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MINISTRY OF EDUCATION, YOUTH AND SPORTS

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INVESTMENTS IN EDUCATION DEVELOPMENT

Innovation and Development of Study Field Nanomaterials at the Technical University of Liberec

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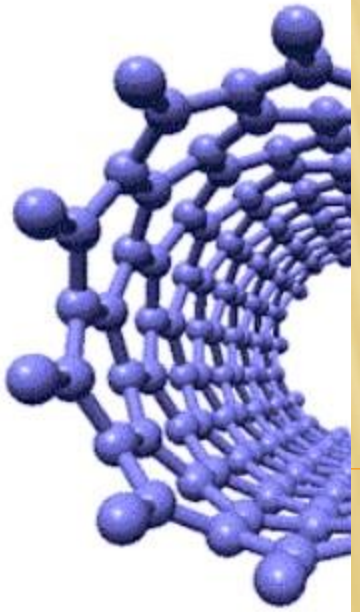

These materials have been developed within the ESF project: Innovation and development of study field Nanomaterials at the Technical University of Liberec

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INOVATION AND BUSINESS IN NEW TECHNOLOGIES

Managing innovation within firms

Managing innovation within firms

- **Almost all innovations occur within organisations**
- **Major technological innovations only in firms**
- **The management of innovation is a very broad subject**
- **Plenty of factors and issues affecting the management of innovation**

- Theories about organisations and innovation
- The dilemma of innovation management
- Managing uncertainty
- Organisational characteristics that facilitate the innovation process
- Classification of industrial firms
- Organisational structures and innovation
- The role of the individual in the innovation proces
- IT systems and their impact on innovation
- Establishing an innovative environment
- Case studies: W.L. Gore & Associates, Oxylane, 3M

Multiple-perspective approach

Classical or scientific management
Instrument for achieving goals
Employees of the organisation
can be made to serve these goals
Organisation can be rationalised
Predictable flow of work
Rational decisions ►►
Clearly defined outcome

Human relations
Informal communications and activities
Firms tend to impose routine solutions
Higher stress-threat situation ►►
Only reason for innovation

Systems theory
Organisation = goal directed systems
Systems have structures and processes
Structures are relatively stable
Processes are dynamic relationships
Importance of the organisation's
interaction with the external world

Contingency theory
Internal activities rather than structure
Characteristics of organisation
•certainty versus uncertainty
•stability versus instability
•uniform versus non-uniform ►►
•few exceptions versus many exceptions
•many repetitive events versus few repetitive events

Organisational characteristics

- **Growth orientation** - commitment to long-term growth rather than
- short-term profit
- **Vigilance** – ability to be aware of its threats and opportunities
- **Commitment to technology** - willingness to invest in the long-term
- development of technology
- **Acceptance of risks** - willingness to include risky opportunities in a
- balanced portfolio
- **Cross-functional cooperation** - mutual respect among individuals and a willingness to work together across functions
- **Receptivity** - ability to be aware of, to identify and to take effective advantage of externally developed technology
- **‘Slack’** - ability to manage the innovation dilemma and provide room for creativity
- **Adaptability** - readiness to accept change
- **Diverse range of skills** - combination of specialization and diversity of
- knowledge and skills

Dilemma of innovation management

Tension between the need for stability and the need for creativity
Both necessary for competitiveness

Stability and static routines (present)

- Drive down costs
- Improve efficiency
- Tasks done quickly
- Stable and controlled environment

Creativity (future)

- Encourage
- Develop new ideas and new products
- Loose and flexible environment

Any solution for this dilemma?

