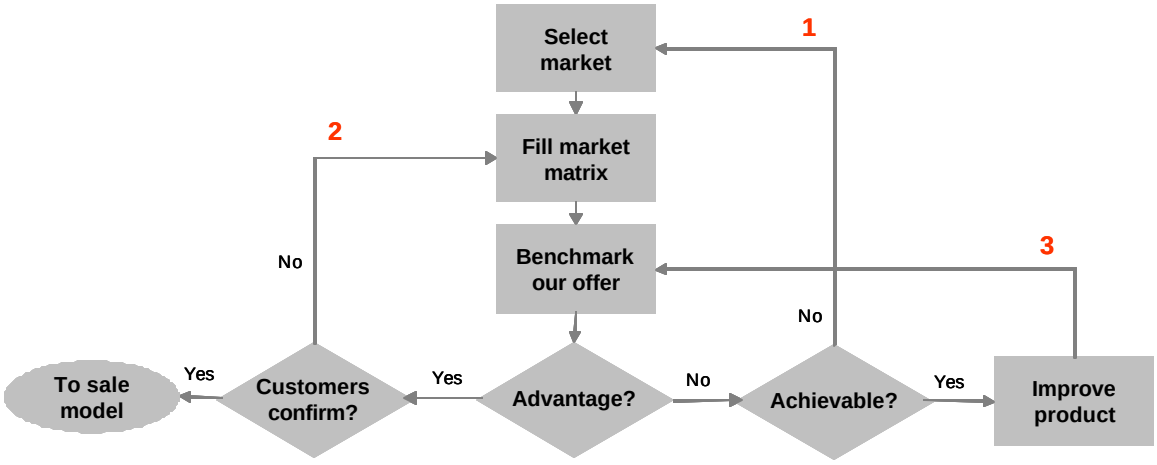
After the target segment is defined, the market requirement section should be filled, by working with the potential customers, salespeople and other experts who understand the segment purchasing process. They can be interviewed, surveyed, or observed; sometimes, it is possible to conduct a case study of the past purchasing decisions. Entrepreneur can start from filling this portion of the matrix himself, using intuition, analyst reports or input from experts. Then, he can show it to the customers, and ask for help to refine it. Typically, visits to at least 30 customers are necessary to get correct input. This process is challenging, because it requires to identify relevant companies, find employees within them who might posses this information, and get their time. Also, customers often can not clearly explain their decisions, and an entrepreneur must not only have skills to ask the right questions, but also be able to read between the lines. Whenever possible, he should seek help of the consultants with strong experience in both market research and the target industry.

After the market requirement matrix is ready, entrepreneur fills out the product section. First, he should estimate where our product stands relatively to the customer requirements. These early estimates can be made, ideally, by measuring proof-of-concept model performance, or at least by making educated guesses together with the researchers. Then, he should formulate several hypothetical offers, with potential for significant, but realistically achievable advantage. These offers should be shown to the customers to get their initial feedback ("if we give you a product with this parameters, will you buy?"). To facilitate the feedback, it is very helpful to visualize the offer using drawings, mock-up (non-functional) models, or at least present them as "score-cards". Customer response allows entrepreneur to select the most potent concept, and ask researchers to develop a development roadmap – what is the fastest and simplest way to demonstrate that such offer can be build? The researchers should list the challenges they anticipate, the required budgets, time and other resources.

Entrepreneur can use the roadmap to drive the development of the increasingly improved product model. It should periodically be shown to the prospective customers to verify that the development is on target. After the customers confirm that the model convincingly conveys an attractive offer with significant advantage, we can move to the next stage (sale modeling). Product development cycle requires special expertise, which researchers usually don't have. Whenever possible, the entrepreneur should retain help of qualified product design and modeling companies, such as IDEO (www.ideo.com).

Why filling out the Advantage matrix is difficult, expensive and time-consuming? Unfortunately, the process described above represents the best-case scenario, when at each step we are able to achieve our objectives. In reality, the process is not so linear. Frequent changes and adjustment are always necessary as initial problems are ironed out. This is an trial and error process, involving lots of education and development. Such processes are slow, especially because the required knowledge and experience are being made in the process itself as it develops and cannot be acquired quickly. Mistakes are also inevitably a

part of this trial and error process of continuous development and adjustment. To compensate for them, the process contains three nested feedback loops, which we have to re-visit if our assumptions did not come true:



The advantage cycle contains a targeting improvement loop (arrow 1), which in turn contains market requirement improvement loop (arrow 2), which contains product improvement loop (arrow 3). The product improvement loop requires researchers to make several interactions of developing new models, and benchmarking them against the target parameters. If the targets are met, but the customers don't confirm the advantage, it means that we did not get the market requirements correctly, and have to repeat loop 2 by going back to the customers and refining the data on the purchasing criteria.

