Part 1: Technology and innovation management: key concepts and insights

This part highlights the disciplinary roots or origins of the innovation process.

- **Economic studies of the innovation process**
  - The role of entrepreneurs and established companies
  - Market pull and technology push

- **Insights on the level of innovation systems**
  - The relevancy of support policies (including patent systems)
  - The role of research centres and universities

1

Entrepreneurial enterprises, large established firms and other components of the free market growth machine

William J. Baumol

This paper studies the principal influences accounting for the unprecedented growth and innovation performance of the free-market economies.

- Vigorous oligopolistic competition forces firms to keep innovating in order to survive
    - High-tech firms, internalize innovative activities rather than leaving them to independent inventors (turns invention into a assembly-line process)
- Revolutionary breakthroughs come predominantly from **small entrepreneurial firms**
- **Large industry** provides continuous streams of incremental improvements that also add up to major contributions

Introduction

Entrepreneurship:
Original usage of the term: establishment of a new firm

Shumpeter:
an entrepreneur is the partner of an inventor, the businessperson who:

> Recognises the value of the invention
> Determines how to adapt it to the preferences of prospective users
> Brings the invention to market and promotes its utilisation

Afraid that routinised innovation of big business was threatening to make the entrepreneur obsolete

Baumol's findings:

- The entrepreneur continues to play a critical part in the growth process… but cannot carry out the task most effectively.
  The market mechanism has provided the partners that the entrepreneurs need for this purpose.
- Major breakthroughs have tended to come from small new enterprises and the invaluable incremental contributions have been the domain of the larger firms.
  In addition, important innovations continue to flow from two groups outside the market sector: the government and universities.
- Essential that each is provided with the appropriate incentives to undertake its role in the process.

Market pressures for an enhanced large-firm role in technical progress

Free competition played a critical role in the growth of capitalist economies:

- Many rival oligopolistic firms use innovation as their main battle weapon.
- More and more is the funding for innovation being supplied by large oligopolistic enterprises.
    As a result there is little of the free-wheeling, imaginative and risk-taking approach that characterises the entrepreneur. > it is designed to prevent unwelcome surprises and to keep risks to a minimum

- Schumpeter: the work responsibilities the economy assigns to the independent entrepreneur are narrowing <=> Baumol don’t agree

Revolutionary consequences of aggregated incremental improvements

Incremental contribution often adds more to growth than do the more revolutionary prototype innovations. (Clock speed processor Intel)
Off course the initial invention was a necessity for all the later improvements. But it is only the combined work of the two together that makes things so powerful.

On the role of government and the university in innovation

Role of the government:

- **Passive role:** legal infrastructure that encourages entrepreneurship, the formation of new firms and investment in the innovation process by larger competing enterprises.
  - **> property rights and enforceability of contracts**
  - **> avoidance of rules on employment ant rental: easy formation new firms**
- **Active role:** government support of basic research. Universities and government agencies make direct contributions to technological progress in basic research (distinguished from applied research).

Dissemination of invention and rapid termination of the obsolete

Encouragement of growth and technological change:

- The innovator's financial gain derived from the temporary acquisition of monopoly power
- Rapid dissemination (verspreiding) of improved techniques and products and their widespread adoption by others

There appears to be a conflict (ease of dissemination can threaten the innovator's reward).

- Many business firms guard their **proprietary technology** and strive with the aid of patents, secrecy and other means to prevent other firms, notably rivals, from using the new products and processes.
  This is unfortunate for economic progress because it means that consumers who purchase from other firms are forced to accept obsolete features in the items they buy.
- Luckily**, voluntary licensing of access to proprietary technology** is widespread in the economy.
  - The price mechanism will not only encourage licensing but will also elicit efficient specialisation (inventive activity/production will be undertaken by the more efficient inventor/producer).
  - **Other incentives for exchanges**: sharing the high cost of R&D, reduction of the risk, protecting yourself from new entrants (by forming a consortium -> but make sure that it does not serve for anticompetitive behaviour: *price fixing*)

Indicators of the magnitude of the free-enterprise growth miracle

The growth record of the free-market economies.

The invaluable contribution of 'mere imitation'

Most of the innovation that a relatively small industrial economy can expect to introduce will not have been contributed by the country's own R&D activities, but by those of **other countries.**

The imitation process is also innovative. Substantial improvements can be contributed by the imitators, in part elicited by the need to adapt the technology to local conditions.

"Every inventions contains some borrowing and every borrowing some invention" De Camp, 1963

Also, for every advanced economy, innovation will continue to be of prime importance for economic growth. But one may well expect that a substantial proportion of that innovation will be obtained from foreign sources.

On governmental policy for promotion of innovation and growth

4 contributory sources that play critical roles in expanding an economy's innovation and growth:

- entrepreneurs and small firms
- large firms with internal R&D capacity
- universities
- governments

Focus on the role of government as facilitator of the innovative work of others:

- Funding and execution of **basic research** (= research that can contribute to the economy's growth but its questionable returns make it unattractive to business firms)
- Government role in **acquisition of foreign technology**:

  Provision of certain socially valuable goods and services because private enterprises lack the incentive to supply optimal quantities of such outputs.

  Ex. The work of monitoring foreign technology:

  - **Education and training** abroad
  - **Immigration** of foreign technicians and related personnel
  - Establishment of **observer staff** in the country's embassies
  - **Study of measures** taken by governments in other countries to facilitate absorption of foreign technology by their industry

2

Patterns of industrial innovation

Abernathy William J. and Utterback James M.

How does a company's innovation - and its response to innovative ideas - change as the company grows and matures?

--> Develop a model relating **patterns of innovation** within a unit to that unit's **competitive strategy**, **production capabilities** and **organisational characteristics**.

--> A productive unit's capacity for and methods of innovation depend critically on its **stage of evolution** from a small technology-based enterprise to a major high-volume producer.

A spectrum of innovators

Two units at opposite ends of a spectrum: they form boundary conditions in the evolution of a unit and in the character of its innovation of product and process technologies.

- **Small entrepreneurial organisation**
  - The diversity and uncertainty of performance requirements for new products give an advantage in their innovation to small, adaptable organisations with flexible technical approaches and good external communications
  - Their competitive advantage is based on **superior functional performance** rather than lower initial cost, and so these radical innovations tend to offer higher unit profit margins

- **Larger unit producing standard products in high volume**
  - Innovation is typically incremental in nature and has a gradual cumulative effect on productivity
  - Such incremental innovation typically results in an increasingly specialised system in which economies of scale in production and the development of mass markets are extremely important
    - dependent on high-volume production to cover fixed costs
  - Vulnerable to changed demand and technical obsolescence

A transition from radical to evolutionary innovation

The former two patterns of innovation may be taken to represent extreme types, but are **not** in fact rigid independent categories.

Organisations currently considered in the 'specific' category (incremental innovation motivated by cost reduction) were at their origin small 'fluid' units (intent on new product innovation).

--> A shift from radical to evolutionary product innovation: related to the development of a dominant product design and accompanied by heightened price competition and increased emphasis on process innovation. (Ford launched **cheep** care, not an entirely new one).

Managing technological innovation

Managerial concepts:

- As a unit moves toward large-scale production, **the goals of its innovations change** from ill-defined and uncertain targets to well-articulated design objectives.

- Under conditions where **performance requirements are ambiguous**, users are most likely to produce an **innovation** and manufacturers are least likely to.

- The stimulus for innovation changes as a unit matures:
  - In the **initial fluid stage**, market needs are ill-defined (target uncertainty) and the relevant technologies are little explored (technical uncertainty), so there is little incentive for **major investments in formal R&D.**
  - As the enterprise develops, uncertainty is reduced and **larger R&D investments** are justified.
  - At some point - before increasing specialisation makes the cost of implementing new technological innovations too high and before increasing cost competition erodes profits - the benefits of R&D efforts reach a maximum.

  --> science based firms: invest in formal research and engineering departments, with emphasis on process innovation and product differentiation through functional improvements.

- The organisations' methods of coordination and control change with the increasing standardisation of its products and production processes. It's structure will also change, becoming more formal and having a greater number of levels of authority.

Consistency of management action

Can a firm increase the **variety and diversity of its product** line while simultaneously realising the **hight possible level of efficiency**? No

Is a high rate of product innovation consistent with an effort to substantially reduce costs through extensive backward integration? No

Is government policy to maintain diversified markets for technologically active industries consistent with a policy that seeks a high rate of effective product innovation? No

+ ADDING FIGURE

3

The social construction of facts and artifacts; or how the sociology of science and of technology might benefit each other.

Pinch, T. & Bijker, W. (1987)

The study of science and the study of technology should and can benefit from each other. The social constructivist view provides a useful starting point.

Some relevant literature

Sociology of science

Studies in this area take the actual content of scientific ideas, theories and experiments as the subject of analysis. All knowledge and all knowledge claims are to be treated as being socially constructed.

Science-Technology relationship

Philosophers: attempt to separate technology from science on analytical grounds.
Innovation researchers: investigate the degree to which technological innovation originates from basic science. Most agree that technological innovation takes place in a wide range of circumstances and historical epochs and that the import that can be attached to basic science probably varies considerably.
Scientists and technologist construct their own bodies of knowledge and techniques with each drawing on the resources of the other when and where such resources can profitably be exploited.

Technology studies

Innovation studies: economists looking for the conditions for success in innovation
History of technology: studies of the development of particular technologies
Sociology of technology: understanding of technological artifacts as social constructs

A six-stage model of the innovation process.
Basic research > Applied Research > Technological Development > Product Development > Production > Usage

EPOR and SCOT

The empirical programme of relativism

Approach in the field of sociology of scientific knowledge.
This is an approach that has produced several studies demonstrating the social construction of scientific knowledge in the hard sciences.

Characteristics:

- Focus on the empirical study of contemporary scientific developments
- The study in particular of scientific controversies

Stages:

- The interpretative flexibility of scientific findings is displayed;
- Social mechanisms limit interpretative flexibility and allow scientific controversies to be terminated;

- Relate such closure mechanisms to the wider social-cultural milieu.

The social construction of technology

Approach in the field of sociology of technology.
In Scot the developmental process of a technological artifact is described as an alternation of variation and selection. This results in a multidirectional model.

If a multidirectional model is adopted, it is possible to ask why some of the variants die whereas others survive. To illuminate this selection, we consider the problems and solutions presented by each artifact at particular moments. A problem is defined as such only when there is a social group for which it constitutes a problem.

The social construction of facts and artifacts

The concepts from EPOR can be given empirical reference in the social study of technology.

Interpretative flexibility

EPOR: first stage
SCOT: the demonstration that technological artifacts are culturally constructed and interpreted. There is not only flexibility in how people think of or interpret artifacts but also that there is flexibility in how artifacts are designed.

Closure and stabilisation

EPOR: second stage, mapping of mechanisms for the closure of debate
SCOT: mapping of mechanisms for the stabilisation of an artifact

- **Rhetorical closure**: Closure in technology involves the stabilisation of an artifact and the disappearance of problems. To close a technological controversy, one need not solve the problems but the relevant social groups must see the problem as being solved.
- **Closure by redefinition of the problem:** closure by redefining the key problem with respect to which the artifact should have the meaning of a solution

The wider context

EPOR: to relate the content of a technological artifact to the wider sociopolitical milieu. This aspect has not yet been demonstrated for the science case.
SCOT: offers an operationalization of the relationship between the wider milieu and the actual content of technology.

4

Moving beyond Schumpeter: management research on the determinants of technological innovation.

Ahuja G., Lampert C.M. & Tandon V. (2010)

In this paper we consciously move beyond the Schumpeterian tradition of focusing on firm size and market structure as the primary determinants of innovation to identify a broader set of innovation determinants.

Distinction between:
- Innovative efforts: what factors affect the incentives and the ability to support research?
  --> The research production function
- Innovative output: given a research effort, what factors determine the resultant level of output?
  --> The innovation production function

Group the determinants of innovation:
- Industry structure: horizontal market structure:
  - Shumpeterian legacy
  - Competition and collaboration
  - Buyers
  - Suppliers and complementor
- Firm characteristics: externally observable attributes of a firm
  - Size
  - Scope
  - Alliances and network position
  - Performance
- Intra-organizational attributes: the inside of the firm:
  - Organizational structure and processes
  - Corporate governance arrangements and incentives
  - Backgrounds of managers
  - Organizational search processes
- Institutional influences:
  - The supply of science
  - The appropriability regime/conditions

Industry structure and innovation

The Shumpeterian Legacy: market structure and innovation

Schumpeterian hypotheses:
- Innovation increases with market concentration
- Innovation increases more than propotionately with firm size

Research:
- Inconclusive: market structure has not been found to be strongly related to innovation
  --> lack of conceptual clarity in the research
  - Failure to distinguish between innovative efforts and output
  - Looking for monotonic relationships
  - Possibility of omitted variables

- Market power has been argued to both enhance (Schumpeter) and depress (Arrow) the incentives to invest in innovation. It is not clear whether the relationship can reasonably be expected to be linear. Innovation incentives may go up with market power to a certain point and then dip again.
    - Market dominance provides firms with profits and security to finance risky activities such as innovation (Shumpeter; Baldwin&Scott; Cohen).
      <-> In well functioning capital markets, existing profitability should not be a pre-condition for innovation efforts (Cohen).
      Monopolies that are in a comfortable position may feel less pressured to invest in R&D and innovate (Cohen)
    - Monopolies have more to lose and are therefor more motivated to invest in innovations to preempt competition (Schumpeter; Christensen)
      <-> Arrow replacement: Innovation may cannibalize a monopoly's existing offerings and replace it, while a competing firm can gain more because there is no cannibalization (Arrow)
    - By creating path-breaking innovations, firms can alter the market structure and gain market power which ensures superior profits (Schumpeter, Cohen)
      <-> This is ex post market power in stead of ex ante
- The firm's incentives to invest in innovation may be more dependent on what they consider the competition to be rather than what the actual level of competition is.

- While a number of arguments relate market structure to innovation efforts, none of those arguments provide any reason to believe that possessing or lacking market power should have any impact on the productivity of research effort.

  There are two other arguments which suggest that the structure of an industry may influence the innovative productivity of firms in it. These are distinct from the Schumpeterian effects.
    - To the extent that olgiopolistic market structures may result in more imperfectly correlated research efforts, market structure may have an impact on the innovative productivity of all the firms in the industry. This is because more research efforts improve the possibility that at least some will be successful and will also provide information on more productive research trajectories.
    - Industries characterized by well-connected networks may lead to increased knowledge spill-overs which aid innovative productivity

Collaboration networks

Networks and the research production function:

- In many industries the task of innovation has been sub-divided among a number of interconnected firms
- While all interfirm networks are ultimately composted of individual interfirm linkages, there are also distinctive effects that arise additionally from the network as a collective entity
- Networks to affect motivation to invest in innovation:
    - Inter-firm networks are a good source of information about opportunities and threats
    - Netwerks can amplify or weaken signals provided by the market
    - Networks can lead to the diffusion of practices through imitation

Networks and the innovation production function:

- Inter-organization networks promote innovation productivity directly by providing information and technical know-how and facilitating joint problem solving.
- Networks also pormote innovation productivity indirectly by facilitating increased specialization and division of labor which leads to more focused expertise development. This specialization is made possible by the reduction of transaction costs occurring through increased levels of trust between the transacting parties.

Future directions:

- Initial tests of the hypotheses of above propositions and formal analyses of networks in the context of innovation are still limited.
- The different types of inter-firm netwerks.