- The most obvious solution – separation of production from R&D - fails

Managing uncertainty

Some events beyond control of an organisation
Firms have to respond to them though
Management in general involves coping with uncertainty

Management of innovation

- Coping with uncertainty = necessity
- Making decision under time pressure

Uncertainty can be divided into two separate dimensions

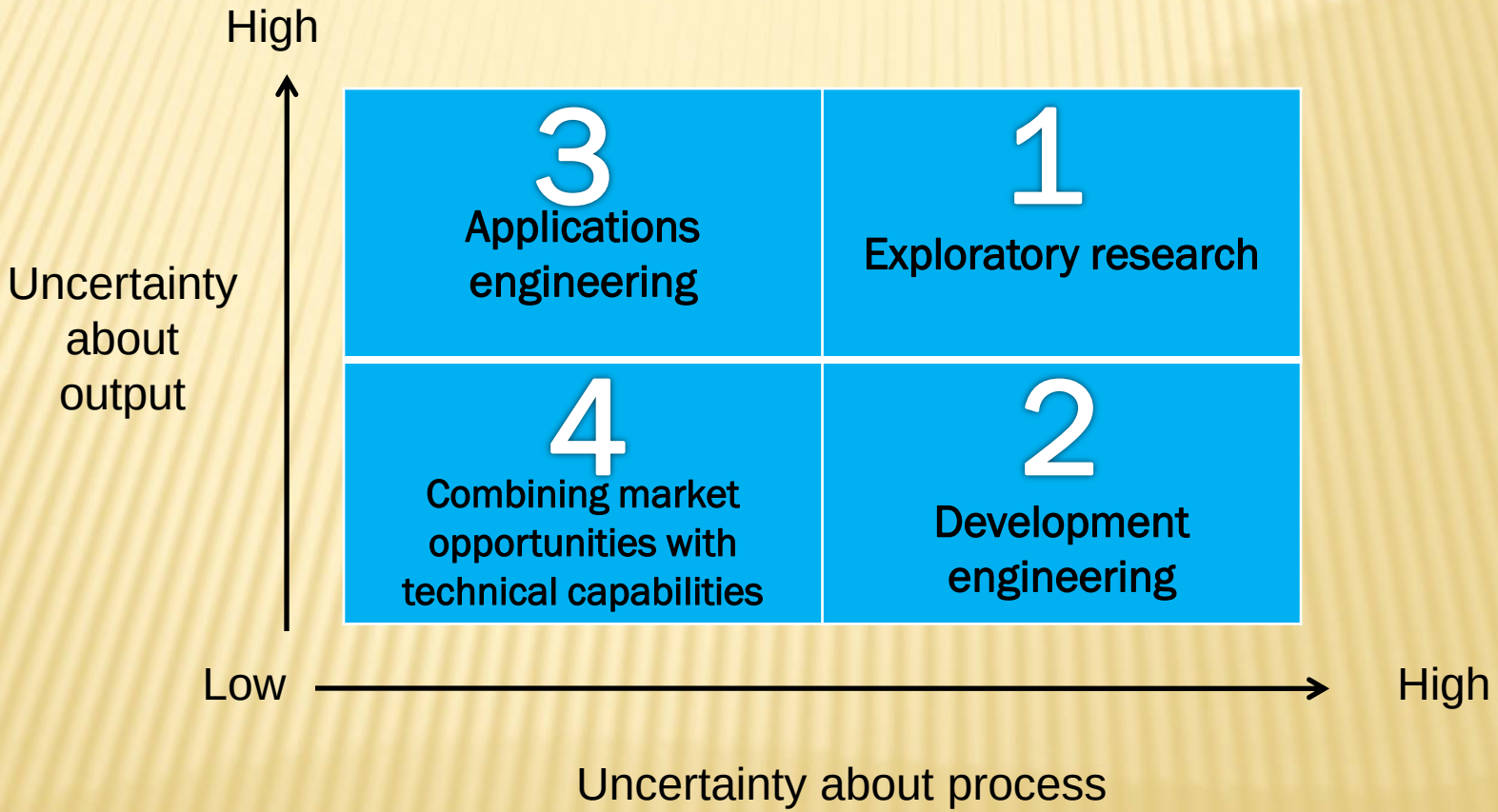
- Uncertainty about ends (what is the eventual target of the activity or project);
  Uncertainty about means (how to achieve this target).

