Technology ForeSight Initiative

WORKBOOK

Foresight Methodologies

Training Module 2

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

economy environment employment

WELCOME

Dear Participants in the course,

On behalf of the organizers let me welcome you to the course "Technology Foresight for Practitioners" being held in Prague from 4 to 8 October 2004 and hosted by the Technology Centre AS CR.

I believe that the course will make a significant contribution to the utilization of technology foresight as a practical tool in designing policies and strategies for a better exploitation of the socio-economic potential of countries with economies in transition.

Welcome in our beautiful City of Prague, which I hope you will have some time to explore. I believe that the course will fulfill its objective and it will meet your expectations regarding practical use of foresight for the benefit of your countries.

I wish you an enjoyable yet demanding week in Prague.

Karel Klusáček

Director of the Technology Centre AS CR

UNIDO Technology Foresight; Programme

Regional Initiative on Technology Foresight in CEE/NIS

Ricardo Seidl da Fonseca
•INDUSTRIAL PROMOTION AND TECHNOLOGY BRANCH
•www.unido.org/foresight

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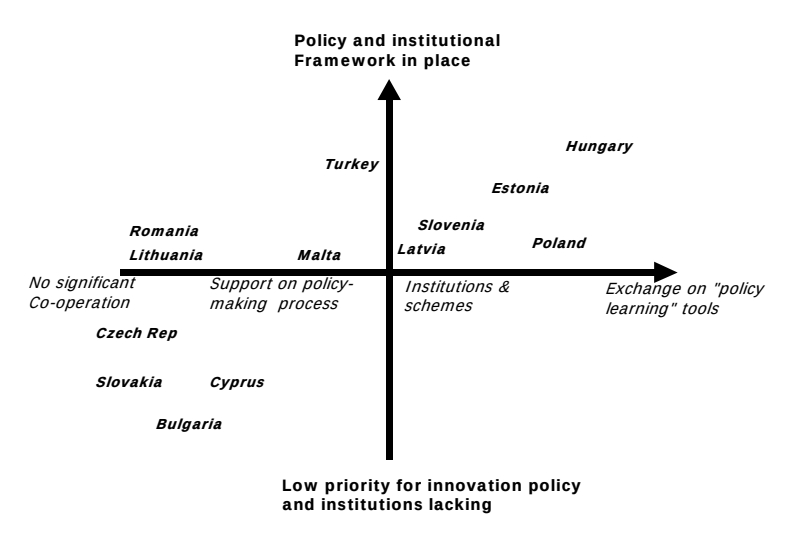
Policy Transfer EU -> CEE



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Economic Growth and Technology Policy

Drivers of economic growth over coming decades:

- increasing **competition**
- increasing **constraints** on public expenditures
- increasing **complexity**
- increasing importance of technological **competencies**

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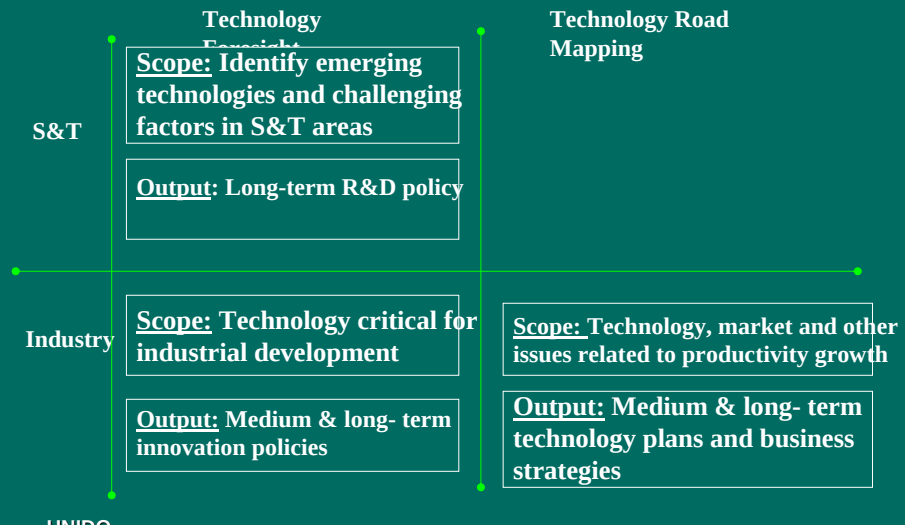
Methodologies & Levels



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Methodologies and Users

Delphi survey	Japan, Germany, France, US, Australia, Austria, Korea, Belgiu Spain, Hungary, APEC, Brazil	France, Germany	Internet Forum
Panel Discussion	Japan, UK, Germany, Korea, Spain, Sweden, Ireland, Belgium, Hungary	US, France	Citation Index
Conference, Workshop, Brainstorming	Netherlands, US, Australia, New Zealand, Austria, Ireland, Finland, Hungary, APEC	US, France	Trend Analysis
SWOT	Netherlands, Canada, Austria, Portugal, Czech Republic	US, France	Interview
Scenario building	UK, Netherlands, US, Canada, Austria, Australia, New Zealand, Ireland, Norway, Finland, Portug APEC	US, France	Environmental Scanning
Critical Technologies	US, Italy, Czech Republic	All Countries	Mixed Methodologies

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Comparative Results

	Technology Foresight	Technology Road Mapping
S&T policy	Japan, Germany, France, UK, New Zealand, Korea, Australia, Austria, Ireland, Belgium, Fran Finland, Hungary, APEC, Czech Republic	
R&D policy for industry	Spain, Portugal, Italy	Netherlands, Australia
Integrated technology strategies and business plan		US, Canada, Sweden

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Why UNIDO Technology Foresight?

- Improve **decision making**
- Guide **technology choices**
- Generate **alternative trajectories and strategies** for industrial development
- Enhance **learning** and improve preparadness for **emergencies**
- Motivate **change**

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Development objectives

- Contribute to enhancing the industrial competitiveness and expand trading potential
- Foster economic, environmental and social benefits at national and regional levels
- Definition of innovation policies and R&D programmes

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Immediate objectives

- Raise awareness of the critical importance of technology change for improving competitiveness of industry
- Identify technology needs and priorities
- Strengthen strategic decisions capability
- Undertake regional studies for common issues
- Promote knowledge on trends and opportunities applied for production chains

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COMPONENTS

- AWARENESS BUILDING AND FORESIGHT CULTURE
- NATIONAL AND REGIONAL CAPABILITIES
- REGIONAL COORDINATION
  - PARTNERSHIPS PROMOTION

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UNIDO support

- International Conferences and workshops on best practices and methodologies (national and regional)
- Integration in the regional initiative
- Promote industry participation
- Task force of experts and methodology development during the foresight exercise
- Cooperation in the post-foresight process

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TOOLS AND METHODOLOGIES

- Book on Technology Foresight principles
- Web page (linked to UNIDO Exchange)
- CD-ROM
- Manuals
- Delphi on-line
- TF for Production Chains (national and supra-national)

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Regional dimension – the UNIDO approach

- Foresight as a tool for regional R&D programmes
- Enhance quality and effectiveness of foresight through multi-country networking
- Reduce costs by sharing common activities
- Awareness of global and regional trends
- Joint vision and solutions for cross-border problems
- Concentration of multi-country production chains

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REGIONAL FORESIGHT STUDIES

- Impact of EU-Accession to local industries
  - Agro-food industry
  - Automotive industry
- Challenges and opportunities of Biotechnology
- Water resources protection
- Competitive Production Chains
  - Fishery industry in Latin America

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FORTHCOMMING EVENTS

- Training on TF Methodologies, Prague, Czech Republic, 06-10 October 2003
- Training on Organizing Foresight programmes, Turkey, 08-12 December 2003
- 2004 Foresight Summit - Budapest, Hungary - September/October 2004
- Conference on Methodologies and Practices on Technology Foresight - Lima, Peru – January 2004