Buyer/user innovation

Users have also been identified as a major source of innovation. They are motivated by considerations other than profiting directly from the innovations and can be of great value to the firms:

- They serve as a source of marketing data for the firms
- They can be a source of valuable product ideas

Buyer innovation and the research production function:

- Factors that motivate users to innovate:
  - Inherent characteristics (ex hobbyists or lead users)
  - Psychological benefits from recognition
  - Reputation and signaling benefits (help them on the job market)

The role of suppliers and complementors

Inter-industry knowledge spillovers are an important source of innovation in many industries and may provide strategic motives to invest in innovation.

The suppliers, complementors and the research production function:

- Suppliers may be motivated to invest in innovations and increase the technological opportunities in the downstream industry
  - When conditions in the downstream industry may induce lesser innovation effort than is optimal from the supplier's perspective (ex when there is faster technological growth in the supplier industry)
  - When the downstream industry is concentrated and has significant barriers to entry such as sunk cost. The supplier has strong incentives to reduce those sunk costs by investing in R&D in the downstream industy.
- Complementors also have an interest in the development of technology. The returns from investments that complementors make in their own technologies often depend significantly on the availability and performance of complementary technologies.

Firm characteristics and innovation

Schumpeter: identifying what kind of size distribution of firms is most conductive for innovation.
Research: many characteristics beyond firm size are relevant to understanding innovation outcomes.

Firm size

Empirical results of the simplistic interpretation of the relationship between firm size and firm innovativeness are inconclusive.

Size as an argument to the research and innovation production functions:

- Positive influences of size on innovative productivity
  - Scale economies in the R&D process benefit firms with larger R&D budgets
  - R&D is more productive in large firms due to complementarities between R&D and other activities
- Negative influences of size on innovative productivity
  - Bureaucratization of inventive activity in large firms stifles the creative instincts of researchers
  - In large firms, incentives of indiviual scientists becom attenuated as their ability to capture the benefits of their efforts diminishes
- Positive influence of size on innovative effort (research production function):

- Large firms can secure finance for risky R&D projects
- Returns to R&D are higher if the innovator has a large volume of sales over which to spread the fixed costs of innovation

Large size is not necessary to realize the benefits of scale and complementarities as two firms can collaborate.
Large size is also not sufficient to realize these benefits because there also have to be increasing returns to scale and more then one activity.

Contingencies:

- A distinction must be made between the size of the firm, the size of R&D effort and the scope of the firm's activities.
- It is necessary to examine relationships between firms as a valid argument to the innovation production function. The scale and complementarity benefits could be obtained through cooperation between firms and inter-firm cooperation could mitigate problems of bureaucratization and incentives.

Firm scope

Research on the effect of diversification on firm innovation efforts and output has not provided conclusive results.

The positive influence of firm scope on innovation:
Diversification provides motivations to invest in research

- Diversification hypotheses: firms with a broad product base have greater incentives to invest in basic research
- It is related diversification (and not overall) that positively influences investments in R&D
- The active pursuit of diversification strategy indicates a mindset of exploration and therefore leads to greater R&D activities
- Diversification can also influence innovation productivity by facilitating cross pollination of ideas across domains

The negative influence of firm scope on innovation:

- Less incentives for the employee to exert efforts becaus the threat of substitute inventions in diversified firms reduces the chances of compensation
- As the firm becomes more diversified, the top management at the corporate level has greater difficulty in monitoring individual divisions. This control loss leads firms to move from strategic control to financial controls, which makes the managers more shortsighted and risk-averse.
  (<-> Ignores the possibility that managers may be rewarded for exceeding goals, which is an incentive to invest, or that in some industries not investing is a greater risk than investing)
- When firms whose primary business is in high R&D intensity areas diversify, they may move to areas which need less R&D, thus the R&D is lower on average.

A primary concern in this literature is the direction of causality.

Access to external knowledge: alliances and networks

There are at least 3 distinct effects of inter-firm collaboration on firm innovation performance:

- Collaboration provide direct benefits to the participating firms through scale economies in research, reduction of wasteful efforts, sharing of knowledge and combining of complementary skills
- Taken collectively, the linkages within an industry form an information network within the industry and thus facilitate knowledge spillovers
- The structure of this network affects the rate at which knowledge travels between firms

Focus on how collaborative arrangements at the firm and dyadic level influence the innovative activity of firms as well as how firms' positions on industry networks influences their innovative effort and output.

Innovation production function: P = f(R&D) (with P the innovation performance)
The benefits of knowledge sharing, complementarity and a favorable position in the network aris through ehnancement of the innovative input (R&D). The advantage of scale economies arises from the properties of the function f.

Dyadic alliances (individual linkages):
- Multiple mechanisms can be identified to relate collaboration to innovation output:
  - Collaboration increases a firm's knowledge inputs into the innovation process, by enabling it to leverage its contributions to an R&D pool
  - Cooperation between partners that bring together dissimilar skills can enhance this leveraging effect significantly, as each partner can benefit from complementarity in addition to the knowledge sharing benefits identified in the first case
  - If the technology of research is characterized by increasing returns to scale, then even minor enhancements in the knowledge of firms through collaboration can lead to significant increases in innovation output
- The relationship between linkages and innovation performance might not be linear
  - Collaboration can influence innovative output by affecting the effective levels of innovative inputs (=internal R&D + part of collaborative). The exact contribution of collaborative R&D is not clear and may be less than the sum of all the collaborator's efforts and less than the contribution of a comparable internal unit
    - Significant additional coordination, monitoring and management costs
    - R&D conducted in cooperation needs to be internalized by the parent firm
    - Collaboration may not be able to eliminate completely the duplication of research efforts
    - Collaboration may lead to strategic behavior on the part of collaborators
  - R&Deff = R&Dint + a*R&Dcollab

Dyadic alliances, effective R&D and Complementarity:
- Ideally firms would prefer to use only a limited set of closely similar skills and build a specialized competence in them. However technology may demand the simultaneous use of different sets of competencies. Firms than face a choice of developing the dissimilar competencies or obtaining them through collaboration
- Compute the impact of both decisions on the effective R&D of the firms (berekening p35)

Dyadic alliances, efficitive R&D and Scale:
- The scale characteristics of the transformation function f determine the degree to which enhanced effective R&D results in enhanced innovation output
- Increasing vs constant vs diminishing returns to scale
- Cooperation may enable firms to take advantage of such scale economies if they exist
- Scale benefits are not necessary for collaboration to result in enhanced innovative output

Dyadic alliances, key conceptual conculusions:
- A combination of an innovation production function that is increasing in effective R&D expenditures and moderate to high values of a are sufficient to ensure that collaboration has a positive impact on innovative output, even in the absence of scale economies or complementarity advantages

- To the extent that a is relatively high or there exist scale economies, or complementarity benefits, this effect of collaboration on innovation performance is further enhanced.
- Inter-firm linkages may also generate diseconomies:
  - Increasing management and organizational costs
  - Loss of focus and specialization benefits
  - Possibly adverse scale implications
  - Imperfection in the market for knowledge

Dyadic alliances, empirical results:
- The survey-based studies in general find a positive impact of cooperative activity on technical performance. However the measures of performance are somewhat amorphously defined.
- There are also studies that show that the quality of innovations is less for collaborative firms.
- Also the conclusion that more collaborative linkages help increase the amount of innovations produced by the firms is not always supported. There are other characteristics of the inter-firm relationship that may affect the innovativeness of firms (capability of the partner, absorptive capacity…)
- The separate effects of scale versus complementarity remain unexplored

Netwerk position:
- Look at a network comprised of all inter-firm linkages and analyze the innovation performance of individual firms within the network
- Taken collectively, the network of linkages serves as an information conduit for the industry
- The degree to which any firm participates in the information flow is determined by its position in the network

Networks and effective R&D:
- A firm's effective R&D does not only include its internal and cooperative R&D inputs, but also its access to knowledge spillovers
  R&Deff = R&Dint + a*R&Dcollab + b*R&DSPILLOVERS
- Mechanisms through which spillovers occur:
  - Geographic proximity
  - Scientific conferences
  - Journal and patent publications
  - Vendor relationships
  - Personnel movements
- Relating inter-firm linkage networks to knowledge spillovers:
  - Network serves as an information conduit and carries information from one firm to the other
  - The attributes of a firm's position in the network provide a measure of a firm's access to spillovers

Networks as information conduits:
- The process by which information flows through the network:
  - People meet and talk
  - The context in which the people meet determines the issues they talk about
  - Each person potentially carries away information from a conversation which can be used in subsequent conversations
  - A person carries to each conversation a memory of some elements from conversations with other partners

  Through collaborative linkages, this process works strongly because they are sustained, focused and intense interaction.
- Think of the network as an abstraction of the underlying patterns of communication in the industry
  - The precise communication patterns are unknown

    - The existence of inter-firm linkaged indicates sets of paths with relatively dense communication

The impact of position in the network on innovation performance:
The information benefits of a network accrue in 3 forms

- Access to information: the networks serves as an information gathering and screening device
- Timing: getting information first
- Referrals: the network provides information on personnel and thus helps to choose appropriate people to resolve technical problems or take advantage of opportunities

Empirical studies regarding network position:

- Linkage formation is associated with superior innovation performance (patent frequency)
- Structureal holes account for those ties in which partners are not connected to each other. Access to dissimilar industries lets a firm generate new innovations. Network efficiency (diversity of partners) and network size increase innovativeness.
- In horizontal networks, where competitive motive is strong, closed networks may help to generate trust and thus improve information flow.
  Where the netwerk connects firms across several industries and the competitive motive is weaker, the diversity provided by an open network may be more valuable.
- Strong ties are better than weak ties for transmission of tacit knowledge.
- The institutional environment may affect the influence of networks on innovation output
- Networks can impose costs on the innovative performance of a firm and the technological progress of all the firms in a netwerk.
- Networks can also retard innovation by limiting flexibility

Firm performance

Basic arguments:
Changing fortunes influence the innovative performance of firms

- Less the aspirational performance may positively impact innovation:
    - It motivates firms to undertake search
    - Decision makers become risk-seeking when facing losses (prospect theory). Therefore they will invest in innovation if it is riskier then not investing
- Organizational decline may also decrease innovation
    - Threat results in rigidity and conservative behaviour (emphasize static efficiency)
- Contigency model: variables at three levels (environmental, organizational and individual) determine whether problemistic search or threat rigidity effects dominate in a given setting

Intra-organizational Attributes

Organizational structure and processes

The design of organizational structure and its effect on innovation

- Organization structure influences information flows within the organization as well as responsibilities and incentives
- The effects of wholistic descriptions of organization structure:
    - Organic structures better than mechanistic bureaucratic structures
      -> Organic structures better for smaller firms and superior only when the technogical system is complex
    - Distinguish between incremental and radical innovation
    - Matching innovation needs with organization structure:
        - Cycling organization: organic design to explore and mechanistic design to execute innovation

        - Change the products market of individual divisions to match them with the appropriate needs of the products
        - Use semi-structures (hybrids) with elements from both organizational types
        - Ambidextrous structures that split up the organization into differentiated sub-parts that are connected only at top-management level (each sub-unit optimized for its own goal)
        - Skunkworks: separate a select group of employees from the rest of the organization to develop a product in greater autonomy
        - Spin-outs: separate a part of the organization to run an entire business outside the organization
        - Use corporate venture capital investments
- The effects of the individual components of organizational structure:
    - Complexity: helps innovation by enabling cross fertilization of different ideas and by providing the firm with a source of intellectual capital
    - Decentralization: affects the initiation of innovation activities positively by increasing the feeling of involvement among organizational members, reducing vertical transfer of knowledge and speedier utilization of local knowledge
      <-> Centralized authority has been positively linked with the implementation of innovation and hence potentially with the productivity of innovative efforts
    - Formalization: reduces the openness in an organization, adversely hurting the generation of ideas, while the singleness of purpose enforced by formalization helps in productivity of innovation
- Studies examining the impact of organizational structure on firm innovativeness also need to consider the impact of incentive and control structures (possible interaction effects)
- One should also consider informal structures, such as inter-organizational social networks
- Organizational structure not only affects the overall innovativeness of firms, but also affects the kinds of innovations created by a firm
- The effect of organizational characteristics on output may depend on many contingent factors
    - Stage of technological life cycle
    - The kind of innovation and the stage it is in
    - Age of the firm
    - The nature of the industry

The design of organizational processes and its effect on innovation:
- The role of social ties between organization members
    - Facilitating knowledge transfer
    - Creating social connections helps both in generation and implementation of ideas
- The use of environmental scanning processes
    - Processes to scan the environment and probe the future are proposed to help innovations
- The role of innovation management practices
    - Support from upper management
    - The role of project champions (organizational members that take ownership of the project and garner support and resources from the organization for the project)
    - Top managerment should create a mindset for innovation, make innovation meaningful for the entire firm and make innovation an important part of strategic conversation

Corporate governance, compensation, incentive structures

Corporate governance mechanisms and incentive structures of firms influence the risk appetite of managers and consequently the incentives to invest in innovation activites.

Managers are likely to be less willing to invest in innovation activities than owners would want them to:

- Stockholders and managers differ in their risk preferences (stockholders can diversify it away)
- Investing in innovation is risky since the outcome is unpredictable.

The overall influence of owners on innovation may depend on the mix of shareholders and their investment objectives.
Owners can use monitoring mechanisms or bonding mechanisms to align managers interests with theirs

- Monitoring mechanisms: affect managers' motivation to invest by exerting external pressure
- Bonding mechanisms: short-term cash rewards reduce risk taking, while rewards such as stock options which are longer-term and confer ownership on the manager reduce the risk-aversion of managers.

Background of managers

Characteristics of top management influences the efforts that a firm puts into any strategic activity. The top-managers are themselves influenced by psychological and social biases in their decision making.

- Individual characteristics: The mental maps, biases and filters of top-managers can be inferred from looking at the demographic characteristics such as their age and background.
    - Age:
        - Younger managers are more likely to be trained in new technology
        - Older managers are less able to invest in innovations because of decreasing mental abilities
        - Older managers are less willing to take risks
        - But: Managers learn with experience and may therefor be more motivated to invest
    - Organizational tenure:
        - Leads managers to have psychological commitment to organizational processes and organizational values and therefor resist change and discourage innovation
          -> not proven
        - Top managers become more effective in implementing change as their tenure increases
        - Inverted U relationship between innovative output and tenure
    - Level of education:
        - Increases in the education level increases their cognitive ability to understand and initiate new solutions
        - More favorable attitudes towards innovation
- Since managers take decisions collectively, it is also important to examine the role the composition of the top management team. The most studied characteristic is the level of diversity in the team.
    - Heterogeneity is argued to promote innovativeness because it helps firms to account for a larger set of problems and solutions
    - Heterogeneity is argued to adversely affect the productivity of innovative efforts because of differences of opinions

Organizational search processes

Innovation as the result of an organizational search or learning process:
Understand the nature and direction of exploratory activity conducted by firms and its implications for innovation output

- Firms are more likely to invest in the neighboorhood of their existing technologies and activities

- Recombinatory search models: new inventions emerge from the recombination of existing elements of knowledge. Output can be increased by enhanding the recombinatory set.
  - Search breadth: search can entail the exploration and use of new elements of knowledge
  - Search depth: search can entail the exploration and repeated use of knowledge elements the firm already has
  - The knowledge base varies over time

Institutional influences

Science and innovation

Scientific and technologic progress can directly influence the motivation to innovate by providing knowledge inputs to the innovation process.
Science can also influence innovation efforts indirectly by increasing the need for prior knowledge necessary to profit from the progress in science. They need to invest to create absorptive capacity to understand, modify and assimilate new technologies.