Other elements to be considered

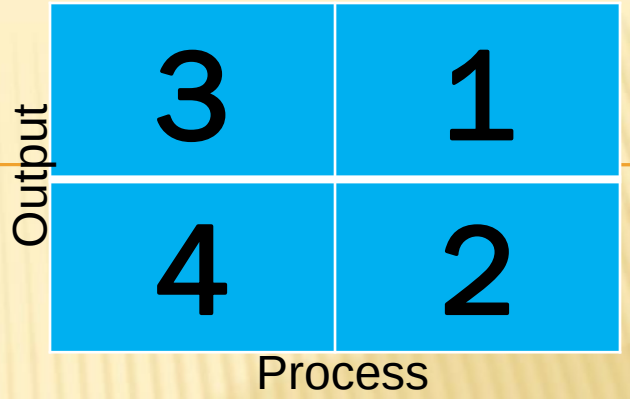
- Limited time
- Imperfect knowledge
- Involved judgement

Pearson's uncertainty map

Addresses the nature of the uncertainty and the way it changes over time



Pearson's uncertainty map



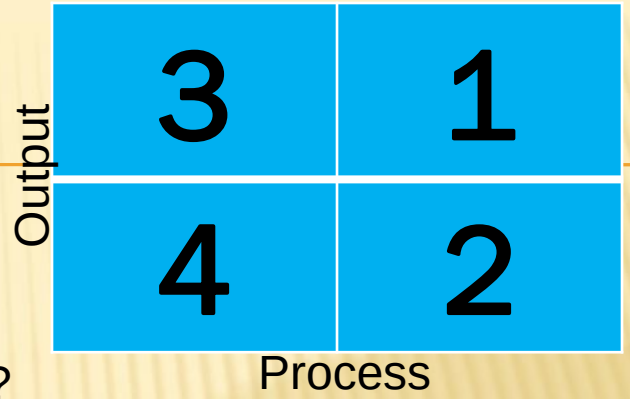
Quadrant 1

- Target is not clearly defined
- How to achieve this target also not clear
- '**Exploratory research**' or 'Blue sky' research
- Technology not fully understood
- Potential products or markets not identified
- Low financial and time pressure
- Typically 'university research'
- Only large organisations have the necessary resources (campuses)

Quadrant 2

- End or target is clear, commercial opportunity identified
- Means of achieving the goal has to be established
- Several different projects with different approached usually defined
- **Development engineering**
- On-going activity within manufacturing companies – looking for efficiencies and ways to reduce costs

Pearson's uncertainty map



Quadrant 3

- Uncertainty regarding ends
- How the technology can be most effectively used?
- **Applications engineering**
- Typically, related to new materials
- Usually ineffective due to costs or performance
- But some new and improved products may emerge

Quadrant 4

- Most certainty
- Improving existing products creating new products
- **Combination of a market opportunity and technical capability**
- Speed of development crucial
- Improvement of appearance or performance

Simplified view of the of the innovation processes

Most organisations have activities between two extremes

- The uncertainty map can be a tool for managers
- Enables identifying the different management skills required

Uncertainty map in Elmarco

Slow move from quadrant 1 to quadrant 4
2004-2007

- Focus on almost unlimited or limited number of application areas
- Research based on the literature search and academic conferences
- Predicting big opportunities based on „nano-samples“
- Project changing quickly and related to public funded money
- Omitting development of a whole technology
- Lack of deep technological knowledge
- Broadening the research in chemistry and polymers
- Weak customer support (operation, cost, technical limits)

- Focus on 2-3 key application areas
  - Surface loading filtration – ongoing
  - Depth filtration
  - Performance apparel
- Understanding the necessity to increase to throughput
  - Key project started with goal to double the throughput by reducing the cost
  - Single-purpose machine approach accepted

Organisational Structures

Channels of communication	
Open with free information flow	Highly structured, restricted flow
Operating styles	
Allowed to vary freely	Uniform and restricted
Authority for decisions	
Expertise of the individual	Formal line management
Free adaptation/Reluctant adaptation	
To changing circumstances	Despite changes in business conditions
Emphasis on getting things done/formally laid down procedures	
Unconstrained by formal procedures	Reliance on management principles
Loose, informal control/Tight control	
With emphasis on norm of cooperation	Through sophisticated control systems
Flexible/Constrained on-job behavior	
Shaped by situation and individual	Conform to job descriptions
Decision-making	
Participation and group consensus	Minimum involvement of subordinates