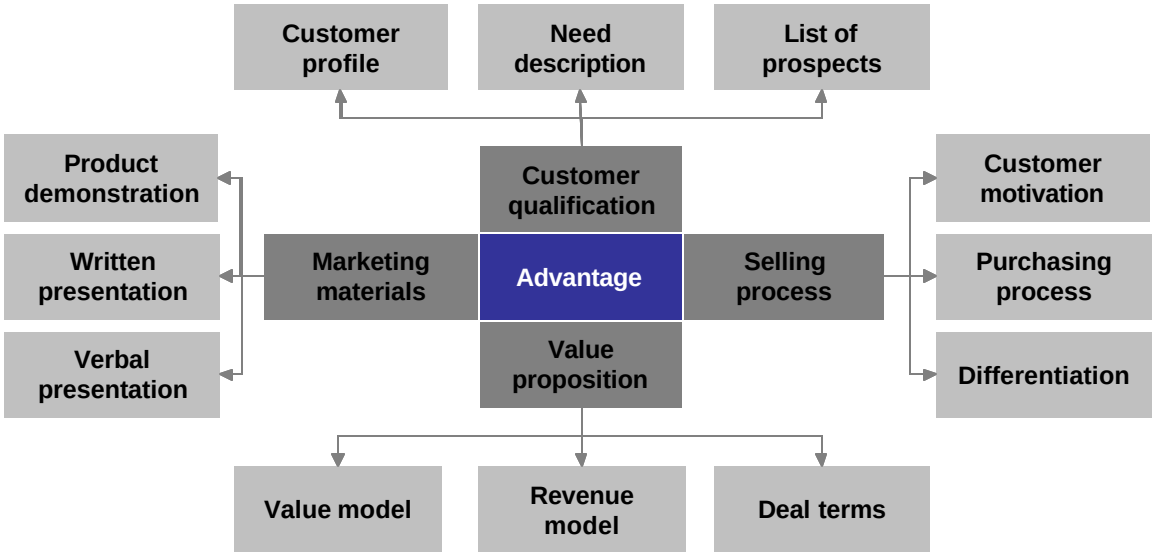
If after a number of iterations it becomes clear that the target is unattainable, it means that we picked the wrong segment, and we should re-start the whole process by formulating a different hypothesis about the target market (loop 1). We can narrow current segment, explore nearby segments, or pick an entirely new segment. If we are still unable to identify a potential advantage after 3-4 interactions in the loop 1, we should re-examine our product concept. At this point, it should be clear if the lack of advantage is caused by the inferiority of our technology (in which case the project should be canceled), or by the wrong choice of the target space (then we should decide if we can afford to explore an entirely new space).

Advantage search process might take up to 6 months and cost over $100,000, consuming most of the innovation grant. It is also clear from the process that the entrepreneur should allocate money at least 1:1 between the market research and engineering[2]. The projects where market research budget falls below the product development budget (typical mistake of technologists) usually fail commercially. The end result of the advantage search process is a properly filled advantage matrix, which can be confirmed by the experts, a product offering which customers consider attractive, and a product model which either makes the offer possible or at least shows a clear product development path. These elements become the foundation for the next stage – sale offer modeling.

[2] *Market budget/Engineering budget is often called "M/E ratio"*

Sale model

The successful advantage search should provide a clear description of the target market and an explanation of our advantage. The next step is to convert this advantage into an attractive sale offer. The goal is to prepare a package sufficient to a) solicit potential customer commitments, and b) explain to qualified salespeople how to sell our product. At this stage, we might be unable to find all answers, and even if we do, they will evolve. However, it is important to make the first draft. There is a huge difference between being unable to answer customer questions because we don't have all the information yet, or because we are simply unprepared. To develop the sale model, we should add new elements to the advantage:



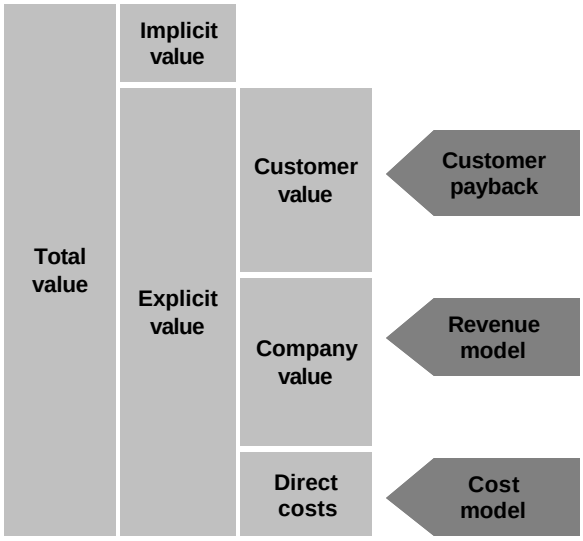
Customer qualification

Customer qualification section should provide information to potential salespeople how to qualify sale leads. First, we should provide a qualitative description of the target problem/need, and include the qualification criteria customers use in this segment to prepare their purchasing sets. Second, we should describe our typical customer profile - how can a qualified salesperson decide if a company is a good potential buyer for our product? This information can be developed from the customer segment definition; cluster analysis is especially helpful for this task, because it can correlate segment preferences with customer demographics. Third, based on the analysis, we should develop a list of our typical customers, including our top most desired prospects. Developing such list without identifying the advantage is usually impossible task, and that's why experienced investors often ask a question: "please name your top 5 most desired customers". If an entrepreneur can't quickly name them and convincingly explain why, investors know the opportunity is not ready yet.

Value proposition

Solving customer problems creates value. This value can be estimated by developing "customer implications" model, which analyzes both direct and indirect impact of our solution on various aspects of the customer life and business, and attempts to quantify it.

The total created value can be split in 2 categories: implicit value and explicit. Explicit value consists of the benefits we can quantify or otherwise clearly link to the customer bottom-line. For example, if a store is loosing $1 million a year to shoplifting, and we solve the problem, we create an explicit value of $1 million. Customer benefits which we can not quantify (for example, improved store reputation or employee morale), represent implicit value:



Entrepreneur's objective is to convert as much of the total value into the explicit value as possible, because it is much easier to communicate to the customers, and as a result, use to make sales. This task is challenging and requires creative thinking and team brainstorming.

Explicit value consists of the three components: product costs, supplier share of value, and customer share. The costs can be estimated by developing a cost model. At this stage, it should only include direct costs, such as bill of materials, and ignore fixed costs. The cost model might also include our estimates of the cost sensitivity to the production volume. The difference between the total explicit value and our costs is the "value margin", which is then split between the customer and the company which created the value. To decide how to make this split, we need 2 additional models: revenue model and customer payback model.[3]

Revenue model is a mechanism to capture our share of value. It includes various revenue sources and pricing – how much we charge per each revenue source. The pricing defines how much value we get versus the customers. As a rule, the value should be split so that we have at least 60% gross margin. Lower margins might be unable to cover start-up costs or will require raising too much capital. If the margins are too low, entrepreneur should develop the value model more, try to reduce costs, or consider another segment.