Challenges for this argument:
- Although there is support for the idea of science as an input to technology, research suggests a more complex relationship between science and innovation
- Science and commercially valuable innovation represent very different institutional systems and are assessed by different criteria

Appropriability conditions and innovation

Appropriability conditions refer to the environmental factors, apart from firm and market structure, that enable an innovator to capture the rents of innovation by creating barriers to imitation by competitors.
The most studied factor is legal protection provided by the patent regime of the country. A patent prevents imitation by competitors and thereby affords the innovator a chance to recover the investments made into innovation. Hence it creates incentives to innovate.

Challenges for this argument:
- Some argue against the idea that knowledge once created, can be easily appropriated by imitators. Patent protection may not be necessary if imitation is costly.
- Some challenge the idea that imitation always creates disincentives to invest in innovation. Imitation may spur innovation while prevention of imitation may hurt it if the innovations are sequential and complementary.
- In many sectors, legal protection mechanisms are not the preferred mode of preventing imitation

Qualifications to the argument:
- The relationship between the motivation to innovat and the intellectual property rights regime also depends on certain dimensions of the patent policy such as the stringency of patentability requirements.
- Raising the threshold level will reduce innovation efforts and will make patents last for a longer time. It will also create bigger innovations with higher returns, wich increases the incentives to innovate.
  -> inverted U shaped relationship between innovation and patentability

Costs of a strong patent regime:
- Discourage follow-on inventions which may slow down the overall rate of technical change
- Reduce the variety of search paths and prevent cross-pollination of ideas
- Provide distorted incentives which may lead to diversion of resources from productive activities

5

Patents as an incentive to innovate.
The economics of the European Patent System

Guellec D. (2007)

Focus on the economic justification and impact of patent systems.

The rationale for patents

Moral justification (or rejection) of IP

France 1971: Every discovery or invention is the property of its owner.
-> Not straightforward for intangible assets:

- It is unclear to what extent one invention can be attributed to one inventor
  -> reward the first
- Everyone's invention is based on **accumulated knowledge**. Granting anyone control over the latest invention endows him or her control over previous inventions. And by granting one a right on a current invention, one deprives possible future inventors of that right.
- To give patents for inventions that come by routine experimentation is to use the patent law to reward capital investment and create monopolies for corporate organisers in stead of men of inventive genius.
- Ideas are naturally free ownership?
  Differentiate between **inventions** (creation by man) and
  discovery (pre-existed to its finding)

The utilitarian approach

Social institutions should be designed to maximise social welfare.
Free competition will generate an under-optimal rate of inventions, due to the 'public good' characteristic of knowledge.

- Patents are viewed as **incentives for further innovation**
  (not as rewards for past innovation)
- Patents as a **policy instrument**, tied to certain aims and circumstances. In which circumstances should this instrument be used?
- Knowledge: can be used at the same time in different places by different persons and does not disappear by use.
  Consequences:
  - The marginal cost of using knowledge is zero; the cost of invention is a sunk cost
  - Re-inventing an existing piece of knowledge is a waste of social resources; once an invention is made, it is beneficial to society that it is made available for free to all potential users
  - An existing piece of knowledge can be beneficial to others without them needing to incur the cost of invention and without depriving the inventor of the use of his invention
  - As private return is lower than social return, certain inventions, whose social return would justify the expenditure needed to obtain them, will not be made due to insufficient private return

    - A competitive market will generate an under optimal rate of inventions, as an inventor must charge a price that will allow him to recoup his fixed cost while his competitors can charge just their marginal cost

- Solutions for this problem:
    - Government **sponsors inventors** an makes inventions free to all users
    - Privatise knowledge (make it an excludable good) by means of **intellectual property rights.**

  This will give incentives to invent, but will also reduce diffusion and knowledge spillovers, so there is a trade-off.

Goals patent system:
1) stimulate inventing
2) disclosure

Variation of the utilitarian approach:
Patents are a contract between the inventor and society, by which society grants transitory monopoly to the inventor in exchange for (temporary) disclosure.
Patents are here a response to secrecy, not to under-investment.
-> Disclosure is certainly one objective of the patent system, but it comes after the provision of incentives to invent.

Are patents property rights?

What strength should be given to patents?

- If they are seen as property rights, many bodies of law providing strict defence of property would apply, whereas keeping them out of that domain gives more flexibility
- Demsetz: **Property rights allow internalisation of externalities, hence promoting social welfare.** Assets which are not subject to private property are subject to over-exploitation (ex fishing).
  This argument holds for tangible assets but does it also work for intangible ones?
    - Demsetz's theory is about internalizing negative externatlities, while knowledge is associated with positive externalities (which should be encouraged in stead of suppressed)
    - What is a positive externality for some (users of knowledge) is at the same time a negative externality for others (producers of the knowledge)
      -> Wrong from the point of view of economics: ignores the public good property of knowledge. Value is created and does not depend on its distribution.
    - Society has interest in the distribution of value only to the extent that it will affect the possibility that the transaction occurs or not, or the total value created through that transaction.
      If a transaction would take place anywey, a patent would only reduce the social benefit.
    - For tangible assets: property rights give access to existing technology, and make sure that thare is no over-exploitation.
      For intangible assets: property rights aim at reducing shortage of new technology by inducing more investment
- Economic view: the owners of an asset have the residual rights of control on that asset. They decide what to do with the asset once certain obligation contracted with third parties (ex banks and workers) have been met. Therefore property rights provide high powerd incentives to invest and produce value.
  Patents are not only a means for their holder to extract more value but hey have also become a way to access others' technology (licensing) or to raise capital (signalling).

The natural rights argument have more favour in courts than the utalitarian argument, but this is because the first needs no further substantiation, whereas the other calls for empirical proofs (supports patent only when they increase social welfare).

Patents as a policy tool

Government wants to:

- Encourage innovation
- Encourage the diffusion and use of new technology (to enhance durable productivity growth and generate further knowledge)

Which instruments exist and how do they use them?

Technology policy

3 categories of policy instruments for encouraging invention:

- The public research system: universities and public laboratories:
    - Research areas:
        - Fundamental knowledge
        - Technology fulfilling collective needs
        - Generic industrial technology that government is considered better equipped to work on
    - Types of funding:
        - Grants are allocated on a competitive basis to particular projects following a call for tender
        - Public laboratories which rely on basic funding
- Public funding of business performed research:
    - Mechanisms:
        - Public procurement: government purchases research from a private party (intellectual property belongs to the government)
        - Research subsidies: government sponsoring research projects performed by private parties for their own use. These subsidies are targeted for a particular objective (ex car safety)
        - Prizes: government controlled competitions regarding well defined innovative projects
        - Soft loans: reduced interest rates or a guarantee of reimbursement by the governement
        - Tax breaks: the company benefits from reduced taxation on its profits in proportion to its research expenditure or to the change in its research expenditure over some reference period
    - Types of funding:
        - Cost based: all except prizes
        - Value based: prizes
    - Informational difficulty: knowing the cost or value of the research
- Intellectual property policies in general, more particularly patents:
    - The exclusive right allows the holder to charge customers with a mark up above the marginal cost. Hence the patent system generates a kind of targeted tax to the buyers of the good. (<-> The other instruments were funded through the general tax system contributed by all citizens.)
    - The funding is related to the value of the invention (willingness to pay by customers and sales volume)
    - Non-discretionary character: all inventions fulfilling certain criteria written in law are eligible to patents. (<-> Other instruments have a case by case decision by the authorities, exept R&D tax credits)
    - Exclusionary effect: reduced competition (<-> other instruments)
    - Patent system operates through an increase in the value of the research outcome. (<-> Other instruments work through a reduction of costs, exept for procurement)
    - Patents not only encourage research but also the commercialization of inventions:
        - A patent will only generate income if the product is economically used out of it

            - Patent infringement is punished only when identified by the owner itself

Samenvatting karakteristieken tabel p59

Which instruments should be used in which circumstances?
Efficiency of an instrument: its ability to generate more (or higher value) innovation at the lowest cost for society.
Considerations relating to fairness and distributive impact will also be taken into consideration.

- Applied vs fundamental research: does technology render direct services to customers or not?
  Research areas with no predictable market application (or only in the long-term) will barely attract private funding, so public funding is needed.
- Certain techniques might not have efficient substitutes, so that the market power granted by patents is very strong.
- Patents exclude customers which are not able to pay the higher price. One has to see what is the cost to society of such an exclusion.
- To what extent is it fair to make all citizens pay for inventions that many of them will not use, as it happens with tax funded instruments? This depends on the type of service that will result from the research.
- The exclusion effect also exists for other policy instruments in an indirect way. The opportunity cost of taxes is not zero but consists in a reduced level of overall consumption, affecting other goods.
- The choice of an instrument is related to the allocation of information, incentives and decision rights among economic agents. Decisions should be taken by the party with most information.
  Patents are more efficient from an informational point of view, when the value of the invention is not known by government or the cost is not observed by government.
- Government can use several instruments at the same time.
- Patents are the most market oriented among instruments of innovation policy: it aims at decentralizing a socially desirable situation for the production and diffusion of *a public good subject to incomplete information.*
  It offers the advantages of the market mechanism relative to political and administrative processes, in terms of information, incentives and competition.

Zie ook box 3.2 p62

An economic incentive

Sequential choice model for the effectiveness of patents for increasing R&D expenditure at the firm level:
- Stage 1: the firm decides whether to invest in R&D or not
- Stage 2: having the invention, the firm decides whether to patent it or not
- Solve this model backwards:
    - Highest expected profit in stage 2?
        - Compare profit when not taking patent with profit-cost when taking patent -> net gain is patent premium minus the cost of taking the premium
        - Patent premium results from the impact of the patent on the degree of competition and from the impact of reduced competition on the market price (formule p64)

      --> impacts are not always clear: patents do not always exclude competitors, not clear if the invention is easily copied or has other means of protection, price elasticity of demand…

- ○Invest in R&D or not? Depends on the impact of R&D on profits. The revenu of the invention should at least cover its costs. This depends on the marginal productivity of R&D.

At the individual company level, a patent system could be considered as effective, if a significant proportion of inventions are pursued thanks to patents which would not have been pursued without patents: this is when the patent premium and the marginal productivity of research are high.

The effectiveness of patents

To what extent and for what purpose do innovative firms use patents or other means of protection?
Studies show that patents should be considered as one component only in the appropriation strategy of firms and often not the most important one. They also show that patents are used for a range of purposes that are not reflected in the simplest economic models.

- Patents are deemed effective for securing the return from inventions in certain industries only: chemicals, biotechnology and drugs. In some other industries, they are deemed moderatly effective.
- Patents are more effective for product innovations than for process innovations. (Processes could be kept secret more effectively and would suffer more from disclosure through patent documents.)
- Patents are more often used for protecting radical innovations based on R&D than for protecting more marginal inventions based on other means.
- The major reasons for firms to patent are:
    - To prevent copying
    - To blok competitors
    - To gain freedom to operate
- Firms patent more of their inventions when they are confronted with more intense competition
- Firms which export part of their production tend to patent more
- Large firms take more patents than small ones

Does patenting add value to innovations? (Is the patent premium positive?)

- For most innovations the patent premium would be negative. That is why so many innovations are not-patented.
- For the innovations that are patented, the patent premium is significant
- The patent premium has a skewed distribution (most patents are worth very little, while a small number have very high value) and differs largely across industries

Do patents induce further R&D and innovation?
Difficult to compare what would happen in reality with in the other case. Research:

- Ask companies directly what fraction of their innovation projects they would not have conducted in the absence of patents.
  -> High for pharmaceuticals and chemicals, low for others.
- Use econometric methods to find the connection between patents and innovation.
  -> Patents have a positive impact on R&D expenditures in most industries, especially drugs.
- Estimate the 'equivalent subsidy rate', the subsidy that a government would have to grant to maintain the company's R&D without patent protection.
  -> Much variation across industries, with chemicals, pharmaceuticals and semiconductors the highest.
- Compare patent regimes across countries and over time and correlate them with economic or innovation performance. (Difficult because of other factors and different patent regimes.)
  -> Stronger patent regimes tend to favour economic performance.

- The effects of patent strength on technological performance (R&D intensity = R&D/GDP)
  -> Positive effect on R&D intensity
- The effects of patent strength on growth of GDP
  -> Positive but weakly significant effect
- Effect of Intellectual Property Rights on Innovation (measured by the number of patents)
  -> IPR is positively related to innovation once other complementary factors are taken into account
  -> the poorest countries are negatively affected by stronger IPR
- Correlate changes in patent law with the numer of patents granted
  -> Strengthening patent rights have generated in general an increase in patent filings from foreign assignees, but had no effect on filings by nationals

Stronger patent regimes imply better economic performance. There might however be an optimal level of protection, possibly different across countries and over time.
Patent regimes are quite effective in increasing R&D in certain industries (drugs and chemicals).
Patents are also taken for other reasons than imitation.
Patent regimes contribute to economic growth and innovation. Through the import of foreign technology for less developed countries, through domestic inventions for more advanced countries.

Inventions disclosure and the social cost of patents.

In the absence of legal protection for an invention, the inventor will often try to keep the invention secret. It is one mission of patents to incentivise the disclosure of their knowledge by inventors so that society would benefit more from it.
A study found that among innovating firms, a patenting firm is more likely than a non-patenting firm to also use secrecy. It also shows that market succes of a product innovation is well correlated with patents but not with the use of secrecy, which tends to show that the most valuable product innovations are patented and that secrecy applies rather to process innovation or pre-market stage of product innovations.
The major reason not to get a patent is 'too much disclosure'. The legislation requires companies to document for example how the products work, how to manufacture it…
It is one aim for the patent system to make disclosure a preferred option to the inventor.
Disclosure facilitates follow up inventions (derived from the initial one) and the invention of substitutes which will increase consumer wellfare and reduce marketprices.
When a new product or process exist from more then one invention it is possible to patent some and keep others secret.

Licensing contracts give under certain conditions (royalty payments), access to patented knowledge to other parties than the inventor. But it does not fully work in certain field because of high transaction costs to set up a licensing contract when there are a lot of pieces of knowledge that are protected by different patents.

Additional advantages from patents:
- They give a general sense of the evolution of technology and of the potential and limits of certain research directions.
- Reduction of duplication in research

Deadweight loss of customers

To know the effect on society, this involves taking into account the effect of patents on customers and other companies.
- Customers benefit from new products and from the reduced cost of goods to ne new processes

- This benefit comes at a cost, a markup inflating the price of patented goods which results in a deadweight loss (customers who are willing to pay more than the marginal cost but less than the price)
- Is it legitimate to deny access to the poorest customers even at the marginal cost? A theoretical solution is price differentiation, but the right information about customers WTP does not exist and it would imply a second hand market being created. A solution could be price differentiation according to country, dependent on the legal status of 'exhaustion of rights'. (If rights are not exhausted, you may not resell it)

Strategic patenting

Defensive patenting: The first effect of patents on companies other than the patent holder is to keep them out of the market. As competitors do not want to be excluded, they will take patents themselves in order to prevent that. Hence preserving freedom to operate is another important reason for patenting.

Distortions in profits and investment

The effectiveness of patent protection differs across many dimensions, notably industry. Therefore the size of the patent premium will vary accordingly which implies that the patent system affects the distribution of profits across industries and probably affects the allocation of investment accordingly.

Common pool problem: strong patent protection in certain industries might result in high payoff, which could attract more investment in R&D than is socially efficient. (Every entrant beyond the first adds cost to society without adding value when one research project is enough for the invention to be done.)