Organisational Characteristics

Growth orientation

- Some companies merely exploit a short-term opportunity (speculation)
- Some companies try to maintain the company at its size (family-run)
- Innovative companies = objective is to grow the business

Vigilance

- Continual external scanning
- Part of this activity may be formalised
    - Market research and competitor analysis
    - Reading the scientific literature
- Collecting valuable information ≠ using it properly (communication

Commitment to technology

- Persistant investment in the new ideas
- Demonstration of the commitment to employees
- Encourage creativity
- All in all, necessary to keep the people

Organisational Characteristics

Acceptance of risks

- Accepting risks does not mean a willingness to gamble
- Willingness to consider carefully risky opportunities
- Ability to make risk-assessment decisions
- Include the decisions in a balanced portfolio of projects

Cross-functional cooperation

- Conflict between departments = barrier to innovation
- Different groups often have very different interests
- Scientists and technologists lose sight of the business objective
- Marketing often fails to understand the technology involved

Receptivity

- Capability of the organisation to be aware of, identify and take effective advantage of externally developed technology
- Almost no technology developed completely in-house

Organisational Characteristics

Slack

- Allow individuals room to think, experiment, discuss ideas and be creative
- Example: allowing scientists to spend 10–15 per cent of their time on the
- projects they choose
- Usually not supported in other functional areas