Customer payback model gives us another perspective on the decision of how much value to leave to the customers. We should give them enough incentives to prefer our solution over other alternatives. The payback model should provide estimated ROI (Return on Investment)

[3] *Often called "Customer ROI" model*

and payback time. As a rule, if the model can show a payback of less than a year, customers can easily make purchasing decisions and our chances to sell are high.

The value model should eventually be converted into a sale proposal – a list of terms we can offer to the prospective customers. Besides the revenue model and pricing, this proposal should include possible volume discounts, delivery times, service and warranty terms, and other considerations customers usually ask when making a purchase of this type of product. It is also helpful to develop a "quoting model" – a spreadsheet generating sale quotes based on the key sale parameters such as volume, required lead times, product configuration, etc.

Although a lot of this information might be unknown at this stage, it is important to initiate a written document which outlines the key terms we must provide. This draft can be then jointly developed with the pilot customers and will evolve with the innovation process.

Selling process

After we formulate our proposal, we must learn the customer purchasing process. First, we should understand who is involved in making the purchasing decisions, and in what capacity. For large and technically complex sales, for example, we usually will have to deal with at least four types of people: political (CEO), financial (CFO), technical (head of R&D), and end-users (employees who will actually use the product). We must understand how all these participants make their decisions, how long it typically takes, what budget category this purchase fits in, how they create a competitive set of purchasing alternatives (where they are looking for their options, how they evaluate them), etc. Most of this data can be collected from the industry experts, customer purchasing managers or experienced salespeople.

The next step is to understand customer motivation to purchase – customer "hot buttons" which can be pushed to make a sale. Entrepreneurs often assume that if they have a good solution, they can make a sale. This is not necessarily true, because customers must not only have a problem, but also a strong motivation to solve it. For example, livestock farmers everywhere in the world have problems with smells and ammonia pollution. However, while EU farmers are actively buying products to address the problem, the US farmers are not. What is the difference? EU farmers have strong motivation – EU farm pollution law, while the US does not have a similar law yet.

Customer motivation to buy is usually a combination of incentives (such as high ROI or short payback time), and pressures (such as legislation, environmental penalties, customer complaints, shrinking market share). These pressures should be identified and thoroughly analyzed. In many cases, we might be able to increase customer motivation either by designing attractive incentives, or by making the problems more obvious, or by increasing external pressures (for example, by lobbying new legislation). In any case, understanding customer motivation to spend money allows us to understand how to sell our product.

Finally, we should be prepared to answer customer questions such as "how are you different from product A?" or "why should we choose you over product B?". When purchasing, most customers attempt to solicit several competing proposals (typically at least 3-4), and no

matter how novel or unique our product is, they always find alternative ways to address the problem. Therefore, we must anticipate what competing products our salespeople will most likely encounter in the sale process, and how they should position our product relatively to them to win the sale. This analysis should be based on the market section of the Advantage matrix, converted from the general market levels into a set of specific competing products. This is one of the key uses of the advantage matrix – without it, making clear and convincing differentiation is an impossible challenge.

Marketing materials

After our sale offer has been formulated, we must be able to communicate it effectively to the prospective customers. The market communication package can be split into three categories: technical demonstration, written presentation, and verbal presentation.

Technical demonstration goal is to prove the claims made during the business sale. This demonstration should be developed jointly by the salespeople and scientists. The best way to design it is to rank business claims by their importance (from Advantage matrix), and then show how the product addresses them, one by one. Technical demonstration should include the product model, and a demonstration scenario and script. Showing complex technology capabilities in a simple but impressive way is a challenge for the entrepreneurial creativity.

Written presentation package should include files we will give or present to the customers. It might include a sale brochure, technical “white paper”, case studies, power point handouts. I also recommend to develop samples of advertisements for newspapers or magazines. Their limited space forces entrepreneurs to crystallize the key selling points of their offers. If they are unable to develop an exciting advertisement message (which can be confirmed by prospective customers), the product is not ready for selling yet.

Verbal presentation package should include materials for the business presentations, such as: 30-second sale pitch, scenario and script of the sale presentation, videos, power-point slides, list of anticipated FAQ (Frequently Asked Questions) and suggested answers, etc. Most of these materials will evolve ; however, it’s important to initiate these documents as easily in the process as possible. These materials can initially be used to get pilot customers, and later become a foundation for fundraising, sale, employee recruiting, and other functions.

Opportunity

Business opportunity model adds two more considerations to the sale model: scale and time. Scale dimension explains a potential to make a large number of sales. Time dimension explains how sustainable the sale potential is. An attractive opportunity then is a chance to make as many of such profitable sales as possible, for as long as possible:

To understand and present an opportunity, we conduct industry analysis. The analysis should estimate market potential and competitive forces, and show how the opportunity might change over time.

Market potential

After modeling our typical sale, we must estimate how many sales we can make – market potential. Many entrepreneurs have poor understanding of how market sizing should be done. As a typical example, a startup designing a new type of sports shoe stated that the US market for its product consisted of 270 million people spending an average of $100/person per year on shoes, and concluded that their market potential is $27 billion. Thus, even if they capture only 1% of the market within 3 years, they will enjoy a revenue of $270 million.

This analysis is a grossly oversimplified, broad, and naive description of the potential market, which most likely will kill any chances to attract qualified venture investments. It fails to recognize the key market sizing challenge – proper market segmentation. In the above example, the company's product actually was a waterproof, lightweight, high-impact running shoe that attracted only 20-37-year-old extreme sport enthusiasts who represented about 2 million people, a relatively small $200 million market segment.

Another issue entrepreneurs are facing is that while the venture investors are interested in the largest potential markets, start-up success odds can be increased by focusing on smaller, well-defined segments with the highest advantage. The best way to resolve this contradiction is to present a properly segmented market, highlight relevant segments, estimate their aggregated potential, and then explain which segment will be the point of entry and how the

company will grow from it into the other segments. This approach demonstrates to investors both high market potential and strong initial focus.