It is not clear however the duplication is really a problem, that all duplication of research a total waste of resources, or that patents reinforce the problem of duplication:

- Parallel research might result in competing patented goods, more competition and lower prices
- Duplication might be partial only, resulting in slightly differentiated goods that bring diversity on the market
- Competitors might do the research in a different way, which highers the expectation that the invention will be made in the end
- Patent races trigger an acceleration of research
- Patent disclose inventions and could prevent duplicative research occurring because of the ignorance of companies about each other's activities

6

Does the European paradox still hold? Did it ever?

Dosi G., LLerena P. & Labini M. (200)

The European paradox:
"Europe plays a leading worldwide role in terms of top-level scientific output, but lags behind in the ability of converting this strength into wealth-generating innovations."
<-> Data reveal that that Europe has a structural lag in top level science compared with the US. There is also a lag in research investments.

Introduction

Since the second half of the nineties, the economic performance of the Euro (measured by labor productivity) has been weak, with less annual growth than in the US.
European institutions have been unfit to foster economic growth stemming from the complex relationship between new scientific disoveries, novel technical innovation and their industrial exploitation. Europe does not invest enough in R&D, why is this?

The myth of European leadership in science

Scientific impact of Europe:

- Number of publications per euro spent in non-business enterprise R&D: higher in Europe than the US
- The publications face more obstacles in translating into technological applications than comparable scientific output in the US
- It is not the number of publications that count, but its impact on the relevant research communities, the quality of the research --> number of citations is very low for European research!
- Thus one of the likely causes of the dismal performance of the so-called 'science, technology, innovation systems' is the weak European scientific impact

EU universities in comparative perspective

Performance of European universities:

- The US outperforms European countires in the top50 universities with notable exceptions of Switzerland and to a lesser extent the UK
- The overall gap closes as one moves from the top50 to the top 500
- Across time European universities seem to have lost ground in the top tiers ranking while haven strenghtend in the top 100 and top500 ones.
- Reasons of this outperformance
    - Amount of money spent in higher education is higher in the US
    - Institutional differences:
        - In many European countries, a relevant portion of top quality research is performed by non-university institutions. In the US almost all top research is done at universities.
        - In the US there is a sharp distinction between research-cum-graduate teaching universities, undergraduate liberal art colleges and technical colleges. In Europe, most universities offer a mix because of the authority of the government.
          Centralized control is likely to prevent US style competition for research funcs, faculties and students.

Poorer technological performance: R&D investments and the lisbon agenda

Overall expenditure in R&D as an indicator for European efforts in technology and innovation:

- Lisbon agenda: making the EU the most dynamic and competitive knowledge-based economy in the world. Two targets:
    - EU R&D expenditures were supposed to reach the target of 3% of GDP by 2010
    - The share of this spending funded by business should rise to around two thirds
- Van Pottelsberghe:
    - EU under-invests in R&D, the gap is not shrinking and the 3% target is not reached
    - To be more informative, international comparisons of R&D intensities should consider the industrial specializations of each county
- Channels through which it is feasible to foster R&D investments:
    - Channels through which government might directly invest money in R&D:
        - US government spends more in both R&D carried out by firms as by eduction institutions, government etc. (Especially in the first.)
        - Broader categories of public support for industrial technology:
            - Grants, loans and fiscal measures
            - Government payments to finance R&D as part of procurement programs
            - Public support to research infrastructures (applied research in universities and public institutes)
    - Channels that stimulate industry financed R&D:
        - Quality and financial efforts in academic research: supply of qualified and skilled labor force
        - Scientific output dissemination, public conferences, informal information exchange,…

Conclusion: Rather than establishing unrealistic targets, EU policies should increase mission oriented public R&D and single out the channels through which private R&D efforts might be stimulated.
Improving the scientific impact of Europe and the quality of its top research universities might reveal to be more effective than strengthen university-industry links.

Wrong diagnoses and misguided policies: some modest alternative proposals

The European system of scientific research is lagging behind the US. This calls for strong science and higher education policies.
However this is the opposite of what has happened: The belief in the European paradox and the emphasis on 'usefulness' of research has led to a package of policies whereby EU support to basic research and research universities is basically non-existent. Also with regards to industrial R&D, the focus on pre-competitive research has meant that firms try to tap community money in areas that are marginal enough not to justify the investment of their own funds.

What can be done? Policy implications:

- Increase support to high quality basic science
- Fully acknowledge the differences within the higher education system
- Build ambitious technological daring missions, justifiable for their intrinsic social and political value

7

Is the internet a US invention?

Mowery D. & Simcoe T. (2002)

Although the inventions embodied in the internet originated in a diverse set of industrial economies, the US was consistently the source of critical innovation and an early adopter of new applications.
Why did other nations (including several that made important inventive contributions to the internet) not play a larger role in the development of the internet, particularly in the creation of new business organizations, governance institutions and applications?

The US national innovation system had an important role.
Important preconditions for US leadership in computer networking innovation were:

- Large public funding -> creation of an R&D infrastructure of trained researchers and related institutions including universities
- The presence of a large domestic market and large investments in desktop computing -> rapid diffusion
- A set of antitrust and regulatory policies that weakened the power of incumbent telecommunications firms
- A diverse private/public research community that was willing to work with both domestic and foreign inventions

A brief history of the internet

1960-1985: early computer networks

1985-1995: infrastructure development and growth

1995-present: creating commercial content and applications

The US national innovation system and the internet

The internet was invented and commercialised primarily in the US. The US role in invention, diffusion and commercialisation of computer networking technology reflects the unusual mix of institutions ant policies that characterise the post 1945 US national innovation system, while also exploiting long-established characteristics of the US economy that were important to economic growth and innovation in the first half of the 20th century.

The role of government sponsored research

Federal R&D investments strengthened US universities' research capabilities in computer science, facilitated the formation of university spinoffs and trained a large cohort of technical experts who aided in the development, adoption and commercialisation of the internet.
Program managers in information technologies sought to establish a broad national research infrastructure that was accessible to both civilian and defense-related firms and applications and disseminated technical information to academic, industrial and defence audiences.
The diversity of the federal internet R&D portfolio reflected the fact that federal R&D investments were not coordinated by any central agency, but were distributed among several agencies with distinct yet overlapping agendas.

Other governmental policies

In addition to supporting internet-related R&D, the US government influenced the development and diffusion of the internet through regulatory, antitrust and intellectual property rights policies.
Federal telecommunications policy, particularly the introduction of competition in local markets also affected the evolution of the internet in the US. The spread of local competition promoted the widespread availability of affordable leased lines that allowed commercial ISPs to connect their networks to IX points, long-haul carriers and one another.
State and federal regulation of telecom prices aided the domestic diffusion of the internet.
The relatively weak IPR regime resulted in a widespread diffusion of the internet's core technological innovations (put it in the public domain), which lowered barriers to entry by networking firms in hardware, software and services.

Internet commercialisation and the changing US national innovation system

More and more private sector R&D investments and growth of the VC industry (and less defense-related procurement than before).
Shift from an open IPR regime towards a pro-patent posture.

8

The role of entrepreneurial universities within innovation systems.

Van Looy, B. (2009)

What is the role of entrepreneurial universities within national innovation systems?

Introduction: the phenomenon of entrepreneurial universities

Increasing acknowledgement of the fundamental role of knowledge and innovation in stimulation technological performance, international competitiveness and economic growth.

The innovation system concept: framework to understand innovation dynamics

- Knowledge generating institutions (universities, research laboratories, government institutions) are important players in developing and stimulating the innovative capacity of a particular region or country. (Besides firms and entrepreneurs)
- The importance of interaction between all actors

Reasons that universities are relevant actors within innovation systems:

- They produce information and ideas upon which the development of new products, processes and services can build
- They can work on certain research agendas for a longer period of time which can lead to the creation of new scientific insights… (which can lead to economic applications)
- They can address market failures that occur in the field of innovation (ex in relation to basic research which is characterized by high levels of uncertainty, long time frames before it bears fruit and knowledge as output)

Economic growth within a region, based on knowledge intensive entrepreneurship:

- The region's technology portfolio should strike a balance between routine and non-routine technological activities
- The exploration of new fields of knowledge (non-routine), and the continued diffusion of this knowledge among regional actors can be considered an essential task of knowledge centers and especially universities.
- An explicit research focus coincides with a larger number of enterprising activities (patents, spinoffs, contract research)
- To contribute effectively to the innovative capacity of an innovation system, universities have to be willing to become more entrepreneurial: more intense commercialization of research results, patent and license activities, spinoff activities, collaboration projects with industry, involvement in economic and social development
- Knowledge transfer must improve in order to accelerate the exploitation of research and the development of new products and services. To that end, European universities and public research institutions should be given incentives to develop skills and resources to collaborate effectively with business and other stakeholders, both within and across borders
- Besides direct effects, it has also been shown that the presence of knowledge centers is taken into consideration by companies choosing a location

Entrepreneurial universities: concerns

Scientific and entrepreneurial activities at the level of professors: complementary or contradictory?

Fears:

- The impact of university-industry cooperation on the research agendas of university researchers
- Conflicts of commitment and interest that occur when faculty members' full-time duties (teaching, research,…) are affected by activities stemming from involvement in company cooperation such as consulting activities
- Different reward and incentive systems of academic and private sector research in terms of
  - The relationship between disclosure and secrecy
    'The secrecy problem': industry support for research may restrict or delay the disclosure of research
  - The complementarities and substitution effects between public and private R&D expenditures

  'The corporate manipulation thesis': the academic research agenda may be contaminated by the application-oriented needs of industrial corporations (-> less basic research)

-> reopening of debates on the norms and values that guide academic research

But:

- It may be that researchers adjust their agendas in response to an increased cooperation with industry. On the other hand, industrial partners might turn to research centers that already had an application oriented agenda. (Then the observed effect would only be a selection effect.)
- Some studies show that performing more applied research does not necessarily imply a trade-off with basic research.
- It is shown that the number of citations for university-industry papers was higher than for single university papers, which suggests that university researchers may be able to enhance their scientific impact by collaborating with industry partners
- Recently, Owen-Smith highlighted the changed relationship between commercial and academic systems. Whereas these used to be separate systems, findings suggest that commercial and academic standards for success have now become integrated into what is called a hybrid regime, where achievement in one realm is dependent upon success in the other.
- *Former researches show that there is a correlation between patenting/inventing and the quantity (and some studies also say quality) of publications (scientific output). So academics who are more entrepreneurial are also better researchers*
- Contract research only represents one type of entrepreneurial activity occurring at universities. In the case of inventions, the potential conflict beween public- and prive-oriented considerations in terms of diffusion of knowledge (secrecy versus free dissemination) seems most salient.
  -> But majority of studies signals a positive relationship between inventive activity and scientific activy.

On the role of legislative framework conditions

Legislation with respect to the ownership of intellectual property rights originating from publicly funded research:

- US: Whether performed by universities or companies, the involved institutions obtain in principle the right of ownership. This has contributed to the strong increase of patenting activity undertaken by American universities.
- EU: Adopting a similar legislative framework might be an interesting option for European countries in order to further stimulate innovative activity. Ownership rights

will give scientific inventors incentives to engage in further development efforts and follow up research.

- These rights should be situated at the level of universities, not individual inventors, to avoid under-investment or conflicts of commitment and to create a more transparent market situation.

Part 2: Models of the innovation process and innovation strategy

This part develops models of the innovation process and examines the strategic management of technology and innovation on the level of the firm.
Both defining and implementing an innovation strategy will be discussed.
We will also look at the nature and relevance of alliances and cooperation.

9

Creating project plans to focus.

Wheelwright S.C. & Clarck K. (1992)

The long-term competitiveness of any manufacturing company depends ultimately on the success of its product development capabilities.
But much can and does go wrong during development. Often problems arise from the way companies approach the development process. They lack what we call an 'aggregate project plan'.

- A lot of organizations spend their time putting out fires and pursuing projects aimed at catching up to their competitors.
- They have far too many projects going at once and overcommit their development resources.
- They spend too much time dealing with short-term pressures and not enough time on the strategic mission of product development
- Management directs all its attention to individual projects - it micromanages project development. But no single project defines a company's future or its market growth over time; the 'set' of projects does.
- Aggregate plan: companies need to plan how the project set evolves over time, which new projects get added when, how resources are allocated, and what role each project should play in the overall development effort. The projects should form a set consistent with the company's development strategies, rather than selecting individual projects from a long list of ad hoc proposals.

How to map projects/creating an aggregate plan

- Define and map the different types of development projects (categorize according to degree of change in the product and the degree of change in the manufactering process):
  - Pre-commercial development
    - R&D: creation of know-how and know)why of new materials and technologies that eventually translate into commercial development (close relationship with commercial development is essential)
      -> competes with commercial development for resources
  - Commercial development
    - Derivative projects: incremental product changes, process changes or both
      -> need few resources and little management involvement
    - Breakthrough projects: significant product and process changes (new product category, new technologies and materials)
      -> need many resources and freedom to work with new equipment, techniques,...
    - Platform projects: in the middle, improve across a range of performance dimensions, create a new generation of the products and process (<-> derivative improves only across one or two)
      -> need considerable upfront planning and the involvement of engineering, marketing, manufacturing and senior management
  - Alliances and partnerships: can be formed to pursue any type of project
    -> amount of resources and management attention needed can vary

All five development categories are vital for creating a development organization that is responsive to the market. Breakthrough projects can shape new platforms, which can define new derivatives.

Focus on the platform

The more mature the industry, the more important it is to focus on platform projects on which a generation of products can be build.

Steady stream sequencing

Periodically evaluating the product mix keeps development activities on the right track. Companies must decide how to sequence projects over time, how the set of projects should evolve with the business strategy and how to build development capabilities through such projects.
Ex. Develop a new platform every year, followed by two or three derivatives spaced at appropriate intervals

An alternative: secondary wave planning

This strategy can be more appropriate for companies that have multiple product lines, each with their ow base platforms but with more time between succeeding generations of a platform.

A development team begins work on a next-generation platform. Once the that is completed, the key people start to work on another platform for a different product family. Once the first platform begins to age, the company refocuses development on derivatives for the existing platform. Information about these products is being gattered and they start defining the next generation platform.

A variation of this strategy is to immediately start working on derivatives after the platform introduction.

The long-term goal: building critical capabilities

Possibly the greatest value of an aggregate project plan over the long-term is its ability to shape and build development capabilities, both individual and organizational. It provides a vehicle for training people in the different skill sets needed by the company.
Besides improving people's skills, the aggregate project plan can be used to identify weaknesses in capabilities, improve development processes, and incorporate new tools and techniques into the development environment.

10

New problems, new solutions: making portfolio management more effective

Robert G. Cooper, Scott J. Edgett and Elko J. Kleinschmidt.

Those businesses that implement a systematic process for managing their project portfolios clearly outperform the rest.

Portfolio management is about resource allocation: how your business spends its capital and people resources and which development projects it invests in. It is also about project selection and about operationalizing your business' strategy.
This article focuses on doing the right projects.

Most companies' development portfolios suffer from:

- Bad resource balancing: too many projects for the limited resources available and failure to allocate resources effectively
- Ineffective project prioritization and selection methods (go with all positive NPV projects in stead of ranking the projects and keeping in mind the needed resources)
- Go/kill decisions made in the absence of solid information
- Too many minor projects in the portfolio, there also have to be platform and breakthrough projects

End result:

- Poor performance
- Low-impact projects
- Too long to get to market
- Higher-than-acceptable failure rates, low quality because of leaving out activities to save time

Solutions:

- Implement a systematic gating or stage-gate new product process
    - Define the key tasks, activities and accountabilities within each stage
    - Define the deliverables required for the gate decisions (information items needed to make the go/kill decision)
    - Specify the criteria against which each project is evaluated

  -> Improves the quality of information in your projects
- Build in resource capacity analysis
    - Do you have enough of the right resources to handle projects currently in your pipeline?
    - Do you have enough resources to achieve your new product goals?