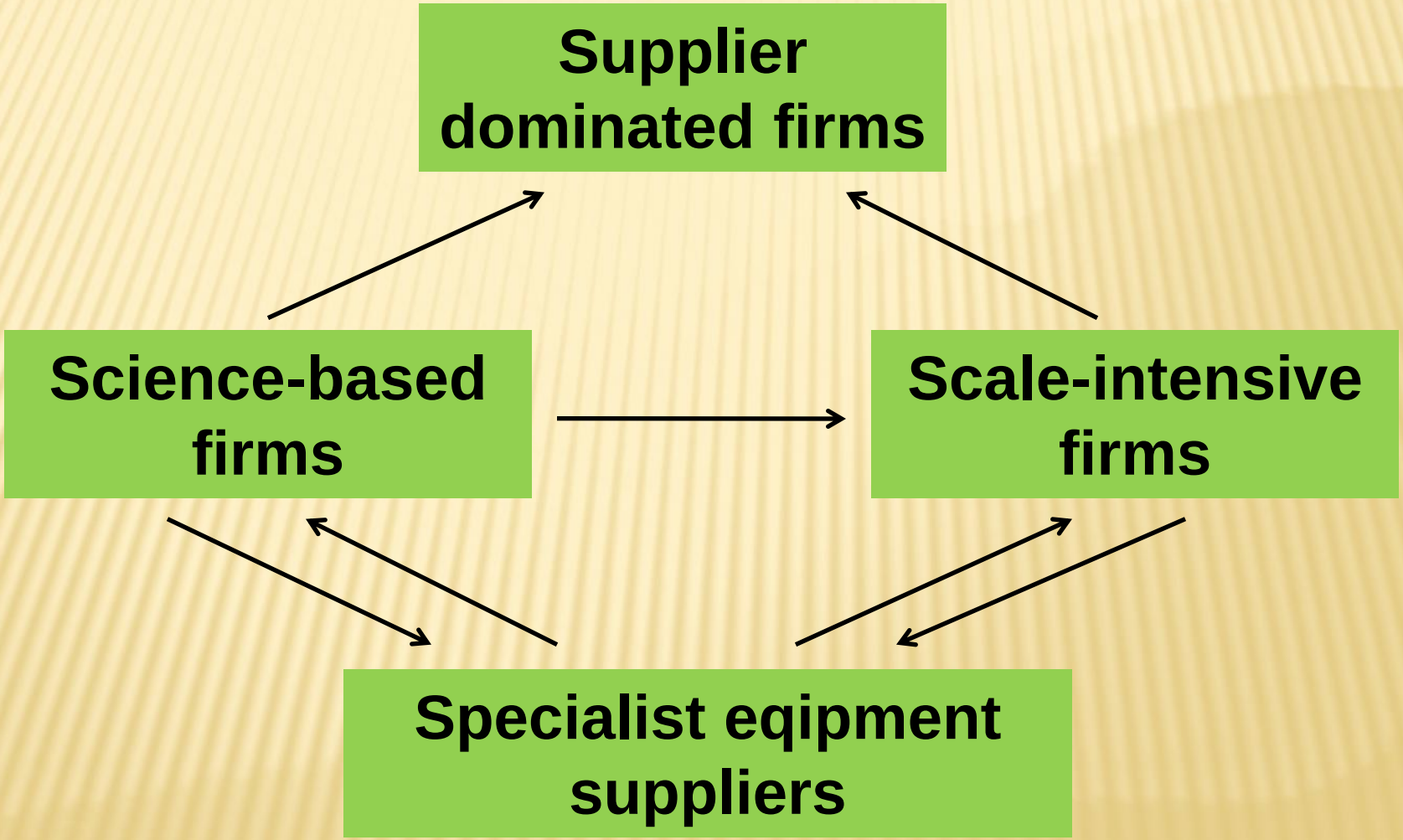
Adaptability

- Innovations may result in significant changes
- Organisation must be ready to accept change
- Change must be followed by all internal activities

Diverse range of skills

- Combination of specialists and generalists necessary
- Perfect – hybrid individuals - transfer of knowledge within the company
- Hybrid manager most useful in the area of product development

Classification of Firms



Classification of Firms

Supplier-dominated firms

- Offering services to local people
- Purchasing a product and matching it to customer needs
- Usually small in size, with little R&D or manufacturing
- Small shops, carpenters, electricians, builders etc.

Science-based firms

- Technology-intensive companies
- R&D departments provide foundation for the firms' growth and success
- These companies tend to become large
- Chemicals, pharmaceuticals, life-science, electronics, computing etc.

Scale-intensive firms

- Process technology and manufacturing based companies
- ability to produce high volumes at low cost
- capabilities in engineering, design and manufacturing
- science-based firms might be also scale-intensive firms
- Large chemical companies,

Specialist equipment suppliers

- Source of technology for scale-intensive and science-based firms
- Companies producing measuring instruments etc.

Organisational structures and innovation

Clear link between organisational structure and innovative performance
Various studies on ‘organic’ and ‘mechanistic’ structures
Comparison of these structures indicates the ‘organic’ structures as more effectively supporting the innovation

Roles of key individuals in the organisation

- **Technical innovator** - expert in one or two fields, generates new ideas and sees new and different ways of doing things =‘mad scientist’
- **Technical/commercial scanner** – gathers information from outside
- **Gatekeeper** – passes information on to others, serves as an information resource for others in the organisation
- **Product champion** - sells new ideas to others in the organisation and acquires resources for them
- **Project leader** - provides the team with leadership and motivation, plans and organises the project, balances project goals with organisational needs
- **Sponsor** – a senior person providing access to a power base within the organisation, eliminated organisational constraints, helps the project team to get what it needs from other parts of the organisation.

Organisational structures and innovation

Formalisation

- Increase in formalisation of procedures = decrease in innovative activity
- Unclear if opposite becomes effective
- But routines necessary for achieving efficiencies

Complexity

- Number of professional groups or diversity of specialists

Centralisation

- Decision-making activity and the location of power
- Decentralised an organisation the fewer levels of hierarchy
- More responsive decision making closer to the action

Organisational size

- Proxy variable for economic and organisational resources
- Below a certain size, there is a major qualitative difference

Role of the individual

Individual probably most important in the innovation process

- Only individuals may generate ideas
- Only individual might be enthusiastic
- Most individuals are eager to get information
- Certain individuals can fulfill a variety of roles, even
    - Decision-making processes
    - Delegation of authority