The best way to size a market is a "bottom-up" approach: identify key sale drivers, and research how many typical sale transaction they allow to make. For example, the following analysis gives quite accurate market estimate for the pig farm ammonia removal systems:

- The sale driver: number of pigs raised in the industrial-size facilities (> 1000 heads)
- Typical sale: one unit serves 500 heads
- Pig headcount globally: 1 billion heads
- Share of the industrial facilities versus small farms: 30%/70%.

Based on this data from the US Association of Pork Producers, we conclude that the real base for the possible sales is 300 million heads (1 Bln x 30%), or 600,000 (300,000/500) units. This estimate can be converted into revenues and gross margins once pricing and sale economics are known. The analysis should also include the trends in the key drivers. In the above example, I found that the world pig population is growing by 3%, and the number of the large-scale facilities is growing by 20% annually versus -5% decline in small farms. These trends allow us to make reasonable projections of the potential unit sales.

Competition

There are 2 fundamental reasons why our ability to make a large number of profitable sales might diminish over time: declining demand or increasing competition. The first issue should be addressed in the market potential analysis by evaluating trends in the demand drivers. The second issue should be addressed by the competitive analysis.

Competitive analysis is another misunderstood area of the innovation process and usually one of the weakest sections of the business plans. Many entrepreneurs either naively declare that they have no competition, or just list names of (often irrelevant) companies "playing in this space". The real competitive analysis must serve two purposes: a) it should help us to identify the highest threats to winning sales, and b) help us formulate a defense strategy to keep winning sales for as long as possible.

The competitive threats fall into 2 categories: products and companies. Product-level threats deal with the fact that we might lose sales to the better competing products. Company-level threats evaluate the risks of losing sales to other companies due to their superiority in financial resources, strategic market position, reputation, ability to copy our product, etc. To evaluate these threats, we should first create a list of competing products and companies, and then collect detailed dossiers on them.

The first step is to expand Advantage matrix using customer input and secondary market research, to list key competing conceptual platforms and products within them. This list should be limited to the products we most likely will encounter during the sales, according to the customer opinions. This criteria ensures the relevance of the analysis. The selected products can be then aggregated across the platforms by the companies producing them.

The next step is to rank the products by the perceived danger of loosing sales to them. This task can be accomplished by evaluating each product on the purchasing preferences in the Advantage matrix (perhaps even quantify their value using [-2..+2] scoring system), and benchmarking them against our offer. For the top-ranked competing products we should create dossiers, to systematically collect and organize information about them. The dossiers should contain pictures of the product, copies of the sale materials, advertisements, pricing data, cost estimates, customer opinions, and other information allowing to understand the threat better. These dossiers will provide input to the competitive strategy planning during the business plan preparation, when we will look for ways to increase and protect our relative advantage. This information can also help us improve our marketing message by capitalizing on the competitors investments in the marketing materials and customer research.

Next, we should consider strategic threats from the largest, most entrenched companies. Even if we have a superior product, we still might lose sales because established players have better resources, reputation and relationships with the customers. This area of competitive analysis must address 2 key questions:

1. What companies are to lose most if we are successful, and what might be their reaction?
2. What companies are most likely to develop superior products?

To evaluate these threats, we must create company dossiers and collect information on the competitor organization and the top management. Organizational section should contain information about the company itself – its history, culture, core values, financial strengths, size, market share, growth, list of relevant products, ownership, legal structure, industry alliances, etc[4]. It should also contain estimates of the company strength and weaknesses (some companies are strong in sales and marketing, others in R&D and operations), confirmed by the opinion of other industry patricians and customers. This information will later help us formulate competitive defense against the company.

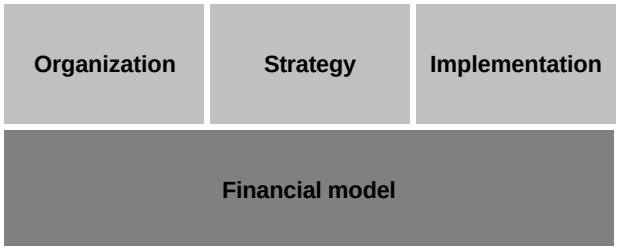
Management section should contain information about the leadership of the company – CEO, key managers, active founders, and board. It should profile their backgrounds, characters, reputations and past responses to the competitive threats. This data can help us predict likely responses of the company against our entry. Although managers react differently to the competitive threats - some lowers prices, others try to copy more successful products or file law suites - most managers have consistent pattern of such reactions, and studying their carries and past responses gives fairly good sense of the possible actions. Based on this analysis, entrepreneur can rank the companies by the perceived threat, and use this ranking during the business planning to develop a solid long-term competitive defense strategy.

Business plan

Business plan is a document which serves dual purposes: it is a project plan how to exploit an opportunity, and a marketing document to share vision with perspective investors, partners and employees. Every business plan has 2 sides: financial and operational. Financial side is presented in a form of financial projections derived from a financial model.

[4] *I will provide a template for the dossier later.*

Operational side consists of organizational (how we plan to organize our business), strategy (how we plan to accomplish our goals), and implementation (how we plan to implement the organizational model and strategy) sections:



Financial model

Financial model is not just another section of the business plan, as entrepreneurs often assume - it is an operational side of the plan translated into finances. This concept suggests the following approach to the business-planning. Immediately after an opportunity has been evaluated and industry analysis conducted, entrepreneur should develop the first version of the financial model, which provides a framework for collecting and organizing information for the business planning. Initially, it can be populated with dummy numbers and unverified assumptions. Then we should plan operational side and periodically coordinate it with the financial model, until they are fully synchronized. Well-defined model can make business planning much more efficient by focusing market research efforts on finding the key missing data and verifying the most important model assumptions.

Financial projections are the result of the financial modeling. Often entrepreneurs complain that these projections don't make sense and only include them because investors demand so. This might be true if the projections are prepared by creating an exponential curve quickly ending in billions of dollars. To create realistic projections, instead of trying to forecast, we should first choose an exit horizon (for example, 5-7 years – typical venture investor payback time), and then set an attractive but realistic revenue target at the end of this period, using information from the opportunity analysis (which includes data on market potential, competition and trends). We can also set realistic target gross margin at the exit point, by studying our market and competitors' economics.