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IMPLEMENTATION OF THE CEE/NISTF INITIATIVE

	AWARENESS BUILDING	EVENTS	TRAINING	STUDIES	COORDINATION AND PARTNERSHIPS
2001	*INTERNET LIVE*	*- REGIONAL CONFERENCE - Experts Group Meet.*	*MODULE 1 Budapest*	*METHODOS and TOOLS*	*CORE GROUP*
2002	*WEB PAGE*	*Kiev Conference*	*- Manuals - CD ROM - Book*	*EU ACCESSION IMPACT Automotive Agro-food*	*NATIONAL FOCAL POINTS*
2003	*e-MEDIA*	*TF Summit 2003 Budapest*	*- MODULE 1 Turkey - MODULE 2 Prag*	*BIOTECHNOLOGY*	*INDUSTRIAL PARTNERS*
2004	*e-POLICY*	*TF Summit 2004 Budapest*	*MODULE 3 - Moscow*	*PRODUCTION CHAINS*	*REGIONAL R&D PROGRAMS*

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REGIONAL LATIN AMERICA

- **National foresight activities:**
  - **Chile - Identify strategic economic and technology sectors**
  - **Brazil - Production chains: textiles, plastics, wood, construction**
  - **Uruguay - Macro-sectors trends: food biotechnology, energy and transportation and logistics**
  - **Venezuela - Application of the results of the TF exercise**

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REGIONAL LATIN AMERICA

- Regional activities:
  - Trieste, Montevideo and Quito conferences (1999, 2000, 2003)
  - Production chain study for Fish industry in Chile, Colombia, Ecuador, Peru, Spain (2003/2004)

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UNIDO TECHNOLOGY FORESIGHT INITIATIVE

www.unido.org/foresight

Ricardo Seidl da Fonseca
INDUSTRIAL PROMOTION AND TECHNOLOGY BRANCH

2004 Technology Foresight for Practitioners

Training course
4-8 October 2004, Prague, Czech Republic

Regional Initiative on Technology Foresight for Central and Eastern Europe and the Newly Independent States

Organizer: United Nations Industrial Development Organization in cooperation with Technology Centre of the Academy of Sciences of the Czech Republic

Sponsor: The Government of the Czech Republic, the Ministry of Foreign Affairs of the Czech Republic

Guarantor: The Ministry of Education, Youth and Sports of the Czech Republic

OBJECTIVES

The main objective is to provide participants with the knowledge of technology foresight tools as well as hands-on experience in applying such tools and methodologies to address strategic questions and decisions such as:

What technologies are likely and/or desirable to be dominant in national or regional economy?
What priorities should national research and development programmes feature?
Where should the budget for publicly funded research and development be allocated?
What skills and competencies should be developed for the future?
What will be the demand of society for industrial products, services, food, housing, health care, education, life style and welfare over the next 10 years?

EXPECTED OUTPUTS

The course will provide the participants with practical knowledge of technology foresight helping them to design and manage foresight exercises.

- principal foresight methods and possibilities of their applications;
- case studies as a reference and inspiration for solving problems;
- guided hands-on exercises in the application of selected foresight methods;
- networking – establishing contacts with workshop participants and lecturers.

METHODOLOGY

The five-day course will include a brief introduction of foresight as a tool for shaping the future and illustrate the range of issues on which foresight can or cannot be applied. Presentation of major methods used in foresight will include illustrative examples and case studies. The course participants will have an opportunity to verify the acquired knowledge in practical hands-on sessions. The final stage of the course will offer to course participants an opportunity to prepare their own foresight exercise.

Programme

Day 1 – Monday 4 October 2004

09:00-09:30	**Opening Ceremony** Representatives of: Ministry of Foreign Affairs of the Czech Republic United Nations Industrial Development Organisation Ministry of Education, Youth and Sports of the Czech Republic.
09:30-10:00	**Introductory Session** Ricardo Seidl da Fonseca, United Nations Industrial Development Organisation: *UNIDO Regional Initiative on Technology Foresight.* Karel Klusacek, Technology Centre AS CR, Czech Republic: *Objectives of the course, introduction of participants.*
10:00-11:30	**Technology Foresight – An Introduction** Michael Keenan, PREST, University of Manchester, United Kingdom: *Background, basic principles, objectives, some national foresight case studies, emerging developments.*
11:30-13:00	**Foresight – Organising and Managing a Foresight Exercise** Karel Klusacek, Technology Centre AS CR, Czech Republic: *General guidelines, focusing the exercise, objectives, choosing a relevant/suitable method, identification of main stakeholders and participants, executive and management structure, budget, timing, possible resources, case examples.*
13:00-14:00	Lunch
14:00-15:30	**Overview of Methods Used in Foresight** Michael Keenan, PREST, University of Manchester, United Kingdom: *Why to use formal methods, selecting foresight methods, key characteristics, presenting foresight methods, examples of methods in use*
15:30-18:00	**Introduction to Futures Thinking** Hans Georg Graf, Centre for Futures Research, University of St. Gallen, Switzerland: *Methodological Considerations, Megatrend Analysis/Scenario Planning*

Day 2 – Tuesday 5 October 2004

09:00-11:00	**Idea Generation** Halka Balackova, Masaryk Institute of Advanced Studies, Czech Technical University, Czech Republic: *Brainstorming and other creative problem-solving methods.*
11:00 -13:00	**Using Expert Panels in Foresight** Michael Keenan, PREST, University of Manchester, United Kingdom: *Principles, defining a panel´s mandate, panel profile, identifying panel members, costs, organizing and managing a panel´s work, outputs and action, case examples.*
13:00-14:00	Lunch
14:00-18:00	**Scenario Planning** Ian Miles, PREST, University of Manchester, United Kingdom: *Principles and purposes, organization of a scenario workshop, practice sessions.*

Day 3 – Wednesday 6 October 2004

09:00-11:00	**Delphi Surveys** Kerstin Cuhls, ISI Fraunhofer Gesellschaft mbH, Karlsruhe, Germany: *Principles, process, examples, group activity.*
11:00-13:00	**Priority-Setting in Foresight** Kerstin Cuhls, ISI Fraunhofer Gesellschaft mbH, Karlsruhe, Germany: *Objectives, methods, examples, criteria, larger framework.*
13:00-14:00	Lunch
14:00-16:00	**Critical Technologies** Karel Klusacek, Technology Centre AS CR, Czech Republic: *Principles, process, example – national research priorities, practical exercise.*
16:00	Cultural and social event

Day 4 – Thursday 7 October 2004

09:00-13:00	**Technology Roadmapping** Robert Phaal, University of Cambridge, United Kingdom: *Principles and practice, T-Plan 'fast-start' approach, group activity.*
13:00-14:00	Lunch
14:00-18:00	**Designing Foresight Exercise I** *Course participants, divided into small groups, will be given concrete tasks, which could be solved by foresight methods. Groups will decide which method(s) would be suitable to conduct the exercise.*

Day 5 – Friday 8 October 2004

09:00-10:00	**Testing Knowledge Acquired During the Course** Course participants will be subjected to a multiple-choice test.
10:00-13:00	**Designing Foresight Exercise II** Groups will define basic elements and develop the structure of a foresight exercise they choose.
13:00-14:00	Lunch
14:00-16:00	**Presentation of Foresight Exercises** Groups will report on their exercises to course participants and evaluators.
16:00-17:00	**Final discussion, awarding diplomas and closing**

Coffee breaks *will be announced during the morning and afternoon sessions as appears convenient.*

Technology Foresight- an Introduction

Michael Keenan

Technology Foresight – An Introduction

Michael Keenan

PREST, University of Manchester, Manchester M13 9PL , United Kingdom

Summary

The 1990s have seen an explosion in technology foresight activities across the world, with most industrialised countries now conducting national foresight exercises of one sort or another. By the late 1990s, this wave of foresight activity had started to wash over other levels of government, from international bodies such as the EU and UNIDO, down to regions, municipalities and cities. The reasons for this increase in activity are manifold, and include new regimes for the production of knowledge, the belief that governments should better target their R&D spending, and even simple policy transfer (bandwagon effects) from one territory to another. In this presentation, we look at the nature of technology foresight, comparing and contracting it to other future-oriented activities like forecasting and planning. We then critically examine some of the many rationales and objectives given for conducting foresight exercises, and consider some of the players typically involved and the 'levels' at which such activities are organised. Drawing on this, we present a small number of cases of national foresight exercises that have been conducted over the last decade or so. This is followed by a brief look at exercises conducted at the sub- and supra-national levels. Finally, before summarising our conclusions, we consider some emerging developments that are likely to have a bearing on the evolution of foresight over the coming decade.