Typical activities of a scientist

- Literature scanning
- Conferences, symposiums
- Small scale try and error experiments

- Some scientists may feel, such activities will not be accepted as a constructive use of their time

Impact of IT systems

Noticeable change within organisations since the late 1990s

- ERP business software used everywhere - SAP, Oracle,Baan, PeopleSoft
- For larger company, a complete system could take several years and from a few up to hundred of million dollars to deploy
- Claims are made about the software's capabilities
- Impact of these systems on a firm's innovative disputable
- Creativity restricted by the ERP systems
- ERP systems do not easily fit any organisation
- Processes have to be made to fit their system demands
- Reconfiguration of work processes and routines very often
- **Increase efficiency and effectiveness**
- **Rigidity that hinders innovation and creativity**

Potential benefits of implementing ERP

- More efficient business processes
- Reduction of costs to several business procedures
- Better coordination and cooperation between functions and departments
- Better management monitoring and controlling functions
- Modification and adaptation abilities to company market requirements
- More competitive and efficient entrance to e-markets and e-commerce
- Possible redesigning of ineffective business functions
- Access to globalisation and integration to the global economy
- Inventory visibility and better decision support
- Active technology for market research and media environment
- Improving communication between partners of the channel

Impact of ERP on the innovative climate

Standardised information processing and work routines cause

- Many people feel unhappy when they are asked to change established ‘ways of doing things’
- Feel that new standardised work processes may undermine autonomy
- Everyone’s performance and achievements become much more visible
- Information sharing is perceived as tightening of management control
- ERP systems may reduce the richness of information
- Tacit information and knowledge may be sidelined
- Explicit knowledge may get preference over tacit knowledge
- Culture of instant control and accountability might evolve
- Intrinsic motivation of employees may be undermined
- Risk taking and experimentation becomes less desirable

Paradox of ERP and innovation requirements

Key features of Innovative organization

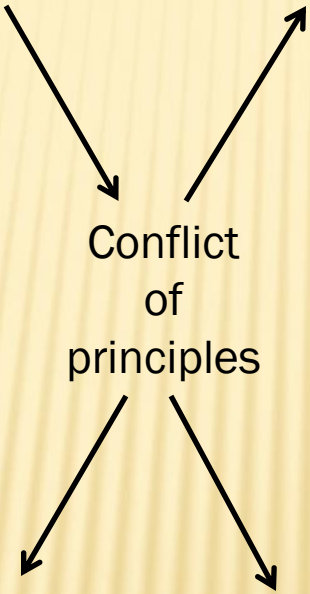
Autonomy of individual

Professional accountability

Provision of creative space (scientific freedom)