  -> Quantify your projects's demand for resources versus the availability of these resources
- Develop a product innovation and technology strategy to help select the best projects
    - Define goals, arenas for focus deployment of resources an the attack plan for your new project

  -> Improve balance in of projects in your portfolio. Strategy guides the split in resources across project types.
- Integrate portfolio management into your gating process
    - Goals of portfolio management:
        - Value maximization of the portfolio
        - Balance (long/short term, high/low risk, markets, technologies,…)

        - Strategic direction (portfolio reflects business strategy
    - Approaches for integration:
        - The gates dominate:
          Sharpen gate decision making for all projects separetly: go/kill and then prioritization (go/hold) compared with the projects that are active and on hold. Does the project improve the portfolio's strategic alignment and the balance of projects? After all the decisions there's a portfolio review.
        - Portfolio review dominates:
          All projects are considered together for the go/kill at the gate. Spot the 'must do' and 'won't do' projects and rank the ones in the middle. Check for balance and strategic alignment and decide.

11

Intellectual property policies and strategies.

Grandstrand O. (1999)

Advantages and disadvantages of patenting

schema p236

Advantages

The primary motive to apply for a patent is to increase the economic returns of its R&D efforts by ensuring restricted but enforcable monopoly rights (rights to exclude others from the protected technology).
However, ther are a number of other important motives:

External advantages

- Protection:
  - Technology protection: most important reason
  - Retaliatory power and patent arms race:
    As products and processes become linked to several patents, companies become increasingly interdependent on each other's portfolio.
    This puts a price on second order deterrence and general bargaining power.
    Retaliatory power through a broad patent portfolio held by a competitor may weaken the protective advantage of single patents held by an innovator, who in turn will need a broad portfolio for protection.
- Bargaining power:
  - Licensing out
  - Cross-licensing
  - Cooperative R&D:
    Patents good for identifying and attracting R&D partners and negotiating with them.
  - Standard-setting
- Corporate image as being technologically progressive

Internal advantages (less important than external)

- Providing motivation for employees to invent (patents for reward schemes and motivation)
- Providing a measure for R&D productivity

Disadvantages

The importance is ranked significantly lower than the advantages.

- Disclosing of technical information
- Incurring direct costs of patenting

Defensive and offensive advantages

An important motive is to block competitors:

- Offensive:
  Block them from using a technology and increase their costs and time for imitation or inventing around the patent, in order to increase their willingness to pay for a license or to stay away from the market
- Defensive:
  To block competitors from blocking oneself and thereby insure design freedom

The traditional motive for patenting has been to protect significant inventions for one's own business. However, there has been a gradual shift of emphasis towards other more offensive purposes and aggressive action, where patents are used more strategically as both a competitive weapon and an economic asset.

IP policies

A policy is a set of statements to be used as a general guideline for operations in an area. A business policy can express basic business ideas, missions and philosophies for a company as well as being educational.

Both IP policies and IP organizations have evolved so as to become more comprehensive, strategic and integrated with business management and technology management.

In many companies, the demand for policies exceeds the supply from policy-makers. It is then useful to have a 'living policy' in the sense that there is always one set of policy issues pending , awaiting a policy decision, and another set of policies already in place.

Patent strategies

Patent strategies in general

Patent strategies can be defined at the level of individual patents, or at the level of the patent portfolio of the business or company as a whole. Here some portfolio level strategies will be explained:

- Patenting in technology space
  -> A space which is gradually explored by R&D processes
  -> Patent strategies must also take into account the qualities of individual patents as well as the company situation in general
  - Ad hoc blocking and inventing around
    - One or a few patents to protect an innovation in a special application
    - Many possibilities to invent around, low R&D costs and time
  - Strategic patent searching
    - A single patent with large blocking power
  - Blanketing and flooding
    - Blanketing: Turn an are into a jungle or minefield of patents (systematically bomb/patent every step of the process)
    - Flooding: a less structured way of taking out multiple patents, major as well as minor
    - Strategy in emerging technologies when uncertainty is high about R&D directions or economic importance
  - Fencing
    - A series of patents, ordered in some way, block certain lines or directions of R&D (ex patent all variants or conditions of a process)
  - Surrounding
    - Block the use of an important strategic patent by surrounding it with small patents which collectively block the commercial use of the central patent
  - Combination into patent networks
    - Building a portfolio in which patents of various kinds and configurations are consciously used to strengthen overall protection and bargaining power
- Patenting over time
  - Sporadic patenting:
    - A few patents at key steps in the R&D process (ex product patent, application patent and process patent)
  - Continuous or follow-up patenting:

        - A conscious effort is made to build up a rich patent portfolio, and patents are applied for more or less continuously in the R&D process (a number of product patents, application patents and process patents)
        - Typically established firms with high market and patent shares for an established product generation are slow to build up strategic patent positions in a new competing technology, thereby risking the loss of market share in the new product generation
    - R&D investment strategies
        - Patenting strategies are linked to the R&D strategies of competing companies
        - R&D strategies typically shift from emphasising product R&D to process R&D and application developments
        - In technology based business there is a multitude of patent races (several competing products and technologies)
        - Patents can be useful to track down R&D strategies of firms. They can be disguised by patent flooding or decoy patenting

Patent strategies in Japan

- Evolution of strategy
    - Past: in Japan emphasize on the quantity of patents and many patents of minor technical and economic importance. Western patents often more significant.
    - Now: more high quality Japanese patents and relevant strategies in many industrial sectors
- Strategic patents
    - Focus now more on the quality of patents and on obtaining 'strategic patents' (= patents of decisive importance for someone wanting to commercialise a technology in a product area)
    - It is also a common strategy to rely upon the possibility that a license will be obtainable from someone who succeeds in a field and has a strategic patent
    - Licensing policies:
        - Very open in the early 1990's
        - From an open licensing policy to more selective licensing in the mid 1990s
        - Because of technological interdependence between products and companies, clusters of companies have to license fairly open among themselves to avoid retaliation
        - The decision to license out or not is a matter of pricing
        - More en more broad based licence agreements -> stimulates new forms of cooperation and competition (ex systems competition between families of cooperating companies linked to different technical systems)
    - Next to the race for strategic patents, there is a race for surrounding patents, often linked to production processes or to different applications. The strategic patent holder itself is also compelled to search for surrounding patents to protect itself. The second patent race determines the distribution of bargaining power among the competing companies and their prospects for cross-licensing.
- Many Western firms fail to pursue follow-up patenting and to build up patent portfolios. This is because there has been the belief that a single good patent is sufficient to protect a new business.

General response strategies when confronting a blocking or strategic patent

Figure p232

Litigation strategies
Infringement monitoring in a large corporation with a large diversified product and patent portfolio may be difficult. The monitoring costs must not exceed expected benefits from patent enforcement (involving probabilities of deterrence, detection, settlements, damages, license payments…). If this is not the case, patenting may not pay off either.
If infringement occurs, various litigation strategies for legal enforcement of patent rights could be employed.
Before choosing an offensive litigation strategy, one should also assess the risks of rataliation, which in addition to risks of counter-litigation include risks of losing some business.

Secrecy strategies

General secrecy strategies
Part of a company's technology can at least temporarily be protected by secrecy rather than by patents.

General means or secrecy measures:
- Implementation of an internal secrecy policy
  - Control of publishing by researchers and employees
  - Avoidance of patenting
  - Employee loyalty and low inter-firm mobility
  - Fragmentation of proprietary information in the company
    <-> bad for R&D productivity and innovativeness because of little internal communication

Secrecy and prophylaxis as alternatives to patents
Secrecy is only an alternative to patenting when there is a low risk of being blocked by patents of others.
Possible cases:
- One is convinced of having a substantial technological lead
- The competitor's cost and time for overcoming the secrecy barrier are substantial (ex production technologies which leave no traces in the product)
- Infringement monitoring is difficult and of little value
- Possibilities to invent around the patent are numerous and cheap, while costly to block with patents

Prophylactic publishing: technical information is disclosed to prevent competitors from fulfilling the novelty requirement for obtaining patent rights. (seldom used)

Combination: apply for a patent, then withdraw --> keep secrecy until the competitor applies for a patent and you may point to your withdrawn application as evidence for invalidating the competitor's patent

Trademark strategies

Trademarks in general
Trademarks can be perpetuated permanently and thereby accumulates value is managed properly through advertising and so on.
As with any reputation-based value, trademark values are vulnerable to bad publicity and customer dissatisfaction, but they are surprisingly resilient in the long run, once they have gained strength. A special threat to a trademark is so-called dilution. This happens when a trademark becomes so successful that it is incorporated into everyday language and loses the distinctiveness that is required for legal protection.

Trademarks offer economies of scale, scope and speed.

Trademark strategies in Japan

Multiprotection and total IP strategies

The different types of intellectual property (patents, trade marks, trade secrets, copyrights…) are complementary and raise the total asset value when used in combination. Nevertheless patent matters dominate when dealing with IP. But IP should be treated more comprehensively, creating complementarities among different IP elements and thus multiprotection.

Selecting and securing property rights for various elements constituting a business is not enough for multiprotection. The rights have to be enforced and infringers have to be deterred.

12

Disruptive technologies: catching the wave.

Bower, J.L. and Christensen, C.M. (1995)

One of the most consistent patterns in business is the failure of leading companies to stay at the top of their industries when technologies or markets change.

The fundamental reason is that leading companies succumb to one of the most popular and valuable management dogmas: they stay close to their customers. Their investments will be aligned with the needs of their customers and they will not commercialize new technologies that don't initially meet the functional demand of their mainstream customers and appeal only to small or emerging markets.

The technological changes that damage established companies are usually not radically new or difficult from a technological point of view. They do however have important characteristics:

- They typically present a different package of performance attributes (that are not valued by existing customers)
- The performance attributes that existing customers do value improve at such rapid rate that the new technology can later invade those established markets

Only at this point will mainstream customers want the technology. By then the pioneers of the new technology often already dominate the market.

To remain at the top, managers must be able to spot these technologies and protect them from the processes and incentives that are used to serve mainstream customers by creating independent organizations.

Performance trajectories: the rate at which the performance of a product has improved and is expected to improve over time.
Different types of technological innovations affect performance trajectories in different ways.

- Sustaining technologies tend to maintain a rate of improvement. They give customers something more or better in the attributes they already value.
- Disruptive technologies introduce a very different package of attributes from the one mainstream customers historically value and they often perform far worse along one or two dimensions that are particularly important to those customers. The customers are unwilling to use a disruptive product in applications they know and understand. At first then disruptive technologies tend to be used and valued only in new markets or new applications.

Disruptive technologies look financially unattractive to established companies because their potential revenues are small and it is difficult to project how big the markets for the technology will be over the long term. Also established companies often have high costs to serve their sustaining technologies. Therefore managers choose to go upmarket with their sustaining technologies to segments with high profit margins in stead of down market with the new technologies.

Managers of companies that use the new technology have less high cost structures and find the emerging markets appealing. Once the disruptive architectures became established in their new markets, sustaining innovations raised each architecture's performance along steep trajectories until the performance available from each architecture soon satisfied the needs of customers in the established markets. Once they have secured foothold in the emerging markets and improved the performance of their technologies, they go for the established markets above them.

Leading companies could not move the products with the new technology through their organizations and into the market in a timely way. Each time a disruptive technology emerged, between one half and two thirds of the established manufacturers failed to introduce models employing the new architecture or did it very late.
The entrant companies first captured the new markets and then dethroned the leading companies in the mainstream markets.

How to avoid this?
The processes of successful companies have developed to allocate resources among proposed investments are incapable of funneling resources into programs that current customers explicitly don't want and whose profit margins seem unattractive. Because managers are evaluated on their ability to place the right bets, it is not surprising that in a well managed company, managers back projects in which the market seems assured.
However, there is a method to spotting and cultivating disruptive technologies:

- Determine whether the technology is disruptive or sustaining and which technologies can be threats
  - Examine internal disagreements over the development of new products or technologies: marketing and financial management versus technical personnel
- Define the strategic significance of the disruptive technology
  - Don't ask mainstream customers to assess the value of innovative products
  - If knowledgeable technologist believe the new technology might progress faster than the market's demand for performance improvement, then that technology, which does not meet customers' needs today, may very well address them tomorrow
    -> Compare the new technology thus with the market needs, not with the old technology
- Locate the initial market for the disruptive technology
  - Market research is seldom helpful, no concrete market exists
  - Create information about the emergence of new markets by experimenting: who will the customers be, which dimensions of product performance will matter most to which custumors, what will the right price be?
  - Let start-ups conduct the experiments (fund one by the company or follow ones that are not connected). They can agilely change product and market strategies in response to feedback from initial forays into the market.
  - Don't be too late with entering the new market (don't hold the performance of small-market pioneers to the financial standards of your own performance; lower the threshold for size of the new market)
- Place responsibility for building a disruptive-technology business in an independent organization
  - Form small teams into skunk-works projects to isolate them from the stifling demands of the mainstream organization
  - Creating this separate organization is necessary only when the disruptive technology has a lower profit margin that the mainstream business and must serve the unique needs of a new set of customers
- Keep the disruptive organization independent
  - Trying to integrate the spinoff into the mainstream organization can be disastrous. Arguments about resources will arise and fear that they will cannibalize each others products.
  - Eventually they might replace the mainstream business unit

13

The ambidextrous organization.

O'Reilly C. & Tushman M. (2004)

Manager must constantly look backward (attending to the products and processes of the past), while also gazing forward, preparing for the innovation that will define the future. Most successful enterprises are adept at refining their current offerings, but they falter when it comes to pioneering radically new products and services.
Proposed solutions:

- No solution, establisched companies simply lack the flexibility to explore new territory
- Adopt a venture capital model, funding exploratory expeditions but staying out of their way
- Cross functional teams to create breakthrough innovations
- Shift back and forth between different innovation models, focusing on innovation for a period and then moving into exploration mode

Characteristics of organizations who were successful at both exploitation and exploration: Ambidextrous organizations: they separate the new explorative units from the old exploitative ones, allowing for different processes, structures and cultures. At the same time they maintain tight links across units at the senior executive level.

Companies need to maintain a variety of innovation efforts:

- Incremental innovations: small improvements to existing products and operations
- Architectural innovation: apply technological or process advances to fundamentally change some component or element of the business
- Discontinuous innovations: radical advances that profoundly alter the basis for competition in an industry, often rendering old products or ways of working obsolete

Companies tend to structure their breakthrough projects in one of four basic ways:

- Within existing functional designs
- Set up cross functional teams within the established organization but outside the existing management hierarchy
- Set up unsupported teams, independent units outside the established organization and management hierarcy
- Set up ambidextrous organizations, where breakthrough efforts are organized as structurally independent units with each their different processes, structures and culture, but integrated into the existing senior management hierarchy

When it comes to launching breakthrough products, ambidextrous organizations are more succesful than the other structures.

- The structure of ambidextrous organizations allows cross-fertilization (cash, talent, expertise,…) among units while preventing cross-contamination (processes, structures, cultures)

Becoming ambidextrous:

- Ambidextrous organizations need ambidextrous senior teams and managers - executives who have the ability to understand and be sensitive to the needs of very different kinds of businesses.
- A company's senior team must be committed to operating ambidextrously even if its members aren't ambidextrous themselves.
- A clear and compelling vision, relentlessly communicated by a company's senior team, is crucial in building ambidextrous designs.

14

Organising for continuous innovation: on the sustainability of ambidextrous organisations.