Technology Foresight
An Introduction

Dr. Michael Keenan
PREST, University of Manchester, UK
Michael.Keenan@man.ac.uk

UNIDO Foresight Course
Prague, October 2004

Outline

1. What is foresight?
2. Why is it said to be important?
3. Objectives of foresight
4. Some national foresight case studies
5. Emerging developments

What do we mean by foresight?

- Martin (1995):- **Research** foresight is "the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits."

- Georghiou (1996):- **Technology** foresight is "a systematic means of assessing those scientific and technological developments which could have a strong impact on industrial competitiveness, wealth creation and quality of life."

Defining foresight

The key term is SYSTEMATIC. Actors are always engaged in 'informal' scenario activities, but this 'endogenous' scenario building is considered to be distinct from the more systematic, purposeful and CO-ORDINATED activities associated with foresight exercises

Forecasting, Planning, and Foresight (1)

Foresight can use forecasts, as well as contribute to planning, but it should not be confused with either activity.

Forecasting tends to assume that there is one probable future, whereas Foresight assumes that there are numerous possible futures, and that the future is in fact there to be created through the actions we choose to take today.

Forecasting, Planning, and Foresight (2)

As for planning, Foresight time horizons should be beyond the usual planning period, but not so far out as to turn people off.

But Foresight should not be seen simply in terms of the value it may make as inputs to planning processes. A common rationale for doing Foresight centres on the so-called process benefits - the five C's

Foresight's five C's

(Martin & Irvine, 1989)

- **Communication**: bringing together disparate groups in a novel forum in which they can interact
- **Concentration** on the longer term, forcing participants to look further into the future more than they might do otherwise
- **Co-ordination**: so that different actors can form productive partnerships
- **Consensus**: creating a shared vision of the future that participants would like to achieve
- **Commitment**: ensuring that actors participate fully, and are able and willing to implement changes in light of foresight findings. Such commitment to a shared vision can become, to a large extent, a self-fulfilling prophecy

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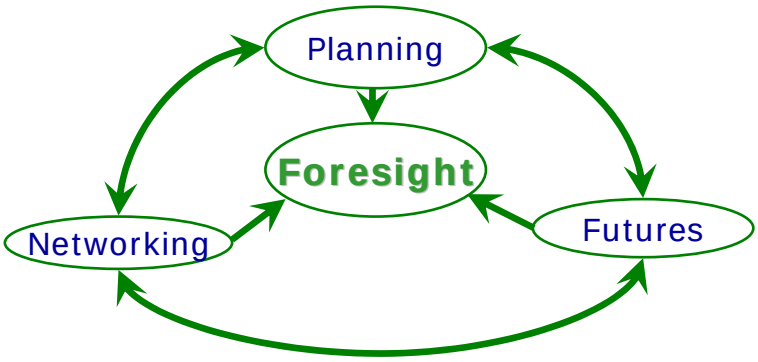
Positioning Foresight



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Five essential elements

- Anticipation and projections of long-term developments
- Interactive and participative methods of debate and analysis
- Forging new social networks
- Elaboration of strategic visions based on a shared sense of commitment
- Implications for present-day decisions and actions

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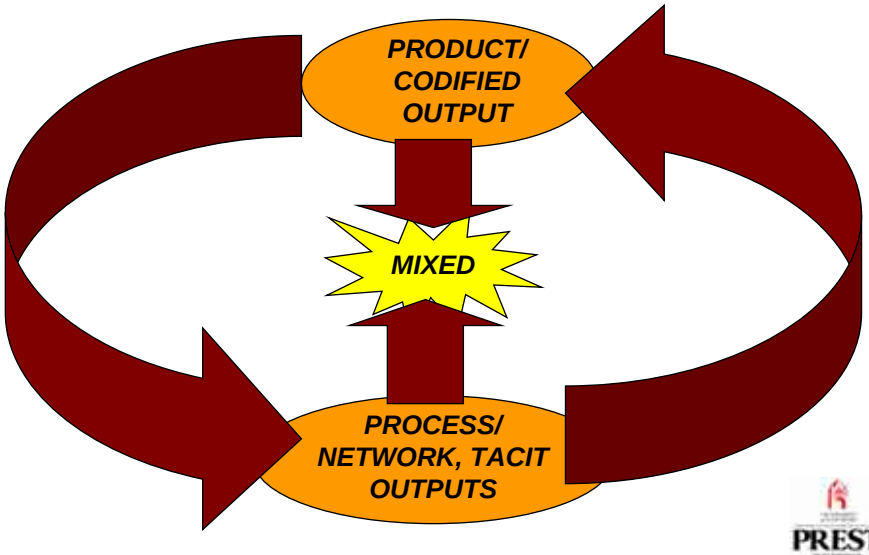
Orientation of Foresight



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Typical stakeholders in a Foresight exercise

Foresight is about providing a framework for ongoing DIALOGUE between various societal actors, such as:

- Government
- Industry
- Academe - natural & social scientists
- Others, e.g. NGOs, trades unions, the media, banks, schools, the general public, etc.

An important benefit for these actors is mutual (and collective) learning . . .

Starting 'levels' for Foresight

(Not mutually exclusive)

- **Territorial**: National (most visible), Sub-national (regional, city-region / municipality), Supranational (bilateral, multilateral, International Organisation), Global
- **Domain**: economic, social, environmental, technology, scientific discipline
- Alternative starting points:
  - **Flows** (e.g. rivers, pollutants, people, traffic, goods and services, etc.);
  - **Networks** (e.g. people, organisations, infrastructures, etc.);
  - **Markets** (e.g. goods, services, labour)

Rationales

- Escalating industrial and economic competition
- Increasing pressure on governmental spending
- Changing nature of knowledge production
- Emergence of new styles of policy-making
- Increasing desire for anticipatory intelligence
- Building advocacy coalitions
- Policy transfer (bandwagon effects?)
- The “Millennium Effect”

Common aims of Foresight

- Direction-setting
- Determining priorities
- Anticipatory intelligence
- Informing debate
- Increasing involvement
- Building social capital
- Building identities
- Advocacy
- Consensus-generation
- Communication & education

Modern Foresight family tree

- From 1970 Japanese Science and Technology Agency began periodic 30 year forecasts
- French initiatives in early 1980s
- Dutch began activity in 1989
- US Congress established Critical Technologies Institute in 1991
- German and UK exercises major milestones
- Major upsurge during 1990s, especially in Western Europe and East Asia
- 2000 – EU Candidate Countries and Latin America

Year	Delphi	Mixed	Panel/scenario
1970s -	30 years in Japan		
1989			Ministry of Economic Affairs Netherlands
1990	1st German		
1991			Critical Technologies USA
1992			New Zealand
1993	South Korea		Technologies at Threshold of 21st Century Germany
1994	France Japan/ Germany Mini Delphi	1st UK TF Programme	
1995			100 Key Technologies France
1996	Japan – German Delphi		Australia Foresight Steering Committee Netherlands 1st Italy Industry Foresight
1997		OPTI Spain	Ireland
1998	Austria	Hungary	South Africa New Zealand Sweden
1999			2nd UK TF Programme FUTUR Germany
2000			2nd French 100 Key Technologies Portugal Industrial Association 2nd Italy Industry Foresight
2001	7th Japanese Delphi		Czech Republic Malta, Cyprus, Estonia
2002		Turkey	Bulgaria Romania 3rd UK TF Programme

Mutual policy learning – selective national foresight chronology

Czech Technology Foresight

- Aim: Preparations for new National R&D Policy – identification of research directions
- Time horizon: 10 years
- Coverage: 14 thematic and 3 cross-cutting panels
- Key technologies approach, involving panels, interviews, CSIRO importance-feasibility matrix
- 90 key research directions identified