Participation in open cross-functional terms

Richness and diversity of data



ERP system requirements

Control and discipline

System-led accountability

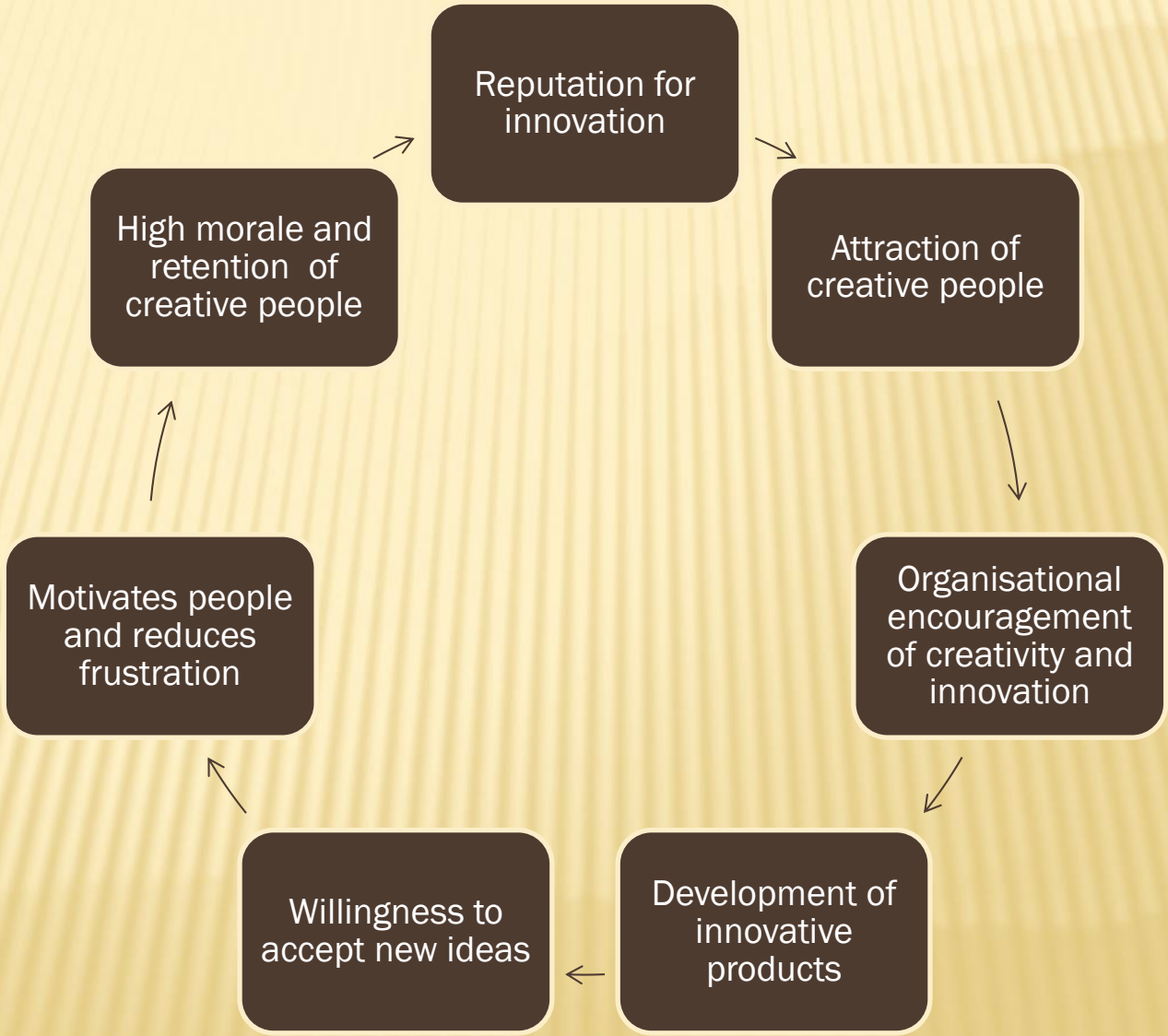
Efficiency through standardization

Participation in pre-designed processes

Accuracy and uniformity of data

Establishing an innovative environment

Developing a reputation for innovation helps propagate a virtuous circle that reinforces a company's abilities



Reputation of the organisation

Takes many years to develop, strongly linked to overall performance

Why some regarded as more innovative than others externally

- Recent product launches
- Recent successful programmes
- High levels of expenditure on R&D
- Effective publicity
- Serendipity

What it means internally

- Only genuine developments perceived as innovation
- Willingness to accept new ideas including their completion
- Individuals can see their ideas and efforts link to the company performance
- Rewarding and enjoyable working environment

Creative individuals are attracted by the reputation of the company

Internally, innovation has to be supported with actions and resources

- Build an environment that tolerates errors and mistakes
- Encourage people to try new ideas without fear
- Successful new ideas need to be rewarded
- Creativity-stimulation techniques outside company

Most admired companies in innovation

1. Apple
2. Sistema – IT, telecoms, microelectronics, banking, retail, media, oil
3. GDF Suez - electricity generation and distribution, natural gas and renewable energy
4. Limited Brands - lingerie, personal care and beauty products, apparel and accessories
5. Qualcomm - leader in 3G and next-generation mobile technologies
6. Enterprise Products Partners - provider of midstream energy services
7. Koç Holding – automotive, food, finance, energy, construction, defence
8. Amazon.com
9. Sealed Air – packaging, materials, systems and equipment
10. Nike