The revenue and margin targets become a basis for the company capacity planning. Capacity is our ability to generate and process sales, and can be expressed as a number of sale transactions, number of customers, or number of units sold. Knowing our sale model, we can translate target revenues into the capacity required to reach them. For example, if $20,000 is an average price of ammonia removal system, to reach $1 billion in revenues we must sell 50,000 units/year. Knowing the target capacity, we can then estimate resources required to build it: employees, facilities, equipment, etc. This task can be accomplished by using industry average capacity/resource ratios. For example, if an average salesperson sells 2,000 systems/year in this business, we should plan for 25 salespeople. The resource requirements then are translated into budgets, such as rent, compensation, marketing, which are parts of the overhead model. The overhead model, in turn, allows us to conduct break-even analysis and thus estimate amount of capital required to build the company.

As a result of the modeling, we now have a vision of our business at the exit point: revenues, margins, capacity, headcount, budgets, etc. This vision will help us prepare an operational side of the business plan, and significantly facilitate preparation for the negotiations with investors, who use such projections to estimate how much to pay for the company shares.

Organization

This section of the business plan should describe how we plan to organize key areas of operation, such as manufacturing, customer support, distribution, sales, etc.

Strategy

This section should describe a set of strategies we need to exploit the opportunity. Usually it includes market entry and growth strategy, competitive defense strategy, customer acquisition and retention strategy, etc.

Implementation

This section should convert organizational, financial and strategic plans into an actionable project, with specific milestones, timelines, budgets, funding requirements, team recruiting plans, company formation plans, etc.

Fundraising

A spinout is ready for fundraising when we have the following components in place:

- Business plan
- Product model demo
- Customer commitments
- Experienced and motivated entrepreneur
- Company formed
- Patents granted

As mentioned before, venture investors are extremely selective – they invest in 1 out of 100 business plans they see. Why might they say "No"? One of the surveys among the US venture investors provided the following reasons, ranked by importance:

1. Lack of an experienced, complete management team - 40%
2. No fit (does not fit VC investment criteria, industry or geographic focus) - 17%
3. Need is too small and company will not grow large enough - 13%
4. Company has no clear competitive advantage - 13%
5. No clear execution strategy - 10%
6. Too early stage - 8%
7. Too high valuation - 4%
8. Company faces huge, entrenched competitors
9. The entrepreneur did a poor job presenting the opportunity
10. The entrepreneur views investors only as a source of money, not as value added partners

Based on this feedback, to successfully raise capital, we need to develop a process which mitigates the key rejection reasons. We have to develop an attractive investment offer, identify qualified investors, gain access to their time, sell our opportunity to them, survive their due diligence, and be prepared to negotiate a deal:

Investment offer

We should prepare a formal investment offer, which includes a type of securities we sell ("preferred stock series "A"), board seat availability, how much money we need, how it will be spent, etc.

Targeting VCs

The lack of fit between the opportunity and investor focus is the second strongest reason for rejection. Therefore, it is critical for entrepreneurs to qualify investors before approaching them. In addition, it is much easier to explain the opportunity to the investors with the relevant expertise. At the same time, entrepreneurs should check if the VCs invested in potential competitors, or have a negative reputation in the entrepreneurial community.

The first step is to understand what we want and what criteria the qualified investors should fit. Then, to identify the VCs with the appropriate backgrounds and interests, entrepreneurs can use various methods, such as sourcing the names of the local VC funds and angels from official sources and personal networks, exploring their web sites and annual reports, checking their current and past portfolio companies (including calling their CEOs and founders). The objective of this search is to develop a short-list of potential investors who have experience, interest and valuable resources in the target space.

Accessing VCs

The best way to access venture investors is to develop on-going relationships with them, by involving them into the innovation process early on (asking for advice, brainstorming participation, etc). If this is not possible, entrepreneurs should try to acquire referrals from a source the investors trust, such as banks, lawyers, other entrepreneurs, executives, etc. The worst way to approach VCs is to send out unsolicited business plans.

If the contact is established, the first step is usually to send a 1-2 page executive summary, outlining the opportunity. If the investors are interested, they will ask for a business plan and schedule a first meeting. Getting such meetings is the goal of this step.

Selling opportunity

The main goal of the meeting is not to make a presentation, but to "sell" the opportunity. Investors "buy" opportunities when the perceived risk/reward ratio is attractive to them. Thus, entrepreneur must always be conscious of presenting the opportunity in ways that not only show high market potential, but also reduce the investor's perception of the risks (remember risk reduction concept!). To be effective, entrepreneurs can use risk matrix to profile opportunities, and then allocating most of the presentation time to address key risks.

The presentation package should include a product demo, videos, power point slides, handouts, presentation scenario and scripts, and a list of anticipated FAQ and possible answers. A significant portion of this package can be developed from the sale package prepared for the perspective customers. If the presentation is successful, VCs will request a follow-up meeting and ask for a due diligence package. If not, entrepreneurs should use the opportunity to get feedback and learn how to improve their business plan or presentation.