Spanish Technology Foresight

- Aim: strengthen NIS by exploring future tech trends and needs of Spanish industry
- Institutionalised into permanent 'observatory'
- 8 industrial sectors lead by 8 industrial orgs
- Three Delphi cycles – 26 Delphis in all
- 5000 experts, mostly from industry
- Megatrends and promising areas identified
- Process seen as very beneficial

First UK TFP

- Aim: Improvements in wealth creation and quality of life
- 15-20 year time horizon
- 15 sectoral panels
- Delphi and workshops
- 10,000 people involved
- 360 recommendations for action
- Significant implementation activity followed

German Futur

- Aim: formulate leading visions for BMBF programmes
- Strong participatory element, oriented towards social goals
- 20 year time horizon
- Inner (850) and Outer (600) Circle
- Workshops, open space discussions, panels, scenarios, online voting, road shows
- Four guiding visions resulted (by 2002)

Supranational foresight and IOs

- Recognition that many issues cannot be adequately examined at the national level has seen cross-border co-operation in foresight. Recent examples include:
  - Baltic STRING (2000-)
  - RegAlp (2002-2004)
  - UNIDO Fisheries Foresight (2004-)
- Some IOs that have used foresight include OECD, IBRD, UN, UNIDO, UNESCO, APEC, EC
  - Global, supranational and national studies often conducted by dedicated units
  - Provision of training
  - Provision of resources for others to conduct foresight

Sub-regional foresight

- Regional foresight exercises especially found in US, Australia, and (to an increasing extent) Europe
- FOREN initiative (DG RTD) major driver in diffusion of foresight in European regions
- FOREN Practical Guide to Regional Foresight (2001)
  - "Regions are arguably well-suited to the participative and vision-building Foresight approaches. The stronger links between regionally-based actors, the immediacy and sensitivity of people to changes in their region, and a heightened level of awareness and commitment to community, should all render such approaches valuable in regional settings".
  - Guide translated into MS + some CC languages
  - http://www.cordis.lu/foresight/cgrf

Overall Emerging Developments

1. Foresight increasingly viewed within a wider Strategic Intelligence practice
2. From national to distributed exercises (e.g. regional, sectoral, organisational, etc.)
3. Supranational and IO foresight
4. Mission shift and mission creep
5. ICTs and their impacts on the different tasks associated with foresight
6. Broadening in participation and the de-reification of expertise
7. Emergence (and structuring) of a Foresight community?

Questions and Comments?

Dr. Michael Keenan
Michael.Keenan@man.ac.uk

Dr. Michael Keenan is Research Fellow and Lecturer at PREST, University of Manchester, England. His research interests focus mostly upon policy analysis and advice, with particular emphasis upon Foresight and evaluation studies. Since joining PREST in 1999, he has participated in more than 20 research projects including: R&D programme evaluations for the Department of Health and the Health & Safety Executive; an evaluation of the Research Assessment Exercise; an EC project on the changing dynamics of public sector research establishments; an EC Foresight study on the Knowledge Society ("Euforia"); a series of scenario workshops for the ESRC (with the Institute for Alternative Futures); and coordinating an EC network on Regional Foresight ("FOREN"). More recently, he has led two multi-partner EC projects, one on mapping European Foresight activities ("Eurofore") and another concerned with the establishment of a sustainable European Foresight Academy. He is currently leading a project for the European Monitoring Centre for Change on future prospects in nine industrial sectors, and is also a key partner in the EC's Foresight Knowledge Platform project.

Besides research, Michael has also been extensively engaged in consulting and mentoring activities. Over the last five years, he has given around 50 presentations in more than 25 countries around the world, mostly on the design and use of Foresight processes in support of public policy. Much of this activity has been supported by the EC (e.g. in Poland, Cyprus, Belgium, Romania and Bulgaria), the British Council (e.g. in Russia, Ukraine, Czech Republic, Jamaica, and Turkey), and UNIDO (e.g. in Ukraine, Iran, Hungary, Venezuela and Russia). He has also advised upon or facilitated Foresight activities for the private sector in the UK, Malaysia, Colombia and Peru.

Finally, Michael is also a teacher, contributing two modules on science and technology policy to PREST's MSc course, and a contributor to a module on R&D evaluation. He is also joint-course director for the annual PREST Foresight course. Outside of PREST, Michael teaches on annual R&D Evaluation courses at the University of Twente in the Netherlands and at the University of Copenhagen. He is also regularly retained by UNIDO to teach their Foresight courses in various parts of the world.

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Foresight – Organising and Managing a Foresight Exercise

Karel Klusáček

Foresight - organising and managing a foresight exercise

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Summary

Organisation and management of foresight exercises do not follow a unique general pattern. Usually a mix of approaches is used depending on the specific circumstances confronted. The organisation and management structure is linked to the type of exercise and to its objectives and expected outputs. However, several common features are usually included in any foresight exercise and those are structured into three basic groups:

1) What should be done before the exercise? In this section sponsors, objectives of the exercise, selection of suitable method and identification of resources are discussed in detail.
2) What should be done before the exercise? This section deals with selection of experts, it discusses important building of momentum, considers a key question of getting results and emphasises a significance of continuous communication.
3) What should be done after the exercise? The final part of presentation is dedicated to the implementation of results and evaluation of the whole foresight exercise.

The presentation is closed by an illustrative example showing organisation and management of the recent foresight in the Czech Republic.

Foresight - organising and managing a foresight exercise

Karel Klusacek
Technology Centre AS CR, Prague, Czech Republic
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Training course „Technology Foresight for Practitioners“
4-8 October 2004, Prague

Structure of this session

- **WHAT SHOUD BE DONE**
  - **Before the exercise**
    - **Sponsors (Clients)**
    - **Objectives**
    - **Method**
    - **Resources (including budget and timing)**
  - **During the exercise**
    - **Selection of experts**
    - **Bulding momentum -awareness and consensus building**
    - **Getting results**
    - **Continuous communication**
  - **After the exercise**
    - **Implementation**
    - **Evaluation**
  - **CASE EXAMPLE**

2

Sponsor (1)

- Sponsor / client is a FUNDAMENTAL issue
- Not necessarily paying 100% of the bill
- There must be a „market pull“ (demand)
- It could be government, industry, a company, association
- „top-down“ NOT „bottom-up“ approach
- Needed a clear commitment of a „right“ client a user of results

3

Sponsor (2)

- „Right“ client:
  - Clear understanding how could foresight contribute to his strategic objectives
  - TOR well defined
  - Realistic expectations
  - Providing sufficient time to complete the exercise
  - Institutionally (politically) strong enough to ensure implementation of results – there is no greater disappointment than if results remain just „a report in a bookshelf“
  - Either financially strong enough to cover a majority of the budget or able to collect funds from other sources
  - Stable enough to survive (maintain high level of interest) at least for the whole exercise and a substantial part of implementation

4

Sponsor (3)

- Government:
  - plays a central role in national foresight projects, usually through the appropriate ministry
  - foresight exercise needs substantial resources – finance could be generated rather quickly but human resources for management of the exercise are usually not available - outsourcing – management of the project needs a strong central team although the exercise is widely open for consultations
  - example of objectives : outcomes for formulation of policies, research programmes, supportive schemes

5

Sponsor (4)

- Regional authority:
  - regional foresight with regional authorities as sponsors are playing increasingly important role in development knowledge-based economies
  - example of objectives: input for regional innovation strategy, strategic development plans, conversion of entrepreneurial sector, collapse of key regional industry

6

Sponsor (5)

- Industry, company, association:
  - narrowly focused than national studies
  - example of objectives: development of key market sectors, technology roadmaps

7

Objectives (1)

- Two basic questions:
  1. What are the problems / challenges?
  2. Is foresight capable to help?
- The first question should be answered in terms of reference
- The second question has a positive answer if:
  - creating of strategic visions is needed
  - alternative futures should be considered
  - longer time horizon should be considered (10 and more years)