Fortune, March, 2012

1. Apple
2. Google
3. Nike
4. Amazon.com
5. Charles Schwab - brokerage and banking
6. 3M
7. Statoil - oil and gas company
8. Exxon Mobil
9. Walt Disney
10. Whole Foods Market - chain of natural *foods* supermarkets

Fortune, March, 2011

An innovative company and culture – Example 1

Oxylane group

- One of the largest French companies
- Over 50.000 employees worldwide
- Over 6 billion EUR turnover
- A few tens of own passion brands and component brands
- Hundred of own brands
- Sales only through hundreds of own retails stores in different formats
- Broad patent suite
- Majority of development and manufacturing in Europe
- Many thousands on new product brought in the market each year
- Employees also own the company
- Small flexible groups of employees
- Clearly visible signs of culture
- Offices next to the stores
- Open space offices similar to trade fair
- People can bring their new ideas
- New ideas presented and evaluated at internal symposiums
- Clear indication of success of each new product

An innovative company and culture – Example 2

W.L.Gore & Associates

- Bill Gore worked as a scientist for DuPont
- Nobody at DuPont wanted to invest in his new idea
- He bough the patent and founded his own business in 1958
- Over 7.000 employees worldwide
- Over 1 billion EUR turnover
- Broad patent suite
- Gore-Tex® fabric were first introduced in 1976, patent expired 1996
- New patents are still active on improved methods of making Gore-Tex®
- Major growth in sales in 1990s together with outdoor popularity
- 5th 2006 and 10th 2007 – 100 best companies to work for (Fortune)
- Teams are organized around opportunities
- No pre-determined channels of communication
- Associate is a new term for someone working with the company
- Sponsors help to introduce the new ideas within the company
- Employee ownership structure
- Stock Ownership Plan, vacation, holidays, profit sharing, sick pay, life insurance, travel accident insurance

An innovative company and culture – Example 2

W.L.Gore & Associates Associate Stock Ownership Plan

- Provide equity ownership and financial security for retirement
- All associates have an opportunity to get their share
- Up to 15 % of pay to an account that purchases W.L. Gore stock for them
- Full ownership of their accounts after five years
- ASOP does own a majority of shares, the rest Gore family
- Cash profit-sharing distributions used as well, usually twice a year
- Associates are provided with pre-tax benefits, called flex dollars
- Flex-dollars are used for the purchase of ‘flexible benefits’
- Flex benefits include medical plans, dental plans, long-term disability insurance, personal days, supplemental individual, life insurance, family life insurance and health care or dependent care spending accounts

An innovative company and culture – Example 3

3M

- Over 55.000 different products, over 23 billion USD turnover
- 9.700 R&D personnel - 14 centers around the world, HQ campus
- In other words, the firm is an R&D lab which researches new technologies

3M's Seven Pillars of Innovation

1. Commitment for innovation - unusually high amount (for an industrial manufacturer) spent on R&D – 6% of the revenue
2. Maintaining of corporate culture – hire good people and let them do their job in their own ways and tolerate mistakes
3. Broad base of technology - leading know-how in 42 diverse technologies, can be shared easily by engineers
4. Encouraged networking among researchers – labs host their own conferences, annual symposium, sharing of know-how easy
5. Reward of employees for outstanding work - dual-career ladder, selection for scientific achievements every year by their peers
6. Quantified efforts – 3M analyses how much of its revenue comes from products introduced in the past four years
7. Research tied to the customer - employees spend a lot of time with customers to understand what their needs

Summary

Key characteristics common for innovative companies

- High quality technology in the center of development – employees can feel their work is creating future
- Superior products and their wide use – employees see the effects
- Small teams around the key activities and tasks – close relationships
- Direct one-on-one communication – fast informed decisions
- Open channels of communication - freedom to meet and discuss
- Lattice structure – no fear from opinion of superiors
- Equity compensation – sense of ownership, increased commitment