Investors cited these top mistakes entrepreneurs make in presenting an opportunity:

- They are not clear in explaining the opportunity - why the business makes sense, why it would make a good investment
- They fail to describe a sustainable competitive advantage
- They do not demonstrate an ability to reach the customers and sell the product
- The analysis of competition is weak. Two critical mistakes: entrepreneurs say there is no competition, or underestimate the strength of competitors
- They provide unrealistic projections with "simplistic assumptions"
- Entrepreneurs "lie" about their credentials

Due diligence

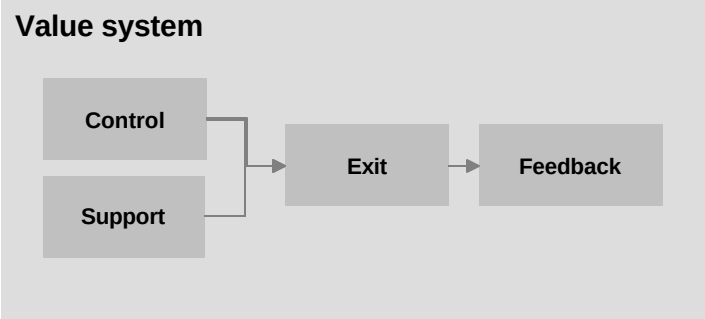
If entrepreneur gains enough investors' interest, they will conduct their due diligence. The purpose of the due diligence is to verify facts and claims presented by the entrepreneur, and to gain an independent prospective on the opportunity. To facilitate this process, we should prepare investor due diligence package in advance. For example of the typical VC due diligence requirements see Appendix 2.

Negotiating deal

If we pass the due diligence process, we will receive a term-sheet, and will have to negotiate a deal. There are two key components in the negotiations: valuation and clauses. Valuation determines what share of the company we will have to give up for the capital. Theoretically, the valuation can be determined by discounting the financial projections on return rates investors require for the perceived risk. In practice, however, valuation is more art than science. Investors often use comparable transactions as a basis for the valuation offer, take in account current state of the market (availability of capital and deals), or simply use their intuitive judgment.

Value system

If the fundraising is successful, the project can graduate from the research institution part of the innovation process, and become a responsibility of the venture investors. Nevertheless, the research institution should develop a process to support and monitor its spin-outs, and to capture the benefits of success. Such process is a part of the Value System:



Support & control

After the spin-out graduates from the research institution incubation system, the institute should provide continuous technical and scientific support for the company. It should allow the researchers to accept consulting contracts for certain number of hours per week. In some cases, it should also allow researchers to take a 1 or 2 year sabbatical to work for the company full-time and then return to the research.

The innovation team should also assign project managers to maintain close control over the progress of the graduated spin-outs. Such control includes participation in the board meetings, and monitoring business plan milestones. Typically, the managers who supervised the spinout incubation should take the board seat at the company after it graduates.

Exit

Research institutions must be prepared to exit spinout investments if they fail. In this case, the innovation team should regain control over the intellectual property contributed into the spinout, and consider whether it can be re-introduced into the innovation pipeline, because the intellectual property accumulates large amount of market and product development expertise, and have strong chances to find a strong advantage in a new market segment.

If a spinout succeeds, it will be able to provide exit opportunity for the research institution. There are 3 traditional ways to reach liquidity:

- Recapitalization (when other investors such as private equity funds, or a management team, buy out existing investors at negotiated prices)
- Acquisition (when the company is acquired by another company for strategic reasons)
- Initial public offering (when company lists shares on a public stock exchange and they become freely tradable).

If any of these events happen, the project managers must decide whether to stay invested or exit. This decision involves the analysis of the company growth prospects, an attractiveness of the offer, and the immediate budget needs of the research institute. If the research institution decides to exit, it should sell its own share and the share of the innovation fund, and it should also offer help to the researchers to sell their shares. The cash from the liquidation should be immediately distributed among the participants, according to the agreements signed at the company formation.

Feedback

Research institute must capitalize on the results and experience of both failure and success. Failure provides an excellent opportunity to learn from mistakes, and improve innovation process and tools. Ideally, the innovation team should write a case study on the failure to analyze its causes and highlighting areas of possible improvements. Over time, these cases will be invaluable source of the process improvement and excellent training materials for the new innovation team members, researchers and entrepreneurs. In addition, the innovation team should use the results of the analysis to minimize the damage the failure might cause to the institute relations with venture investors, entrepreneurs, researchers, creditors, and other involved parties. Objective, non-blaming analysis can often convert negative emotions into a contractive desire to learn and try again with the new knowledge.

Success is not only income, but also an opportunity to:

- Prepare a success story
- Use it as the institution culture change catalyst
- Gain political capital in society
- Promote institute innovation brand in business community

Innovation team should record a detailed success story to capture the experience. The success should also be publicly celebrated, both inside and outside the institution. Internal celebrations will serve as perhaps the strongest culture change catalysts. During the celebration, a joint team of researchers and entrepreneurs should present their story to other researchers. Hearing about the success from the trusted colleagues and respected scientists will create tremendous inspiration and motivation to participate in the innovation process.

Likewise, the institution should promote the success story externally. It should be included into the web site and annual report, presented on business and scientific public events, and published in mass-media. The product built based on the institution innovation, related video materials, and other project artifacts should be included into the innovation show room, to demonstrate to the institute visitors.

Innovation team also must study the implications of the success for the society. Such study should include the number of jobs created, taxes paid, improvements of customer lives, and so on. The results of the study should be shared with the government institutions, investors, advisors and researchers, to generate political currency and stimulate emotional desire to contribute to the similar projects in the future.

Appendix

Appendix 1: Innovation case study[5]

Ralph Grabowski

Problem

Stan Lapidus in 1987 started looking for entrepreneurial challenge and began investigating opportunities for special-purpose machine vision systems in medicine. The initial product idea was a TV camera through the microscope lens, coupled to a special computer, which would examine 250,000 cells in two minutes and subject each cell to perhaps forty separate medical criterion in software. The machine vision would pre-screen every slide without humans to select the few "worst" cells from each slide for presentation to a human Cyto-Technologist who would perform a medical determination. The intent was to replace the tedious, error-prone data processing of human eyeballs with tireless, consistent machine data processing.

Working out of his basement, Stan gave me a single name to launch the process, a page-and-a-half (double-spaced) treatment, a medical textbook on Cytology, and a limited budget with no money to travel. He asked me to research fundamental driving forces that might support investment in PAP automation:

- Demographics
- Financial
- Regulatory
- Technology

Stan then gave me the assignment to probe further into customer needs, confirming the market opportunity and product concept with primary market research.