8

Objectives (2)

- Typical objectives (examples):
  - national level - policy formulation, longer-term visions, national innovation system building/improvement, key technologies
  - regional level – policy translation, regional development strategy, possible development of key regional industries/clusters, social inclusion
  - industry/company level – likely changes of main products and production chains, main technology trends, dynamics of market

9

Selection of methods

- No unique decision for „typical situations“ regarding the particular „best“ method
- Usually a mix of approaches depending on the specific circumstances confronted
- A danger of copying „successful“ exercises without adequate appraisal of necessary modifications
- Several techniques often used (in combination): Delphi, critical technologies, scenarios, technology roadmapping ... more during this course

10

Stakeholders (1)

- Who should participate in the exercise?
- Stakeholders are not only experts used for consultations - also members of steering committee, advisory bodies
- Stakeholders should be selected for the value they can bring into the foresight process (managing change in their institutions, influence politicians, facilitate implementation,..)
- Their structure depends on scope, objectives, themes covered

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Stakeholders (2)

- Some questions should be answered first:
  - Who should be there?
  - Who should not be there?
  - Who cannot be omitted?
  - What do they expect of the exercise?
  - Do they have any conflict of interest: their objectives x objectives of the exercise?
  - Are they consensual people or troublemakers?

12

Stakeholders (3)

- Step-by-step selection
- Starting point are leading research bodies, governmental and non-governmental organisations, industrial and other professional associations
- Selected stakeholders may recommend additional bodies to approach
- Reasonable coverage: institutional, regional

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Organisation and management (1)

- A structure of any foresight activity is linked to the type of the exercise and to its objectives and desired outputs
- Common organisational elements include for example:
- **A Sponsor/Client** is a body 'buying' foresight results. It could be any authority responsible for (strategic) policy decisions. It usually covers at least a part of the project expenses

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Organisation and management (2)

- **A Steering Committee** that should consist of top representatives of key stakeholders (including the Client). The Committee should be chaired by an influential and widely respected person. The main task of the Committee is to evaluate the project progress, comment on its results, provide input on project modification and facilitate a broad consensus enabling the implementation of the project results
- Sometimes the Committee takes more advisory role than its title indicates

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Organisation and management (3)

- **Champion** (Ambassador) – high-ranked influential person involved since early stages of the project ensures high political support. Important but vulnerable – if such a person is replaced, the successor may tend to demonstrate that "everything was wrong"
- **A Project Executive Team** is responsible for conducting the project on a daily basis, performing the executive management of the project, maintaining regular contacts with Experts, keeping records of project costs and reporting. The Team is headed by the Project Manager who reports directly to the Sponsor (Steering Committee)

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Organisation and management (4)

- **Experts** are usually working in panels or working groups, sometimes they prepare individual expert surveys and studies
- Number of experts depends on chosen type of a consultation scheme
- A basic task of experts is to bring the relevant information and knowledge needed for achievement of project objectives

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Resources

- **Political support**
  - the most important component („get them involved since the beginning“)
- **Financial resources**
  - total cost may significantly vary (nature, scale of the exercise)
  - public or private sector often combined
    public: national, regional authorities (usually the largest contribution), ESF, ERDF, FPs
    private: large enterprises, banks, entrepreneurial associations
- **Time**
  - often underestimated, authorities are pushing for quick results
- **Human resources**
  - people running the exercise

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Budget and time

- **Budget**
  - length of the exercise and its „dimension“ - the most important parameters
  - the most significant cost categories – work of a project management team, organisation of meetings and events, experts' fee (sometimes necessary), interviews and surveys, travel and subsistence, publicity
  - no strict figures, budget may vary usually between 100 – 1000 k€
- **Time**
  - usually the critical parameter
  - national exercise usually lasts 1-2 years
  - regional / sectoral / company exercises are usually much shorter

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Selection of experts (1)

- Key initial step of any foresight exercise
- Narrow versus broad consultation schemes
  - Narrow - expert committees, fast, low-cost but biased opinions very likely
  - Broad – panels, needs more time, more expensive, sometimes “too democratic”
- Several months (2-6) needed for broader schemes to select „right people“
- Nomination & co-nomination

20

Selection of experts (2)

- Broad consultation scheme – often hundreds of experts involved
- 1st step
  - leading national research organisations, universities, industrial companies invited to nominate experts
  - existing databases – grant holders, members of professional associations
- 2nd step
  - nominees complete a questionnaire showing their expertise (+ info about the exercise)
  - Co-nomination (snowball sampling)
- The procedure closes after 2-3 cycles

21

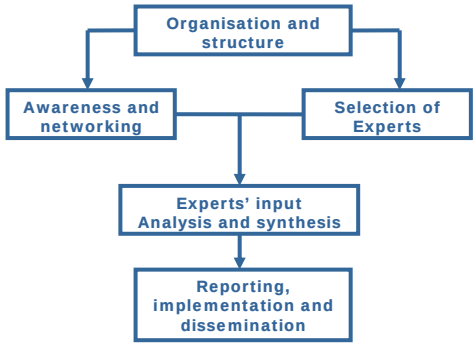
Bulding momentum

- Awareness and networking
  - important component of the consensus building – without consensus there is no sensible exercise
  - stakeholders mapping, seminars, personal contacts, traditional PR channels, media

22

Getting results

- No single universal recipe 'how to conduct foresight'
- Always matter of concrete situation what sequence of steps will be used for regional foresight
- Some basic steps are usually taken:



23

Continuous communication

- „Ownership of the exercise and its results"
- Communicate since the beginning - NOT just the 'final surprise'
- Communication with different groups – academia, industry, politicians
- Purposely tailored 'communication packages'
- Dedicated website (openness), publishing relevant documents and interim results
- Meetings, articles, press releases

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Implementation

- Implementation strategy is a part of project results
- Continuous consultations and trust building with policy-makers and opinion-leaders (their support is essential)
- Visibility of foresight - clear relationship between results of the exercise and following policy measures

25

Evaluation

- Using (at least partly) external (foreign) evaluators
- Better design of next exercise (method, stakeholders, objectives)
- Crucial for establishing continuous foresight program

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Case example – Czech foresight

- Project was ordered by the Czech government through the Ministry of Education
- The main objective:
  Setting research priorities for new National Research Program
- Two stages:
  1st stage: January-November 2001
  2nd stage: September 2003 – March 2004
- Project was managed by the consortium of the Technology Centre AS CR (principal contractor) and the Engineering Academy CR
- Based on a method of critical technologies

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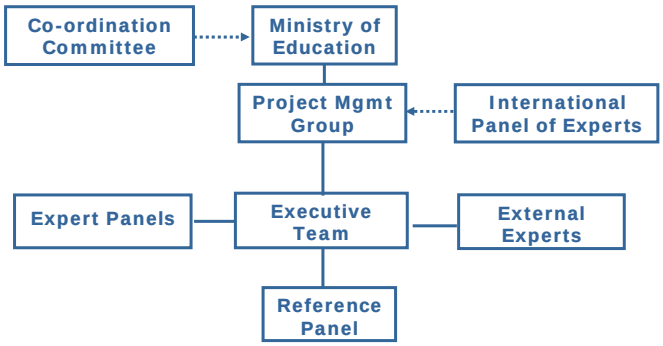
Organisational structure

- All important stakeholders should be represented – the requirement of a broad consensus by the sponsor



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TF - panels

- Agriculture and Food
- Environment
- Health and Pharmacy
- Construction, Urbanism and Housing
- Information Society
- Materials
- Discrete Manufacturing
- Machinery and Equipment
- Devices and Instruments
- Chemical Products and Processes
- Transport Systems
- Energy and Raw Materials

- Socio-economic issues

- Human Resources for R&D
- Integrated R&D
- Regional and International Co-operation in R&D

- Management and Implementation of the National Research Programme

13 application sectors (panels)