Van Looy B., Martens T. & Debackere K. (2006)

Semi- or quasi-structures and ambidextrous organization have been advanced by researchers to handle the complexities of a multiple objectives and requirements when implementing an innovation strategy.
As higher levels of complexity are being introduced, ambidextrous organizations will encounter additional organizational costs.
Under which conditions can they outperform focused firms and thus stay sustainable?

- Extended time frames
- Management practices aimed at cross-fertilization
- The synergetic potential of underlying technologies

Introduction

Innovation is crucial for the long-term survival and growth of the firm.
There are some core dualities that create multiple demands and conflicting requirements:

- Incremental vs radical innovation
- Flexibility vs commitment
- Divergent vs convergent behavior
- Exploitation vs exploration
- Path creation vs path dependence

Ambidextrous organizations imply the simultaneous presence of different activities, coinciding with differences in technology and market maturation.
Firms concentrating on only the most lucrative part of the technology life-cycle will not only experience higher retursn, they will also have less managerial and organizational costs.
Therefore they face the risk of being outperformed by focuses firms (at least on the short term).
Under which conditions can ambidextrous organizations outperform focused firms and thus stay sustainable?

Organising for innovation: setting the stage

One of the root causes of the complex nature of organizing innovation at the firm level constists of the dual and paradoxal requirements between exploitation and exploration.
It is very difficult for an organization to be creative and productive or flexible and committed at one. So when designing and implementing innovation strategies, organizations need to find ways to handle these tensions. This requires designing organizations which are inherently unstable (required for different objectives) but at the same time a clear common vision within which they make sense.

Methodological approach: defining a formal value creation model

Modelling the financial dynamics of different types of firms.
Focus on comparing ambidextrous or diversified firms with firms that focus on only one (the most lucrative) type of activity on the basis of:

- The technology life cycle (affecting the amount of value created in a given time period)
- The resources needed to organize and manage the diversity entailed within ambidextrous organizations (costs and complexities)
- The resources needed to enact the diversity present within ambidextrous organizations (benefits also)

Develop and compare several models; differential emphasis on:
- Resource allocation patterns across the portfolio of products/technologies
- Efforts devoted to constructive gate-keeping activities or coupling
- The characteristics pertaining to herogeneity of the product/technology portfolio present (technolgy distance, concentration)

Value creation reflecting technology life-cycle positions
There are four different stages within the technology life-cycle: seed, growth, mature and decline.
The curves can differ in steepness.
The financial returns created during any given time period are obtained by calculating the integral of the Paul Reed curve for the period under consideration. For diversified firms, the overall value equals the weighted sum of the values obtained by the integral pertaining to the different technological stages.

Resource considerations / costs encountered by diversified firms
A certain proportion of the added value created over time will be taken into account as cost and hence become deduced from the value total obtained by applying the former equation.
- Seed activities are considered as employing more resoures than mature activities
- There is a positive, exponential relationship between distance (as observed at any given time period between different parts of the organization) and the amount of complexity encountered.
- There is a relationship between resource allocation patterns across different parts of the organization and the managerial and organizational costs encountered.

Zie ook figuur 3 p213

Results

Focused vs diversified firms
- As expected, differences in terms of position on the technology life-cycle translate into differences in terms of overall value creation, with the mature stage resulting in the overall best performance.
- A comparison between a focussed firm and a diversified firm combining mature activities with seed activities for the first period finds that the focussed firm has more value creation.
- Doing this comparison over longer time periods: only when the curve of the diversified firm is steep enough (the new technology grows fast enough), will it outperform the focused mature firms which evolve towards maturity and then decline.
- When taking into account the additional costs, the curve has to be even steeper to outperform the focused firm.

Introducing resource reallocation dynamics
It can be argued that a diversified firm might benefit from more than merely the 'technology portfolio' effect:
- The presence of multiple activities allows for reallocation of resources between such activities
- Such firms could actively strive for synergies that start to impact the value curve itself

Outcome: the difference between focused and diversified firms becomes more outspoken and in favour of diversified firms.
Two conditions for a diversified firm to outperform focused firms:

- The rate of decline of a certain technological regime affects the extent to which diversified firms benefit from the presence of a portfolio of activities
- More important: the extent to which resources can be reallocated across different parts of the portfolio affects the value differentials observed. (There is synergetic potential.)

Diversified enacting firms

Model the effect of actively pursuing synergies between the different activities present within diversified firms on financial returns.

Pursuing synergies might result in a superior performance in the extent that diversified are able to

- Grow faster during seed/growth phases
- (and/or) Enlarge the total market size by combining different activities

This gives a better chance at outperforming focused firms, especially in the longer term.

Conclusions

Ambidextrous firms can indeed take on sustainable forms (resulting in overall value creation equal or superior to focused mature firms).
Different elements play a role to accomplish this:

- Longer time frames: when mature activities decline, growth of emerging activities can compensate for this
- Being able to shift resources across different parts of the portfolio (from declining parts to growing parts)
  -> this implies relatedness or synergy on the level of technology
- Actively pursuing or enacting synergies which might affect the inclination (market growth rates) and the upper limit (market size) of the value curve
  - Combining two activities might result in the development of new products and/or market applications
    -> When ambidextrous firms are able to influence the size of the market in this way, sustainability almost becomes a non-issue
  - Management practices have to direct towards enacting synergies. This seems only feasible to the extent underlying technologies and resources do have synergetic potential

15

Unraveling the process of creative destruction: complementary assets and incumbent survival in the typesetter industry.

Tripsas M. (1999)

When radical technological change transforms an industry, established firms sometimes fail drastically and are displaced by new entrants, yet other times survive and proper.
This paper argues that the ultimate commercial performance of incumbents vs new entrants is driven by the balance and interaction of three factors: investment, technical capabilities and appropriability through specialized complementary assets.

There are two contrasting perspectives on the process of creative destruction:

- Tradition of Schumpeter's early work: relatively fluid industries where new entrants innovate with technologically superior products and displace incumbent firms, only to have this cycle repeated
- Build on Schumpeter's later work: focus on the advantages that established firms have over new entrants
    - Ex when incumbents possess critical specialized complementary, new entrants unable to contract for those assets may be at a disadvantage, despite their technological superiority
    - Advantages that accompany the scale and scope of large firms

This paper finds 3 crucial factors that together influence the ultimate commercial performance of incumbents and new entrants:

- Investments in developing the new technology
    - Arrow:
      When innovation is radical (replaces the old technology due to lower price), incumbents have less incentives to invest in the new technology than new entrants.
      Christensen:
      They also fail to invest in developing the new technology because their resource allocation mechanism is guided by the needs of existing customers, while the new technology targets emerging markets.
    - Arrow:
      When innovation is incremental (competes with the old technolg, incumbents have greater incentives to invest than new entrants.
- Technical capabilities:
    - Technical progress: passing through long periods of incremental innovation punctuated by periods of radical change.
    - Different stages of the technology life cycle have major implications for the technical capabilities of incumbents and new entrants. During an incremental period, established firms have an advantage. When faced with a radical shift however, their core competenties are often too rigid, making it difficult to adapt.
      Other work shows that is possible for incumbents to have the resources and ability to develop new capabilities.
- The ability to appropriate the benefits of technological innovation through specialized complementary assets:
    - The extent to which a technological disadvantage of incumbents translates into a commercial disadvantage may depend upon the other assets possessed by the established firms, such as specialized manufacturing

capability, access to distribution channels, service networks and complementary technologies.

- Teece distinguishes between 3 sorts of complementary assets
  - Generic: multiple applications, can be easily contracted for
  - Specialized and cospecialised: useful only in the context of a given innovation
- These complementary assets can provide incumbents a buffer, but technological innovation may also destroy the value of these assets. It is also possible that new entrants can possess relevant complementary assets themselves.

Study typesetter industry

While a lack of investment is sometimes responsible for incumbent failure (Christensen), other times incumbents invest substantial amounts in new technologies.(Here because each new generation was incremental in the economic sense and sustaining in that it met the needs of existing customers.
Despite temly investments, analysis confirmed that established firms were handicapped by their prior experience in that their approach to new product development was shaped by that experience. The initial products by established firms were consistently technologically inferior to those of new entrants. The need for new technical skills and new architectural knowledge proved difficult for incumbents to manage.
When incumbent firms possessed specialized complementary assets that retained their value despite the technological shift, these assets were found to buffer incumbents from the effects of competence destruction. Incumbents only suffered in the market when both competence was destroyed and the value of specialized complementary assets was diminished.

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Organising innovation within incumbent firms: structure enabling strategic autonomy.

Van Looy B. & Visscher K.J. (2011)

How can large established firms be effective in organizing innovation alongside their current business?
The effectiveness of a hybrid firm organizational structure, characterized by semi-permeability, which allows the simultaneous presence of entrepreneurial autonomy and the enactment of technological complementarities. Adopting such a structure seems especially relevant in high-velocity environments where technical configurations combine new components and functionality with existing technological infrastructures.

Introduction

The question how to organize innovative activities alongside current business activities is challenging, as it confronts organizations with multiple, often contradictory demands, stemming from the need for experimentation and flexibility on the one hand and focus and commitment on the other hand.
Two different approaches to arrive at a reconciliation:

- Relatedness and/or complementarities are crucial to reconcile both activities effectively
- The choice of appropriate organizational design arrangements in which both types of activities become embedded

-> Argue in this paper that both perspectives are complementary.
Use a case study (Alcatel) to reveal the effectiveness of a hybrid organizational structure, characterized by semi-permeability. Also will the decisive role of autonomous strategic (intrapreneurial) processes within the incumbent firm be acknowledged.

Theoretical background

To be effective and sustainable over longer time periods, firms need to divide attention and resources between explorative and exploitative activities.

- Exploitation: the leverage of existing capabilities by means of activities such as standardization, scaling and refinement.
- Exploration: the creation of new capabilities by engaging in fundamental research, experimentation and search activities.

Organizing both activities effectively is not straightforward because of complexities that stem from the multitude of objectives such as strategy comprises.

Scope: the importance of a diversified knowledge base an the presence of related and complementary capabilities for combining exploitation and exploration

Resource based view for theorizing on the nature of a firm's technological capabilities:

- Firms can achieve a competitive advantage by building up portfolios of valuable (technology) assets
- In rapidly changing and unpredictable environments, a competitive advantage is only sustainable to the extent that firms continuously renew themselves by creating new assets and capabilities, including technological skills.

  - Exploring such new technical capabilities is affected in a positive way by the level of technology diversification (potential to cross-fertilize)
  - The presence of a diversified set of capabilities does not limit itself to technological capabilities. The presence of specialized complementary assets, which are necessary to produce and commercialize a new technology, can play a crucial role as well.
- A technology portfolios may have synergetic potential by which diversified firms can outperform focused firms when technology or knowledge relatedness allows enacting synergies. These synergies are dependent on the knowledge coherence of the technology portfolio.

Incorporating different objectives into organizational design

Organizational design choices are important in order to effectively organize innovation within one and the same firm.
It is important to differentiate between exploration and exploitation. Exploration benefits from heterogeneity, while exploitation benefits from homogeneity.

- Therefore authors like Christensen conclude that management practices that are most productive for exploiting existing technologies are counterproductive for exploring radically new technologies. Therefore the latter activities should be organized in separate entrepreneurial units, so called ventures or spin outs.
- For Tushman and O'Reilly, both activities can be situated within one ambidextrous organization which combines operational separation (different processes, structures and cultures) with integration capabilities at more senior levels.
- Other scholars argue in favor for more explicitly integrating both activities in order for positive spillovers or synergies to occur.
- Gibson and Birkenshaw argue that within a single business unit, a behioural context can be created that fosters both current and innovative activites and enables people to divide their time between exploration and exploitation.

This paper analyses the effectiveness of innovation strategies while considering simultaneously the presence of related or complentary capabilities and organizational design choices.

Research design

The innovation journey that lead to the successful development and deployment of the ADSL architecture within a large multinational telecommunication firm (Alcatel) was analysed.

The development of ADSL at Alcatel

Exploration of ADSL

Confronted with competing technological options (coax, fiber and adsl) Alcatel decided to maintain a broad technological portfolio and formed a broadband research program to explore these technologies.

Opportunities for exploitation

The foreseen killer application for broadband access technologies was video on demand (VOD). However, the expectations for VOD collapsed.
At that time the internet gained attention as a potential new application. (Implementing optical fiber would be too costly and time-consuming, while the copper netwerk was already in place).

Virtual company

To further develop ADSL technology for internet usage, Alcatel set up a semi-autonomous unit, which they named a virtual company.

Winning the JPC contract

Next to technological choices, several organizational factors played a role in enabling the development of a compliant end-to-end adsl solution in a short period of time:

- The combination of bottom-up entrepreneurial action and top-down support
- The virtual company structure proved to be an effective design to facilitate and make use of intrapreneurial dynamics and top management support -> flexibility and fast decision making, but also corporate resources

Discussion and conclusion

- Phase 1: Research of different technology in a portfolio approach to allow for spillovers and synergies
- Phase 2: Market development efforts organized in an semi-independent structure; a relatively autonomous team but with corporate resources available
  -> ensured sufficient levels of entrepreneurial dynamics and enabled the acceleration of the commercialization process

These findings highlight the interplay between organizational design choices and the presence and relevancy of complementary resouces.
Neither complete separation, nor an ambidextrous organizational design would account for the observed dynamics. Here the effectiveness of a hybrid structure characterized by semi-permeability is revealed (simultaneous presence of entrepreneurial autonomy and the enactment of complementarities).

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The era of open innovation.

Chesbrough H. (2003)

In the past, internal R&D was a valuable strategic asset, even a formidable barrier to entry by competitors in many markets. These days however, the leading industrial enterprises of the past have been encountering remarkably strong competition from many startups. These newcomers conduct little or no basic research of their own but use open innovation to acquire needed technologies from the outside.

From closed to open

Internal R&D is no longer the strategic asset it once was. There has been a fundamental shift in how companies generate new ideas and bring them to market.

In the old model of closed innovation, firms beliefed that successful innovation requires control. Thus companies must generate their own ideas and develop, manufacture, market, distribute and service the products themselves. In this way they were able to get to market first and reap the most profit, which they protected by aggressively controlling their intellectual property.

Toward the end of the 20th a number of factors combined to erode the underpinnings of closed innovation in the united states:

- The rise in the number and mobility of knowledge workers, making it increasingly difficult for companies to control their proprietary ideas and expertise
- The growing availability of private venture capital, which has helped to finance new firms and their efforts to commercialize ideas that have spilled outside the silos of corporate research labs

In the new model of open innovation, firms commercialize external and internal ideas by deploying outside as well as in-house pathways to the market. The boundary between firm and its surrounding environment is more porous:

- Companies can commercialize internal ideas through outside channels
    - Some vehicles for accomplishing this include startup companies and licensing agreement
- Ideas can be originated outside the firm's labs and be brought inside for commercialization

A big difference between open and closed innovation is that when separating good from bad ideas and projects, both can weed out 'false positives', but open innovation also incorporates the ability to rescue 'false negatives'.

How prevalent is open innovation?

Different businesses can be located on a continuum, from essentially closed to completely open.

The different modes of innovation

Funding innovation:

- Innovation investors: the corporate R&D budget, VC's, angel investors, private equity investors,…
- Innovation benefactors: they provide new sources of research funding. Unlike investors, benefactors focus on the early stages of research discovery.