Investment

Stan invested in 15 man-days of my time, over 18 calendar months.

Results

In 3 man-weeks, I supplied, identified, and interviewed enough customers and industry gurus to motivate multi-million dollar first-round Venture Capital (VC) funding for $3,600,000. My market research was used in testimony before Congress and resulted in new legislation that speeded market demand: the Clinical Laboratory Improvement Amendments of 1988 (CLIA -'88), Public Law 100-578. The Wall Street Journal writer won the Pulitzer Prize for his exposé on the topic. Stan Lapidus formed “Cytyc” (www.cytyc.com, NASDAQ: CYTC), which now has market capitalization of $2.5 billion.

Early market research, in advance of engineering, identified profound changes from the initial product concept. Upstream market research identified the real customer problem: data gathering and data preparation of the PAP smear slide, before any human data processing. A

[5] *Adopted from http://marketingvp.com*

patented slide preparation system emerged, the ThinPrep System, which adds to product differentiation and simplifies PAP screening. The ThinPrep Pap Test makes PAP smears by an automated slide preparation unit, the ThinPrep 2000 Processor, that produces uniform thin-layer slides, virtually free of obscuring artifacts such as blood, mucous, and inflammation. With marketing guidance, engineering designed the right product, and captured the business opportunity. “Fortune” magazine featured the ThinPrep Pap Test in "Unmasking Cervical Cancer," February 21, 1994: 89

M/E Ratio = 1.5

Cytyc enjoyed a Marketing/Engineering Investment Ratio of 1.5 during their first twelve months. Stan Lapidus, Cytyc's founder, invested in the up-front market research to develop a comprehensive grasp of his eventual customers, the pathologists. In the ultimate compliment to this market research and to Stan's depth of understanding of their problems, the pathology community asked him to teach them and their medical students: Stan was invited to become Assistant Research Professor of Pathology in Tufts University's School of Medicine, Boston MA.

Process, methods, and systems

1. Learned the language
2. Secondary market research
3. Approached the US government for new legislation
4. Market segmentation and food-chain analysis
5. Primary market research and market confirmation
6. Articulated the new product concept
7. Modeled the customer's business
8. Customer payback analysis
9. "Bottoms-up" market sizing
10. Regional primary market research
11. Competitive intelligence (CI)

1. Learned the language

I scanned a medical textbook on Pathology and Cytology (in ninety minutes) to learn some of the technology and language. This is important, so as to be able to relate to the technologists. I had to capture the respect of, and interview, highly trained medical specialists; pathologists (MD's), Cyto-Technologists (PAP smear readers), and the leaders of their organizations.

2. Secondary market research

Secondary market research is the surfacing of historical data that others have already gathered. It is broad-based, "tops-down," and summary in nature. In spite of its name, secondary research is performed first. While of finite value, secondary research generates a starting point, identifies names of key players, and shapes the questions that follow in the

primary market research. In this assignment, the critical statistics were neither available in libraries, not in published reports, nor obtainable from commercial secondary market research firms. Rather, the data were in file cabinets.

The challenge was to find the key individuals controlling that information. As just one of the sources accessed, that meant identifying and penetrating to the Vice President of Registry of the American Society of Clinical Pathologists, the only certification and registration body for Cyto-Technologists. While this was secondary market research, many of the methods of formal, primary market research were followed; in a special technique that I have termed "primary-secondary market research:"

- written questionnaire
- pursuing planned targets
- formal interview process
- written interview reports

The answers were forthcoming by phone, fax, and letters. The fundamental driving forces were identified:

- Demographic: personnel shortages from reduced Cyto-Technologist graduations for the last 10 years (30% fewer were being certified each year), and from school closings (half the schools had closed). I converted anecdotes into quantified evidence.
- Financial: costs, labor rates, reimbursements, and payback - with both present and proposed new methods.
- Regulatory: trends and developments indicating increasing and positive impact.
- Technology: blood analyzers paved the way for market openness to innovation.

3. Approached the US government for new legislation

A regulatory strategy and legal strategy should be an integral part of the business strategy. Market research is the fundamental intellectual discipline of strategy. I began by working to understand Cytyc's customer demographics; market trends and the industry drivers, which precipitated an exposé of "PAP mills." The outcry lead to Congressional Hearings in Washington, DC, under Massachusetts' Senator Edward Kennedy. By that time, my market research was available to be used in testimony before Congress, helping to result in new legislation. The Clinical Laboratory Improvement Act focused on quality and increased disease detection (that will speed market demand for their products).

4. Market segmentation and food-chain analysis

A market segmentation identified the portion to serve, and a food-chain analysis recognized the access point. Cytyc's market would be the high-volume clinical laboratory chain. This conclusion guided the primary market research. (As HMOs and medical insurance companies have asserted more of a role in the last few years, Cytyc has broadened their approach to include these third-party payers.)

5. Primary market research and market confirmation

Primary market research is the direct gathering of new data, and of future-oriented intelligence. It is narrowly focused, "bottoms-up," and detailed in nature. In spite of its name, primary research is performed second, after secondary research. Primary market research is higher value than secondary research, and tends to require about twenty or more times the investment. It answers the questions generated by the secondary research, and provides depth of understanding of the customer's needs. Formal, primary market research methods were employed for market confirmation:

- list of objectives
- written questionnaire
- description of the proposed new product
- pursuing planned targets
- qualifying the target
- formal interview process
- multi-level correspondence
- written interview reports

Every answer to every question was written up in detailed interview reports. This usually means investing more than twice as much time writing interview reports as was invested in the interview process. A special section of each report itemized each customer's concerns and comments, outside of the formal questions. It was exactly these comments that led Cytyc to identify profound changes from the initial product concept. For example, one Pathologist who was the Director of a major clinical Laboratory said, "The False Negative (FN) rate would, by conventional medical custom, not only include the FN rate of the proposed Cytyc machine vision unit, but would also include the quality of the smear taken by the physician." The objective of the PAP smear is disease detection; providing a (true) Positive alarm upon detecting cancer or precancerous lesions. False Negative (FN) is the diagnosis of a slide as normal (healthy), when there is actually a possible medical problem or disease. FN is "no alarm" when the alarm bell should be sounded. It is the opposite of a false alarm (False Positive). False Negative is worse than False Positive, because it ignores a potential medical situation. However, the fundamental aim is disease detection.