3 cross-cutting panels

1 systemic panel

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Panels
creation

- one of the most critical points of the project
- typically 15-20 experts
- mixed background – research, industry, business, government
- chairperson – a respected „strategic thinker“ assisted by secretary (expert)
- members suggested by important stakeholders (institutions), individual recommendations, co-nomination
- about 300 experts of 1000
- panel members received a modest fee to compensate for travels and other expenses plus a reward for their homework

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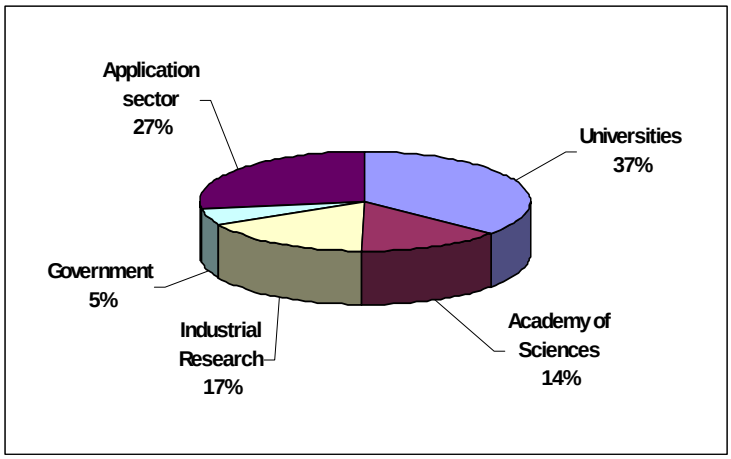
Panels
representation of sectors



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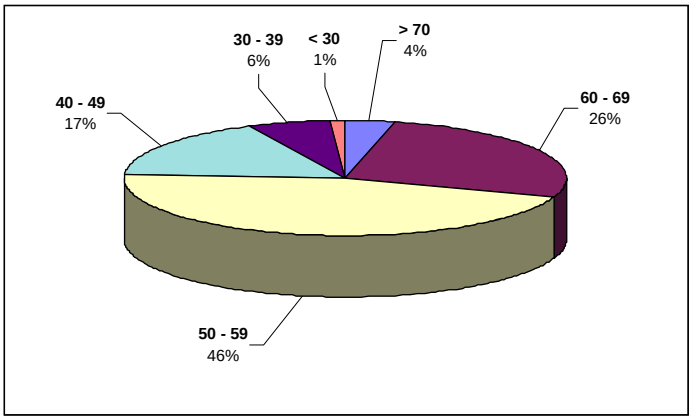
Panels
age structure



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Stages of the project

Preparatory stage: structure building, identification of sectors, location of experts

Data collection: interviews (demand side), desk research (strategic docs, economy, R&D structure), sectoral SWOT analyses

Panels: trends, a first broad group of (612) themes, first prioritisation – voting procedure - reduced number of (163) themes

Public presentation of interim results, feedback

Working group: cross-thematic topics, second prioritisation – using selected indicators (research funding, research outputs, human resources for R&D) – number of themes further reduced (90)

Evaluation of interest of private sector (co-financing of research projects): number of themes further reduced (51), 4 thematic programs formulated

Final report to government, public presentation of final results, dissemination

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National research program - thematic priorities

Thematic program (4)	Thematic sub-program (9)	Number of themes (51)
Sustainable prosperity	Energy for future	5
	Chemistry for society	7
	Progressive technical systems	7
	Sustainable transport	3
Quality of life	Non-traditional agriculture and healthy nutrition	4
	Molecular biology and nanotechnology for pharmacy and medicine	6
	Protection of environment	8
IT for knowledge society	Information technologies for knowledge society	5
Socio-economic development of the society	Socio-economic development of the society	6

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End of presentation

Thank you for your attention

Further information at www.foresight.cz

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Karel Klusáček is a MS graduate of the Institute of Chemical Technology in Prague (1973). He received his PhD from the Academy of Sciences in Physical Chemistry (1978) and his MBA from the Business School of the Sheffield Hallam University, UK (1998). After 17 years of research in Chemical Reaction Engineering at the Academy of Sciences he was appointed Director of the Technology Centre AS CR. His main professional interests include research in technology and science policy and innovation strategies, foresight and evaluation of R&D. He is President of the Czech Society for Promotion of Technology Transfer, Member of the Czech Engineering Academy, Czech delegate to the Programme Committee "Innovation and SMEs" of the European Commission and Czech delegate to the ;European Scientific and Technical Research Committee (CREST). He coordinates several international projects in the area of technology transfer, business incubation and regional innovation strategy. In 2001 and 2003 he was the National Coordinator of the first and the second Czech national foresight exercise.

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Overwiew of Methods Used in Foresight

Michael Keenan

Overview of Methods used in Technology Foresight

Michael Keenan

PREST, University of Manchester, Manchester M13 9PL , United Kingdom

Summary

This presentation sets out to summarise some of the formal methods used in technology Foresight exercises. Formal methods, whilst not strictly essential to the conduct of a Foresight exercise, are nevertheless typically used in such exercises, often in combinations. It is therefore useful to know and understand the full range of formal methods available. Selection of methods will depend upon several factors, most notably available time and financial resources, and the objectives of the exercise. Unfortunately for the novice, no simple recipe book exists for selecting and combining methods. This is because many of the methods can be used in a wide variety of ways to serve a variety of functions within a Foresight exercise. Moreover, the wide variety of contexts in which Foresight might be applied further complicates any attempts to provide generic guidance.

The first part of the presentation is given over to discussion of selecting Foresight methods. With so many methods to choose from, we highlight some of the criteria used (often implicitly) by Foresight practitioners. Next, we discuss three key 'dichotomies' that characterise formal methods – their explorative/normative nature, whether they use/result in quantitative/qualitative inputs/outputs, and the extent to which they are expert-based/assumption-based. Against this background, we briefly present four groups of methods that reflect a typical function within a Foresight exercise: (a) issue identification (environmental scanning, SWOT analysis, issue surveys); (b) extrapolative approaches (trend extrapolation, simulation modelling, genius forecasting, Delphi); (c) creative approaches (brainstorming, expert panels, cross-impact analysis, scenarios); and (d) prioritisation (critical technologies, technology roadmapping). Finally, we present six case examples of methods in use, in order to demonstrate the versatility and variety of approaches used in foresight exercises.

Overview of Methods used in Foresight

UNIDO Foresight Training Course
Prague, October 2004

Dr. Michael Keenan
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Overview

- Why use formal foresight methods?
- Selecting foresight methods
- Key characteristics of foresight methods
- Presenting foresight methods
  - Methods for Identifying Issues
  - Extrapolative Approaches
  - Creative Approaches
  - Prioritisation
- Six examples of methods in use
- Concluding remarks

Why use formal methods?

- Make the foresight process more systematic
- Increase transparency of processes
- Aid creativity
- Constitute space for communication and interaction
- Aid visualisation of possible futures

Selection criteria

- Available resources (time, money . . .)
- Nature of desired participation
- Suitability for combination with other methods
- Desired outputs of a foresight exercise (e.g. product vs. processes)
- Quantitative / Qualitative data requirements of methods
- Methodological competence often a key factor

Three key distinctions

- Exploratory (outward bound) vs. Normative (inward bound) approaches
- Quantitative vs. Qualitative approaches
- Expert-based vs. Assumption-based techniques

Typology of foresight methods

- Methods for Identifying Issues
  - Environmental Scanning
  - SWOT Analysis
  - Issue Surveys
- Extrapolative Approaches
  - Trend Extrapolation
  - Simulation Modelling
  - Genius Forecasting
  - Delphi