Generating innovation:

- Innovation explorers: specialize in performing the discovery research function that previously took place primarily within corporate R&D laboratories
- Innovation merchants: must also explore, but their activities are focussed on a narrow set of technologies that are then codified into intellectual property and aggresively sold to others. (-> Research with more specific commercial goals than explorers)
- Innovation architects: provide a valuable service in complicated technology worlds. They develop architectures that partition this complexity, enabling numerous other companies to provide pieces of the system, all while ensuring that those parts fit together in a coherent way.
- Innovation missionaries: consist of people and organizations that create and advance technologies to serve a cause (ex open source software)

Commercializing innovation:

- Innovation marketers: their difining attribute is their keen ability to profitably market ideas, both their own as well as others
- Innovation one-stop centers: provide comprehensive products and services. They take the best ideas and deliver those offerings to their customers at competitive prices. They typically form unshakable connections to end users.

Some companies do all three of these modes of innovation.
Some 'fully integrated innovators' continue to do everything themselves under the credo 'innovation through total control'.
There won't be one best way to innovate, although some modes will face greater challenges than other.

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Toward an integrative perspective on alliance governance: connecting contract design, trust dynamics and contract application

Faems D., Janssens M., Madhook A., Van Looy B. (2008)

This paper brings an integrative perspective on alliance governance, providing insights into the interactions between structural and relational aspects, both within and between transactions.
In particular it is shown

- How contracts with a similar degree but different nature of formalization (narrow versus broad) trigger different kinds of trust dynamics at both operational and managerial levels
- How trust dynamics and contract application (rigid vs flexible) coevolve over time
- How relational dynamics in previous transactions influence the design of contracts in subsequent transactions

Although alliances are popular, their failure rates are high. Two different perspectives have yielded insights into effective and efficient governance:

- Focus on the structural design of single transactions and emphasize the importance of contracts as a coordination mechanism and as a safeguarding mechanism against the perceived risk of opportunistic behaviour
- Focus on relational processes within ongoing interfirm relationships and emphasize the importance of trust for safeguarding and coordinating alliances

How are the design and application of structural elements related to relational processes such as trust dynamics?

Theoretical background

Structural and relational perspectives on alliance governance

- Structural perspective: rests on the assumption that alliance partners tend to act opportunistically
- Relational perspective: focus on interfirm relationships as they evolve over time and transactions. Contains the assumption that alliance partners tend to behave in a trustworthy manner, especially when a history of successful collaboration is present. (Competence trust (ability) + goodwill trust (intenstions))

Both perspectives think their governance is most important in explaining alliance performance.

Connecting structural and relational perspectives

A study has indicated that these two aspects are related to each other in governing alliances.
-> Relational processes mediate between initial structural conditions and alliance outcomes.

Empirical research has lead to rather ambiguous results. These incosistent findings might be due to 3 issues:

- Focus on the degree of contractual formalization instead of the nature (content of the contractual clauses)

- Focus on the initial design of contracts, while ignoring how such structural elements are applied durng the alliences
- Focus on relational processes at the managerial level, while ignoring this at the operational level

Research questions:

- How does the content of contracts influence trust dynamics at both operational and managerial levels in alliances?
- How does the application of contracts coevolve with trust dynamics at both operational and managerial levels in alliances?

Methodology

The side shooter head and end shooter head alliances

Zie boek en slides voor het verhaaltje

Multilevel process models

For every alliance transaction a multilevel process model is developed, separating out governance, operational and managerial levels.

Contract content and its impact on trust dynamics

Two different kinds of contractual interface structures (monitoring, tast division, information flow):

- Narrow contractual interface structure:
  - Mutually exclusive task division
  - Absence of obligations to exchange information
  - Performance oriented monitoring mechanisms
- Broad contractual interface structure:
  - Overlapping task division
  - Obligations to exchange information
  - Both performance oriented and behavior oriented monitoring

Impact of contractual interface structures on operational joint sensemaking (joint problem definition and solving):
Broad contractual interface structure influences the quality and amount of joint sensemaking on unanticipated technological problems between engineers.

Impact of operational joint sensemaking on managerial trust dynamics:
The quality of joint sensemaking at the operational level influences goodwill trust dynamics at the managerial level.

To sum up: In an exploratory R&D alliance, a broad (narrow) contractual interface structure facilitates (hampers) joint sense making on unanticipated technological problems at the operational level, which in turn positively (negatively) influences goodwill trust dynamics at the managerial level.

Coevolution of contract application and trust dynamics

Impact of trust dynamics on mode of contract application:
In an exploratory R&D alliance, positive (negative) goodwill trust dynamics at the managerial level increase the probability of flexible (rigid) contract application.
However, it was not found that positive goodwill trust dynamics reduced the importance of contracts as governance mechanisms. It changed only the application of the contract.

Application of contracts can trigger both negative reinforcing cycles and positive reinforcing cycles, depending on how contracts are applied.
In an exploratory R&D alliance, a rigid (flexible) application of the contract is likely to trigger negative (positive) trust dynamics at both the operational and managerial levels, which in turn leads to increasing rigidity (flexibility) regarding contract application.

Toward an integrative perspective on alliance governance

Connections between structural design and relational dynamics within transactions

A process oriented view of the contract-trust relationship:

- Contracts with a similar degree of contractual formalization can trigger both positive and negative trust dynamics, depending on the extent to which the nature of contractual formalisation reflects the nature of the alliance activities.
- The relational processes at the operational level are important intermediary processes between contract design at the governance level and goodwill trust dynamics at the managerial level.

An alternative perspective on the role of goodwill trust in governing alliance transactions:

- Goodwill trust is not an alternative government mechanism for contracts but a condition that determines how contracts are applied as governance mechanisms

Connections between relational dynamics and structural design between transactions

How does the relational history in previous alliance transactions influences the structural design in subsequent transactions between the same pair of firms?
Because of learning experiences in previous transactions, a collaborating partner may feel the need to change the nature of the contractual interface structures in subsequent transactions. However, in the case of asymmetric learning experiences, a partner will primarily be able to effect such a shift if it has the necessary bargaining power to do so.

The emergence of positive goodwill trust dynamics in previous transactions induces partners to continue and even expand their relationship through negotiating new transactions.
Findings suggest that mutual interdependence and competence trust might be more important conditions for the continuation of interfirm relationships over multiple transactions than goodwill trust.

Conclusion

P1074
NB: findings are for exploratory R&D alliances. In some other collaborative settings, narrow interface structures can be better.

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Lead users: an important source of novel products concepts.

Von Hippel, E. (1986)

Accurate marketing research depends on accurate user judgments regarding their needs. However for very novel products or for product categories characterised by rapid change most potential users will not have the real-world experience needed to problem solve and provide accurate data to inquiring market researchers. The solution is marketing research which focusses on the lead users of a product or process. Lead users are users whose present strong needs will become general in a marketplace months or years in the future.

Marketing research constrained by user experience

Users selected to provide input data to market analyses have an important limitation: their insights into new product (and process and service) needs and potential solutions are constrained by their own real-world experience. This interferes with an individual's ability to conceive novel attributes and uses.

Lead user's experience is needed for marketing research in fast-moving fields

In many product categories, the constraint of users to the familiar does not lessen the ability of marketing research to evaluate needs for new products by analysing typical users (new is reasonably familiar).

In high technology industries however, the world moves so rapidly that the related real-world experience of ordinary users is often rendered obsolete by the time a product is developed or during the time of its projected commercial lifetime.
For such industries lead users (who do have real-life experience with novel product concepts of interest) are essential to accurate marketing research.

- Lead users face needs that will be general in a market place months or years before the bulk of that marketplace encounters them
- Lead users are positioned to benefit significantly by obtaining a solution to those needs

Users able to obtain the highest net benefit form the solution to a given new product need, will be the ones who have devoted the most resources to understanding it. It follows that this subset of users should have the richest real-world understanding of the need to share with inquiring market researchers.

Utilizing lead users in market research

4 step process to incorporate lead users into marketing research:

- Identify an important market or technical trend
  - Identify the underlying trend on which lead users have a leading position
  - For industrial goods, the needed data on important trends are clear to those with expertise. For consumer goods trend identification is often more difficult
- Identity lead users who lead that trend in terms of experience and intensity of need

- Identifying users at the leading edge of a given trend is usually straightforward in the case of industrial goods because a given firm's position on a range of trends is usually well known to industry experts
  - The second step is identifying the subset of those users that are positioned at the forefront of the trend and who are also able to obtain relatively high net benefit from adopting a solution to trend-related needs. This is done by measuring the net benefit in economic terms.
  - A additional method involves identifying those users who are actively innovating to solve problems at present at the leading edge of a trend.
  - In the case of consumer goods, lead users can be identified by appropriately designed surveys.
  - Complexities when identifying lead users:
    - Key lead users should not necessarily be sought within the usual customer base
    - Do not restrict to identifying lead users who can illumine the entire novel product, process or service which one wishes to develop. You may also seek out those who are lead users with respect to only a few of its attributes
    - Users driven by expectations of high net benefit to develop a solution to a need might well have solved their problem and no longer feel that need
- Analyze lead user need data
  - Incorporate the data in market research analyses using standard methods
  - Find more user-developed product solutions and more substantive need statements in lead user data than he is used to finding in analyses. Ex product development and need statements by the users themselves.
- Project lead user data onto the general market of interest
  - Lead user needs are typically not precisely the same as the needs of the users who will make up a major share of tomorrow's predicted market. Analysts will need to assess how lead user data apply to the more typical user in a target market.
  - Not a serious problem for industrial goods
  - For consumer goods this is not so simple. One approach involves prototyping for a sample of typical users.

Part 3: Operational issues in innovation management

This part discusses the management of day to day operations in innovation environments.

- Organizing innovation activities and projects
- Critical success factors in managing innovation projects
- The concept of project performance in innovative settings
- Techniques and approaches to support project management in innovative environments
- The management of innovative teams and professionals

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Product development: past research, present findings and future directions

Brown, S.L. & Eisenhardt, K. M. (1995)

Streams of literature about product development:

- Product development as rational plan:
  - Focus on a very broad range of determinants of financial performance of the product
  - Exploratory and atheoretical
- As communication web
  - Concerns the narrow effects of communication on project performance
  - Information processing and resource depence theoretical aspects
- As disciplined problem solving
  - The effects of the development team, suppliers and leaders on the product development process
  - Problem-solving strategies from inductive and deductive research

A model of factors affecting the success of product development:

- The distinction between process performance and product effectiveness
- The importance of agents (team members, leaders, management, customers, suppliers,…)

Product development is among the essential processes for success, survival and renewal of organizations, particularly for firms in either fast-paced or competitive markets.

Literature review

Product development as a rational plan

Successful product development is the result of

- Careful planning of a superior product for an attractive market
- The execution of that plan by a competent and well-coordinated cross-functional team
- With the support of senior management

Research: Which independent variables are correlated with the financial success of a product development projects?

- The importance of market issues over purely technical ones for successful product development
- Team composition: cross-functional
- Team organization of work: planning
- Team process: cross-functional communication
- Senior management: support
- Product effectiveness:
  - Fit with market needs (unique benefits, quality, cost, clear concept)
  - Fit with firm competencies
- Market: large, high growth, low competition
- Customer: involvement
- Supplier: involvement

With this research we don't know yet what defines a 'good product' or how you effectively develop a well-executed process etc.

Product development as communication web

Communication among project team members and with outsiders stimulates the performance of development teams.

- Team composition: have gatekeepers (high performing individuals that communicate often internally and externally) and a cross functional team
- Team internal communication (don't let different functions work sequentially but together)
  - High
  - Experiential
  - Iterative
  - Nonroutine
- Team external communication (customer, supplier, other personnel in the organization): not the frequency but the strategy is most important
  - High
  - Ambassadorial: lobbying for support and resources, and buffering from outside pressure
  - Task coordination: increase the amount and variety of information
- Project leader: power to ensure resources

Product development as disciplined problem solving

Successful product development is here seen as a balancing act between relatively autonomous problem solving by the project team and the discipline of a heavyweight leader, strong top management and an overarching product vision. The result is a fast productive development process and a high quality product concept.
(More focus on the development process and product concept than on the financial success of the product <-> rational plan stream)

- Suppliers: involvement
- Team composition: cross-functional
- Project leader: power and vision
- Team organization of work:
  - Autonomy
  - Planning and overlapping (stable products in mature settings) vs iteration, testing and frequent milestones (less predictable products in unsure settings)
- Team process: internal communication
- Senior management: subtle control (giving a clear vision of objectives to the team but also giving them freedom to work autonomously within that vision)
- Product integrity: being consistent with the corporate image

Toward an integrative model of product development

The three streams focus on both overlapping and complementary sets of constructs.
The rational plan perspective contributes a sweeping view of product development, including team, senior management, market and product characteristics to predict financial succes.
The problem solving perspective has a more deeply focused view on the actual development proces and an effective product concept.
The communication web perspective is even more narrow and centers on the internal and external communication by project members.

Model overview

Schema p346

- Process performance is affected by the project team, leader, senior management and suppliers
- Product effectiveness is affected by the project leader, customers and senior management
- Financial succes is affected by the combination of an efficient process, effective product and munificent markets

Project team

- Cross functional teams
- Gatekeepers
- Team tenure:
    - Short history working together -> lack of information sharing
    - Long tenure -> inward focus, neglect external communication
    - Moderate level is preferable
- Group process and communication (internal and external)
- Problem-solving strategy: Planning and overlapping (stable products in mature settings) vs iteration, testing and frequent milestones (less predictable products in unsure settings)

Project leader

- Bridge between project team and senior management
- Power to get the needed resources and command respect
- Vision: create an effective product concept from firm competencies, strategies and needs of the market
- Management skills

Senior management

- Support
- Subtle control

Suppliers and customers

- Involvement

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Communication networks in R&D laboratories

Allen T. (1971)

A large number of studies show that increased use of organizational colleagues (internal consultation within own technical field and in other fields) for information is strongly related to scientific and technological performance.
However project members more often obtain information from outside the firm than from their own technical staff, which leads to a lesser performance (because they cannot communicate effectively with outsiders). This might be because there is a high cost associated with internal consultation (ex. having to admit to a collegue that you need help).

How does information enter the organization?

- Of all possible information sources, only the organizational colleague satisfactorily meets the needs of R&D project members.
- Organizations most effectively import information from outside through an indirect process:
  There are a small number of key people upon whom others rely for information: 'technological gatekeepers'. They read far more professional literature than the average technologist and remain broader relationships with technologists outside the organization.
- Interconnectedness of a communication network shows that gatekeepers also maintain close communication among themselves, thus increasing substantially their effectiveness in coupling the organization to the outside world. (They bring in new outside information and then spread it to other gatekeepers who then further spread it to members of the organization.)

Besides the organization's formal structure, there are two other factors that can be used to promote communication.

- Informal friendshiptype relations within the organization: people are more willing to ask questions
  -> Try to increase the number of acquaintanceships, for example by increasing interdepartmental projects or transfers within the organization
- The physical configuration of the facilities in which the organization is placed: the probability of communication decays with the distance separating people (and this is extremely sensitive)

Trade-off in locating project members:

- Effective coordination of project activity requires the team to be located together
- For the specialists to maintain abreast of developments in their technical fields, they have to be kept in contact with their specialist collegues

-> For long-term projects, technical personnel should remain in the same location with their specialist collegues.
-> For short-term projects, the balance swings in favour of locating all project members together

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Organizing for product development.

Allen T. (2001)

There are many ways of organizing: project team organization, matrix organization, skunk works,...
Most organizations are structured by grouping people by task, specialty or geography.

There are 4 parameters that determine appropriate organizational structure for a research, development or engineering organization:

- Rate of change of knowledge
- Subsystem interdependence
- Project duration
- Rate of market change

A simple model of the innovation process

Innovation can be depicted as a process that mediates between two streams of activity: the development of technology and developing a set of market needs.

Departmental or functional organization

Organizations can be structured to function well with either of the two streams. The difficulty occurs when we try to structure to serve both simultaneously.