6. Articulated the new product concept

I wrote the first customer-oriented description of Cytyc's proposed new product. It was intended to relate the potential of new technology to customers who, while highly trained in medicine, had no knowledge of machine vision or computer-based image processing.

- Consistent across all interviews
- Neutral, dispassionate, and objective. No selling.
- No superlatives (powerful, fast, high, unique, advanced, revolutionary ...)
- Talks the customer's language
- Describes what we believe the unit will not do, and will not change
- Quotes exact specifications and proposed pricing
- Product limitations laid out openly

It was designed to focus the customer on the economic and business issues, and on the justification process that might lead to purchase.

7. Modeled the customer's business

I built models of the customer's current business, and of how their business economics might appear with the availability of the proposed Cytyc product. These models were built one customer at a time, for each interview.

8. Customer payback analysis

Rich's rule: less than one year payback means a sure sale (after Stan Rich, co-founder of the MIT Enterprise Forum.) I calculated customer payback, one customer at a time, for each interview. With some customers, the payback calculations involved as many as fifteen steps. Payback was as quick as five weeks! Clearly, the proposed Cytyc product would results in purchase decisions, and the customers said so. The evidence began to accumulate that would compel investment.

9. "Bottoms-up" market sizing

There are fifty million PAP smears done in the United States every year. A handful of the country's largest Clinical Lab chains do about 40% of the PAP readings, for twenty million PAP tests per year. These numbers were known from the "tops-down" secondary market research. However, "Markets don't buy products, customers do." (Jim Geisman). The task is to build a credible estimate of what real customers would likely purchase. A few of the largest laboratories were surveyed. The number of machines required for each customer lab chain was determined, one lab chain at a time, and totaled for a "bottoms-up" market sizing. This built a believable sales forecast to install into the financial section of the business plan.

10. Regional primary market research

Just as new products may be rolled out (first sold) one region at a time, the up-front market research process may be rolled out regionally. Stan Lapidus, the entrepreneur, was scheduled to make several trips to one particular city on related business. I took advantage of his travel schedule to precede him into that region of the country with primary market research. I guided the allocation of his time by developing a numerical ranking of contacts according to interest, size (PAPs per year), dollar potential, and unique ability to contribute to Cytyc. With that preparation, Stan was then able to visit a selection of the most productive contacts, and to confirm and extend the market research personally.

11. Competitive intelligence (CI)

The competition for most entrepreneurs starting new fields is the current method, not another company. Nevertheless, there may be potential competitors arising in their own basements or garages. This makes the gathering of competitive intelligence especially difficult, since the competitive new start is not yet selling any product, has no literature, and is surely very quite about their developments. I was able to acquire competitive intelligence (CI) on competitors, while they were still "in the basement." I surfaced information on their technological approaches, state of development, and people they were working with.

Appendix 2: VC due diligence requirements

Business plan

Terms

1. Summary of prior financing transactions
2. Full capitalization table prior and pro forma
3. Term sheets from prior series
4. Purchase Agreement of prior series
5. Employee stock option/stock ownership, both issued and to be vested by employee
6. Reserve for future options and list of any anticipated commitments in the next 24 months
7. Employee compensation

Organization

1. Organization chart
2. Hiring plan, option budget for next 2 years
3. Full resumes of key employees (Founders, CEO, VPs, key sales and/or technical personnel) and contact information
4. All employment contracts, agreements, termination agreements, and loans to employees
5. Management References
6. List of directors and key advisors, including
    a. Investors
    b. Attorneys
    c. CPAs
    d. Consultants
    e. Bank relationship
7. Past executives no longer with company
8. Past headcount by quarter

Financial:

1. Financial model and projections (realistic worst case, realistic best case)
    a. Expected monthly next 12 months
    b. Expected monthly or quarterly years 2, 3
2. Last 6 months and all previous yearly financials (P&L, balance sheet, and cash flow)
3. Projections from 6 months prior
4. All audited financial statements

Market:

1. Existing market studies
2. List of prospects and existing customers and key associated contacts
3. Marketing/promotional materials, copies of mass-media advertisements and press-releases

Technical:

1. Attached technical due diligence request
2. Copy of patents, if any

Competition:

1. Describe you principal competitors. How are the similar and different?
2. What is the basis of competition (price, service, technology, distribution, ...)?
3. Who are potential new entrants?
4. What is the value proposition of the competitor's solution?
5. In a competitive sale process, how do you position your product offering relative to each of the competitors?
6. What is the pricing of the competitor's solution?
7. Which competitors have you faced in sales situations to date, and who was chosen by the customer and why?
8. Who are each of the competitor's marquee customers?
9. What switching cost barriers are created if one of the existing competitors is already sold into a target customer?
10. What is the size (number of people, revenue) of each of the competitors?
11. How much financing have the competitors received? Who were their investors?
12. Which competitor do you see as the most significant threat to you?
13. How is your vision different than competitors over a 2-3 year horizon?

Exit:

1. Summary of all previous negotiations with respect to acquisition
2. List of natural acquirers, their market capitalizations and revenues

Corporate:

1. Articles of Incorporation, bylaws and amendments
2. Summary of insurance coverage
3. Minutes of Board of Directors and committees since inception
4. Copy of agreements with shareholders (voting, sale of common stock, preemptive rights, first refusal, registration rights)
5. Summary of past, existing, or threatened disputes or litigation
6. Last complete set of reports given to the Board of Directors

Risø's research is aimed at solving concrete problems in the society.

Research targets are set through continuous dialogue with business, the political system and researchers.

The effects of our research are sustainable energy supply and new technology for the health sector.