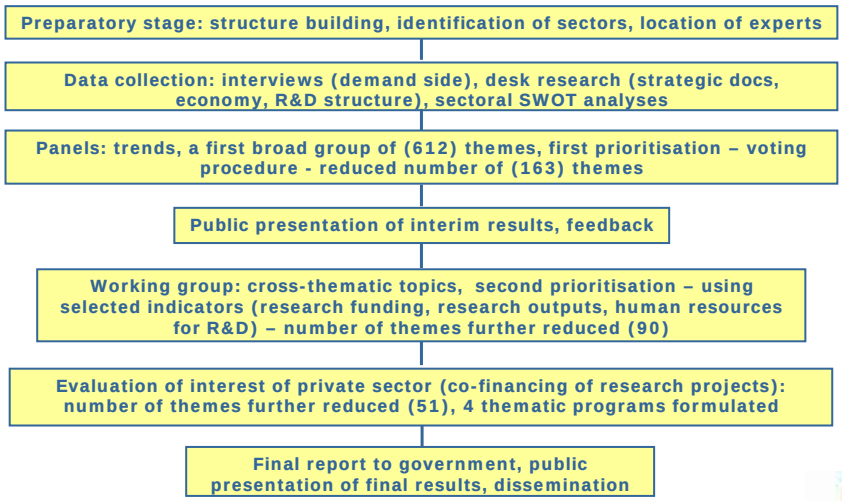
Typology of foresight methods

- Creative Approaches
  - Brainstorming
  - Expert Panels
  - Cross-Impact Analysis
  - Scenarios
- Prioritisation
  - Critical (and Key) Technologies
  - Technology Roadmapping

Examples of Use of Methods

- Six examples of how Foresight exercises have used methods:
  - Czech National S&T Foresight
  - First UK Technology Foresight Programme
  - Belgian SocioForesight Study
  - Gipizkoa Regional Foresight 2020
  - UNIDO South American Fisheries Foresight
  - Scenarios in Daimler Chrysler
- Similarities and Variations? How can these be explained?

Czech National Foresight Programme



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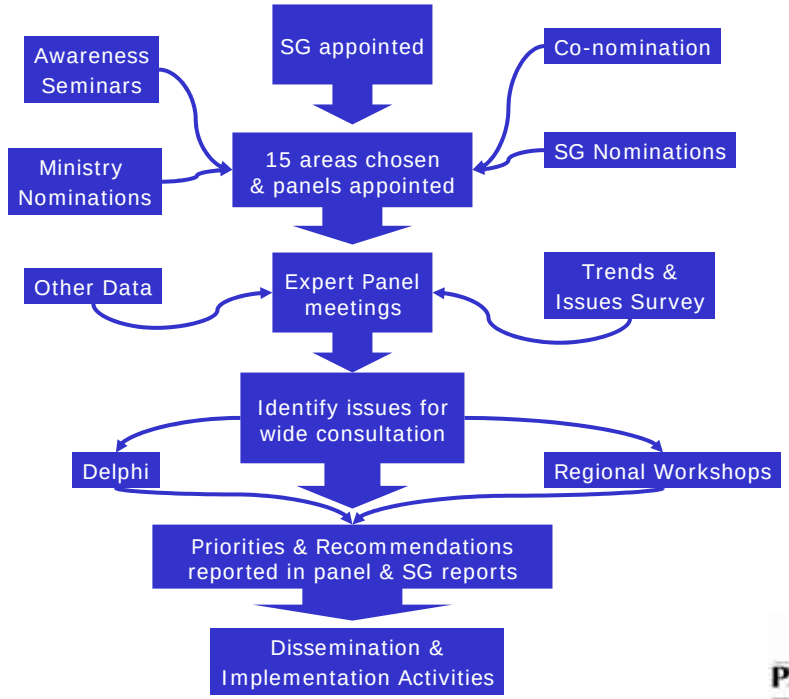
First UK Foresight Programme



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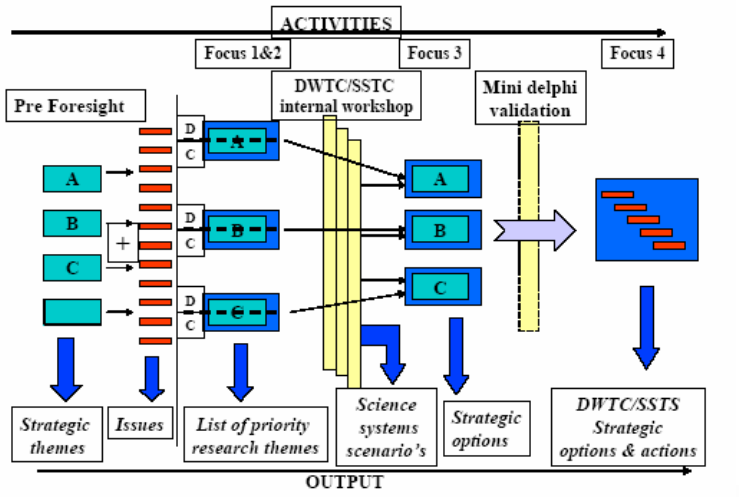
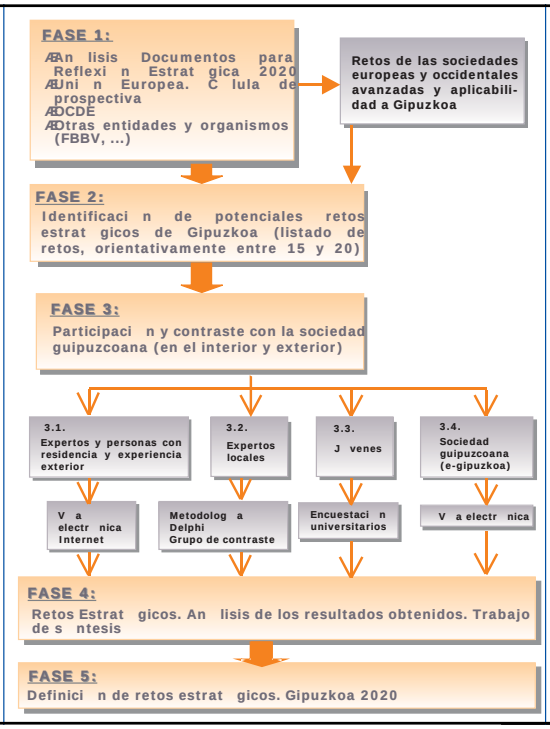
Belgian SocioForesight Study



PREST

Gipuzkoa 2020



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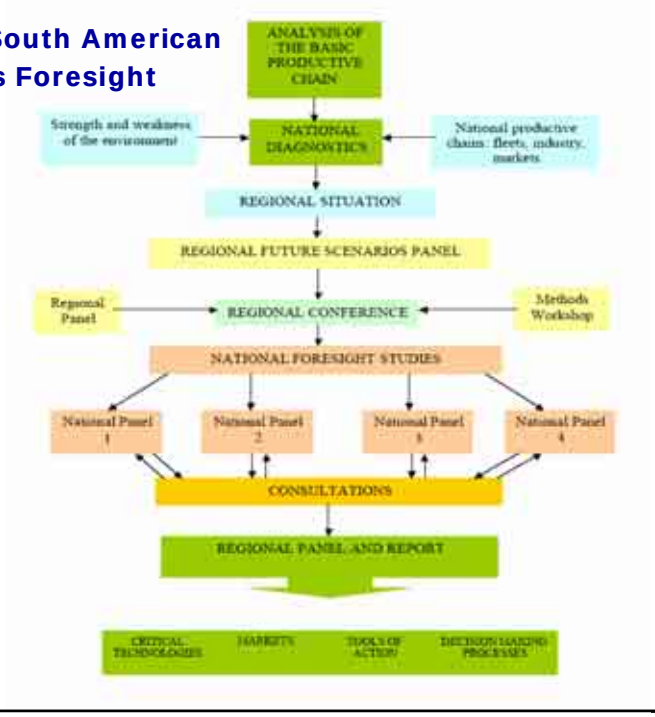
UNIDO South American Fisheries Foresight



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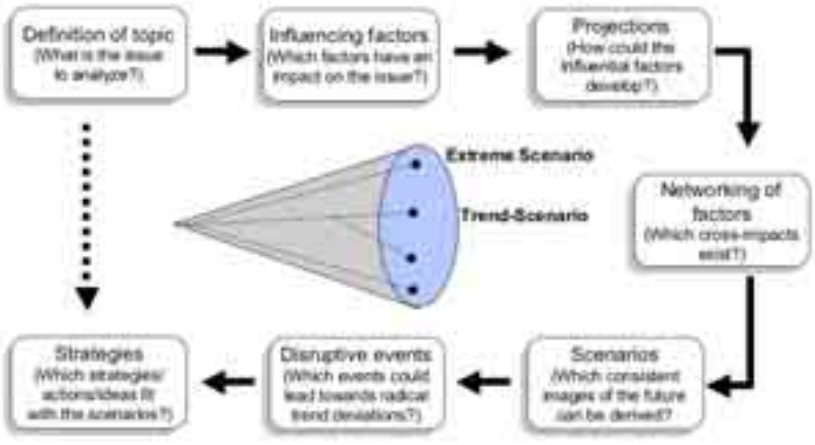
Scenario Process at Daimler Chrysler



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Key Questions

- What are the similarities between the approaches adopted?
- What are the key differences?
- How can we explain similarities and variations?