- Historically, product development organizations first alligned themselves with the structure of the technology. Departmental organization enables people who share the same area of specialized knowledge to more readily communicate with each other and to keep each other informed of new developments.
- But, to organize a firm in departments around specialized areas of knowledge implies difficulties in relating effectively to the market. Market needs are defined in the form of products and services, which do not necessarily allign with technological specialties or disciplines.
- Firms need cross-disciplinary work to develop products. Combining or integrating knowledge from different specialties to develop a new product, requires coordination among the specialists.They must keep one another informed of what they are doing, which is very difficult in a departmental structure.

Project organization

Project organization offers the solution to the coordination problem. Specialists are temporarily removed from their deparments and grouped together in a team under a common boss.
The coordination problem is more effectively revolved but the price for this to pay comes in the form of the separation of the specialists from their knowledge base, by which they are likely to lose sight of new developments within their field of specialization. Too heavy use of a project team organization will lead to the gradual erosion of the organization's technology base.

Matrix organization

In this form of organization, project teams and departments are supposed to interact in a way that accomplishes the necessary coordination while maintaining current knowledge in the relevant technologies.
In practice it seldom works out quite so neatly. There is often a high degree of contention between project teams and departments, particularly between project managers and department heads.

Who should be assigned to a project team and who to a department?

- Large projects: projects coordinators or integrators assist the project manager. They are assigned to a project team and responsible for system level analyses and subsystem integration.
- Specialists: tradeoff between connecting the staff to their knowledge base and improving the coordination of the projectsteam
    - The need for current knowledge is most important in rapidly changing technologies: knowledge is generated at a rapid rate, old knowledge becomes quickly outdated and their is a need to keep up
    - The need for coordination is most important for complex projects with many interdependencies: developments with many interdependent subsystems, tasks or problems that must be solved

The organizational structure space

The two parameters that influence the choice for an organizational structure (rate of change of knowledge and subsystem interdependence) can be assumed to be orthogonal.
Most organizations have a mix of product developments: some will employ primarily mature stable technologies and others dynamic technologies. Some will involove a set of highly interdependent activities and other will comprise activites that are separate and relatively independent.
For projects with high interdepency in stable markets and projects with low interdepency in dynamic technologies, the choice is clear: a projectteam for the first kind and a departmental structure with lines of direction cutting across it (weak matrix) for the second.

So how to organize less extreme cases? This requires a combination of organization structures. But then how to decide who joins the project team and who the departments?

Project duration

A boundary line divides the space into 2 regions to assign individuals to a project team or to a department depending on whether the need for current knowledge or the need for coordination is more important (zie fig p 16).
The position of this boundary line is determined by the time to market or project duration. The longer the project, the larger the region in which departmental organization produces higher performance and the greater the number of people who should be retained in their departments.

Measuring the parameters

Denk nie da da relevant is?
"lack of precise measurements etc"

Normal industrial practice

The normal industrial practice ignores the rate at which technologies are developing and takes only scant notice of project interdependencies. It is based only entirely on project duration and they do it WRONG. For short-term development people are left in their departments and for long term they form a project team. This fails to take into account the relation between project duration and the loss of specialized knowledge.

High interdependence and rapid technology change

There is no clear way to classify these types of projects on the basis of project duration.
Two ways to deal with this situation:

- Repartition the basic problem to reduce interdependencies
- Cycle staff between project team and departments for short periods of time

The market

Customers' needs change in many different ways and at different rates.
The project form of organization is better able to cope with a rapidly changing market. It provides a single well-defined interface with the market.
This introduces a fourth dimension to the model and makes it more complicated. Market change is often the result of technological advance and market dynamics can affect project duration (can cause efforts to accelerate projects). Despite this, the relationships are again presented orthogonal.

For high rates of both technological change and market change, the project team should comprise system integrators and technically knowledgeable people who can translate market needs into the language of the disciplines. Therefore, both the project team and the departmental organization should be staffed simultaneously.

Figuur p21

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Informal leadership roles in the innovation process

Roberts, E.B. and Fusfeld, A.R.

This article examens the main elements of the technology based innovation process in terms of certain informal but critical people functions that can be the key to an effective organizational base for innovation.

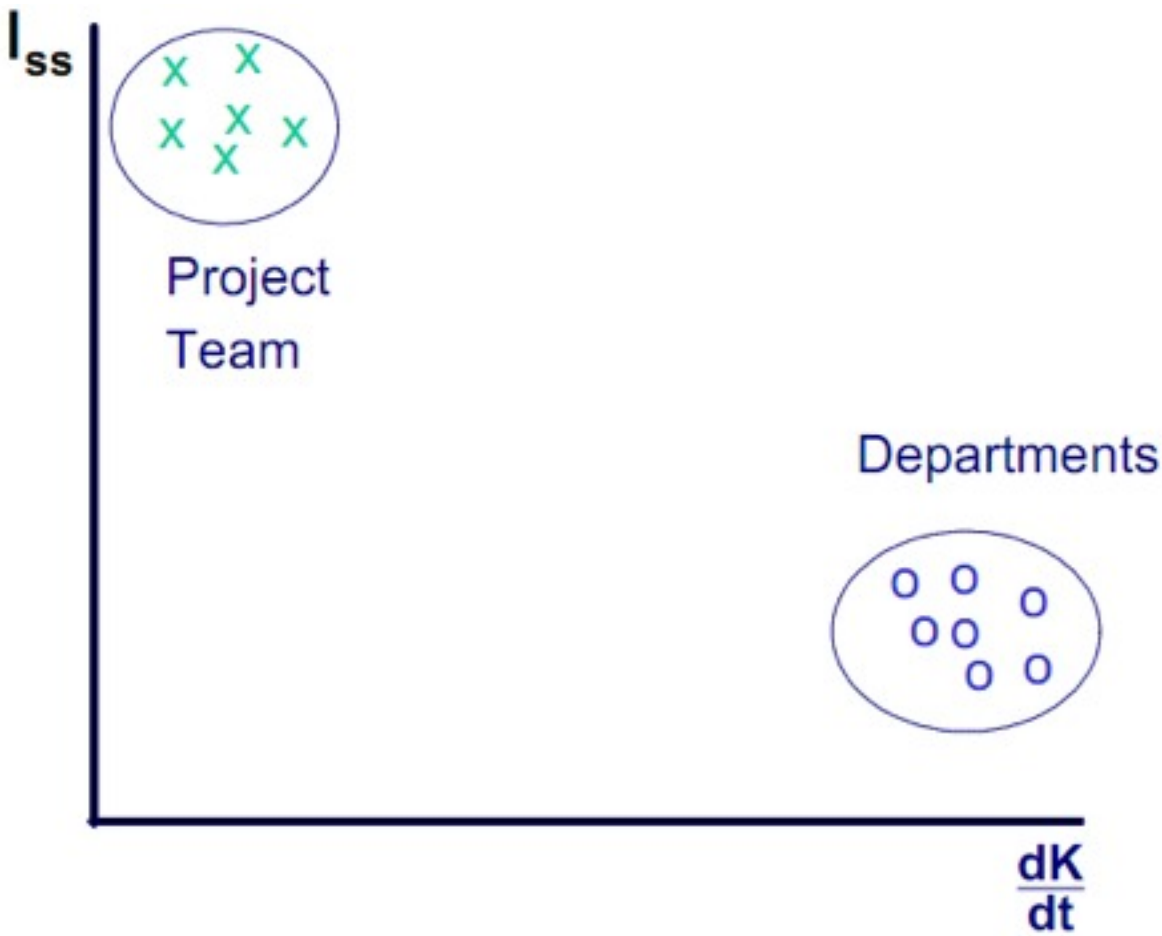
Routine tasks in most organizations are arranged to facilitate work standardization, with expectations that efficient production will result.
For organizing innovation tasks, there is no such comparable theory. Many corporations attempts to innovate consequently suffer from ineffective management and inadequately staffed organizations.
Research teaches us more about the activities that are requisite to innovation as well as the characteristics of the people who perform these activities.

5 basic critical roles that are needed for effective execution of an innovative effort:

The innovation process

The major steps involved in the technology based process form a typical R&D life cycle. These activities do not necessarily follow each other in a linear fashion. They often overlap and frequently recycle. But each stage does require a different mix of people, skills and behaviors to be carried out effectively.

- Pre-project
- Project possibilities
- Project initiation
- Project execution
- Project outcome evaluation
- Project transfer



Needed roles

Repeated direct inputs of five different work roles are critical to innovation.

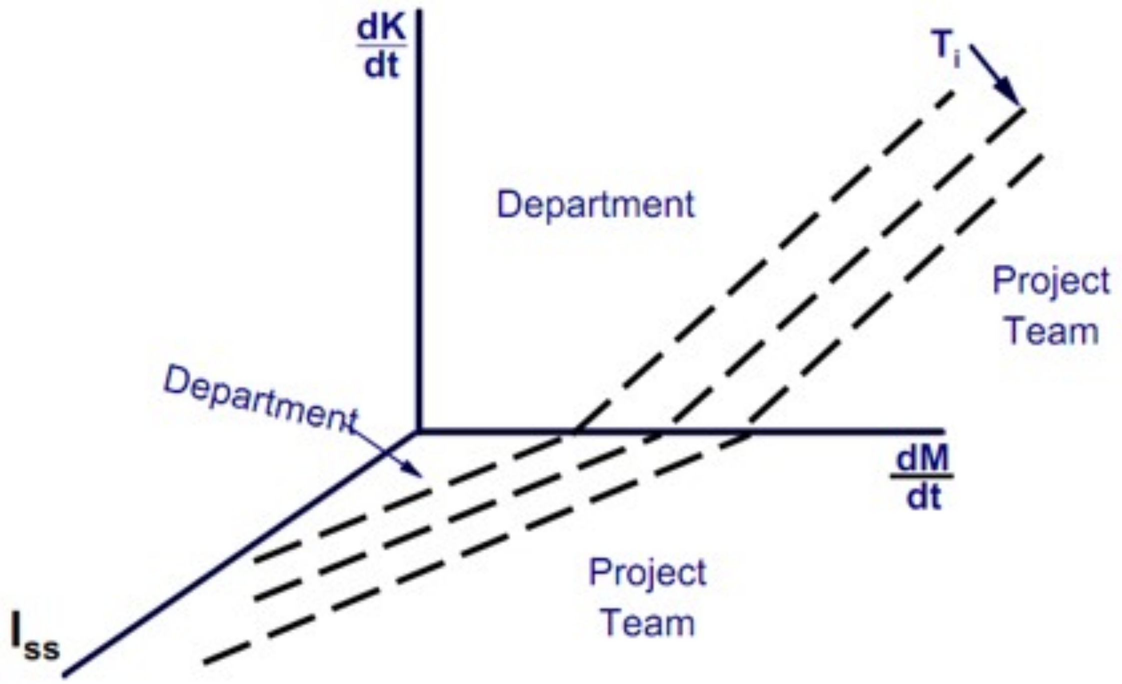
- Idea generating
- Entrepreneuring or championing
- Project leading
- Gatekeeping
- Sponsoring or coaching

Some roles frequently need to be fulfilled by more than one person in a project team in order for the project to be succesful. Some individuals may fulfill more than one of the critical functions. The roles that people play periodically change over a person's career with an organization. This doesn't only reflect personal growth and development but also the individual responses to differing organizational needs, constraints and incentives.

These roles are critical because:

- Each role is different or unique, demanding different skills. A deficiency contributes to serious problems in the innovation effort;
- Each role is carried out by relatively few individuals. If any one critical function filler leaves, finding a replacement is very difficult.

It is desirable for every organization to have a balanced set of abilities for carrying out these roles as needed, but unfortunately few organizations do.



Managing the critical functions for enhanced innovation

To increase organizational innovation, a number of steps can be taken that will facilitate implementation of a balance among the critical functions.

- Manpower planning: apply the critical functions concept to recruiting, job assignment and development or training activities.
- Performance measures and rewards: it is important to recognize the distinct contributions of each of the separate critical functions

Managing the critical functions for enhanced innovation

"results-oriented" reward systems of most organizations reinforce a short-run focus, causing other activities to go unrecognized and unrewarded.

Manpower planning: recruiting, job assignment and development or training activities
→ identify the skills of the applicant
→ make sure there is room available for growth in ay of all critical roles while benefiting the organization ("multiladders"), and each of these paths should be encouraged.

! availability of unstructured time in a job can influence the performance of several of the innovation functions.

Job Design Dimensions

	Critical function				
Dimension of job	Idea generating	Entrepreneuring or championing	Project leading	Gatekeeping	Sponsoring or coaching
Emphasis on deadlines	Little emphasis; exploring encouraged	Jointly set deadlines emphasized by management	Management identifies: needs strong emphasis	Set by the job (i.e., the person needing the information)	Little emphasis
Emphasis on specifically assigned tasks	Low; freedom to pursue new ideas	High; assignments mutually planned and agreed by management and champion	High with respect to overall project goals	Medium; freedom to consult with others	Low

Performance measures and awards: we do those activities that get rewarded
(by motivation and recognition, salary and bonuses are not included here)
→ recognize the distinct contributions of each of the separate critical functions: give informal positive feedback

! organizational and individual differences will generate variations in rewards selected.

Measuring and Rewarding Critical Function Performance

	Critical function				
Dimension of management	Idea generating	Entrepreneuring or championing	Project leading	Gatekeeping	Sponsoring or coaching
Primary contribution of each function for appraisal of performance	Quantity and quality of ideas generated	Ideas picked up; percent carried through	Project technical milestones accomplished; cost/schedule constraints met	People helped; degree of help	Staff developed extent of assistance provided
Rewards appropriate	Opportunities to publish; recognition from professional peers through symposia, etc.	Visibility; publicity; further resources for project	Bigger projects; material signs of organizational status	Travel budget; key "assists" acknowledged; increased freedom and use for advice	Increased freedom; discretionary resources for support of others.

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Innovate or Die: is that a fact?

Isaac Getz and Alan Robinson

Innovation has been highlighted as the origin of growth in free market economies and R&D is a key investment in innovation (investments in capital equipment and the development of new markets, systems and skills are also important).

“Jackpot mentality”: Managers think that their companies had to generate inventions themselves
→ CEO’s dream of transformation by innovation, of getting rich on needs and wants undreamed of by anyone before = **“Innovation Jackpot”**

- innovate before taking care of more important things (customer-focused processes, ..)
  → causes them to believe that the wrong things matter and forget about the risks

<-> Microsoft, Cisco, ..: became leaders (and continue to grow) without originating much in the way of innovation themselves

Truly important for success: continuously improving and putting top-notch products on the market before the competition and at a reasonable cost.
→ Need insiders who know their industry well: they are familiar with the lines of research and inventions, and know how to connect them to market needs, how to sell new product or service prototypes to outside financing bodies, and how to move from prototypes to final products.
→ Need entrepreneurial dynamics and specialized market knowledge, connect research invention with customers’ needs to turn it into a market opportunity

Jackpot approach: IF a company creates a successful invention, there rises a new difficulty: robbers
→ protecting and patenting

- broadcasting to the competition what you are working on

new difficulty after protection: imitators
➔ jackpot approach draws attention and resources away from what a company really needs to drive progress

Alternative approach: customer-focused processes (reliability, quality, ..)and basic continuous improvement = **“boundaryless system”** → search for and apply the best ideas regardless of their source: listen and act on the ideas of front-line employees

+ company has more chance of success and growth
+ improves the quality of its innovation mgmt

although top-down approaches are necessary, they miss the improvement opportunities that regular employees spot → 80% of improvement ideas come from employees and only 20% come through planned improvement activities