Summary remarks

- There are good reasons for using formal methods
- Multiple criteria are used for selecting methods
- No easy classification – methods are rather versatile in how they may be used and combined together
- Consequently, there are no recipe books for doing foresight – different combinations are likely to be needed for different circumstances

Questions and Comments?

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Introduction to Futures Thinking

Hans Georg Graf

Introduction to Futures Thinking

Prof. Dr. Hans Georg Graf

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Postfach 32, CH – 9037 Speicherschwendi, Switzerland

Summary

I. Methodological Considerations

Leading an organization (a company, government, an administrative body, an association or any other institution) means above all to make decisions. Rational and responsible decision-making requires information, especially on the future, as every decision is futures oriented: we want to reach a future goal or to adapt to a development expected in future. As the field of decision-making varies widely according to the problem in question, the adequate approach and methods will have to differ accordingly. Time series analyses may consider univariate approaches as basis for trend extrapolation. Time alone will, however, not provide sufficient information as a basis for planning, neither for economic, nor for corporate policy. As a basic principle, when preparing long-term macroeconomic projections, approaches based on the theory of cause and effect are required. The term “causal theoretical forecast” is used when investigated variables are put in a dependent relationship with relevant determining variables and are then predicted on the basis of this knowledge. Procedures based on this concept range from simple behavioural equations to comprehensive econometric models. Developing the appropriate approach and model to be used for analysis and for projections is a most important step at the outset of this approach. The case study to be worked upon during the lecture aims at showing the causal chain-link model for the market for automobiles. The analysis of the framework of any market and its development always has to be the first step in developing projections, recording the interdependency between the relevant variables.

II. Megatrend analysis

Megatrend analysis on a national and global level will govern the development of specific sectors or markets within a nation. Global megatrends will be discussed and exemplified during the lecture, basic material provided in the textbook as well as included with this abstract. Megatrend analysis uses methodologically the scenario technique which is at the core of other parts of the training course. A major requirement with this approach is the use of a systemic perspective taking into account the 6 dimensions which are relevant when assessing human activity in a systematic and systemic way.

Global issues: (1)

1. **World population is growing most where people can afford the necessities of life the least**

2. **Fresh water is becoming scarce in localized areas of the world**

3. **The gap in living standards between the rich and poor promises to become more extreme and divisive**

4. **The threat of new diseases and reemerging diseases and immune micro-organisms is growing**

5. **The capacity to decide seems to be diminishing as issues become more global and complex under conditions of increasing uncertainty and risk**

6. **Terrorism is growing in intensity, scale, and threat**

7. **The growth of population and economies interacts adversely with environmental quality and natural resources**

Global issues: (2)

8. The status of women is changing

9. The severity of religious, ethnic, and racial conflicts is increasing

10. Information technology holds both promise and peril

11. Organized crime groups are becoming sophisticated global enterprises

12. Nuclear power plants around the world are ageing

13. The HIV pandemic is spreading

14. The meaning of work, unemployment, leisure, and underemployment is changing

15. Climate change endangers coastal regions and aggravates severity of weather related catastrophes

Global opportunities: (1)

1. Achieving sustainable development
2. Increasing acceptance of global long-term perspectives in policy making
3. Expanding potential for scientific and technological breakthroughs
4. Transforming authoritarian regimes to democracies
5. Encouraging diversity and shared ethical values
6. Reducing the rate of population growth
7. Evolving strategies for world peace and security

Global opportunities: (2)

8. Developing alternative sources of energy

9. Globalizing the convergence of information and communications technologies

10. Increasing advances in biotechnology

11. Encouraging economic development through ethical market economies

12. Increasing economic autonomy of women and other groups

13. Promoting the inquiry into new and sometimes counter-intuitive ideas

14. Pursuing promising space projects

15. Improving institutions

Global Problem Fields

Imbalances	Amplifier
• Population - growth - density • Civilization • Basic Supply - (food, water, clothes, dwellings) • Employment • Income (- distribution) • Resources, environment	• Information • Communication • Transport • Identity-crises • Loss of Importance of Institutions

Futures Thinking

Prof. (em.) Dr. H.G. Graf

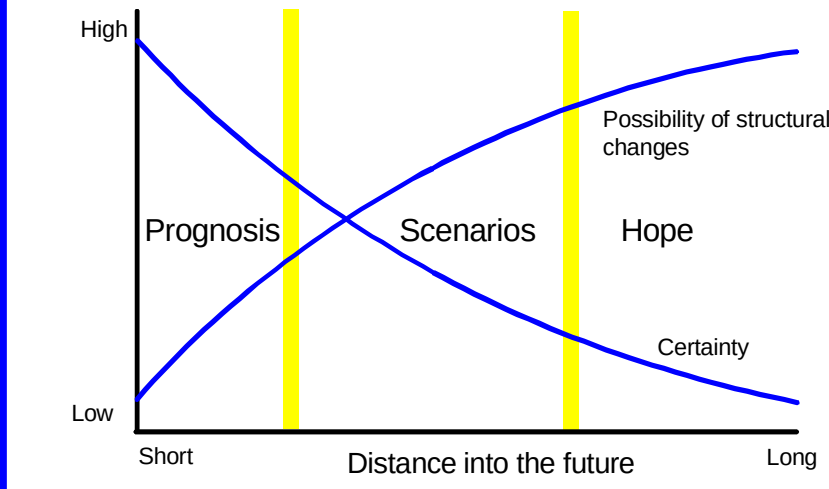
St. Gallen

Futures.....

The trouble with the future is

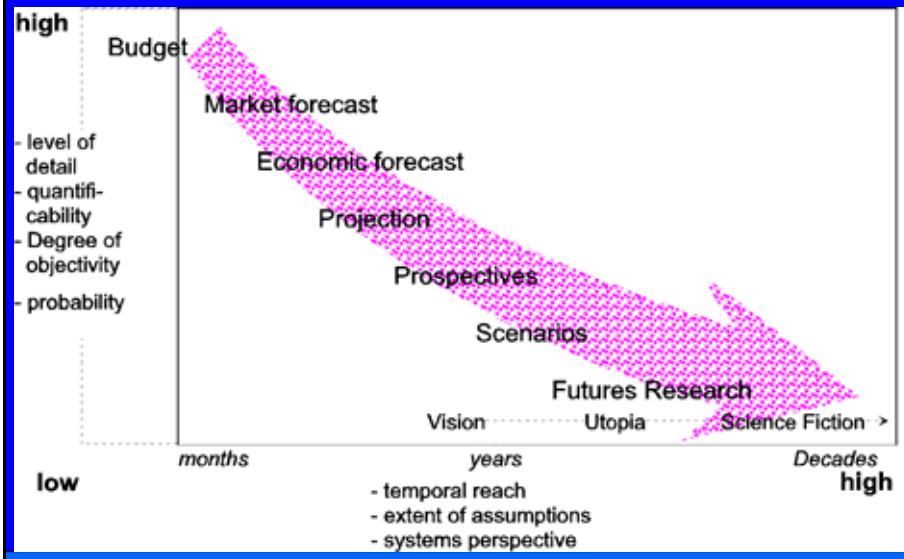
that there are so many of them!

The balance of predictability and uncertainty in the business environment

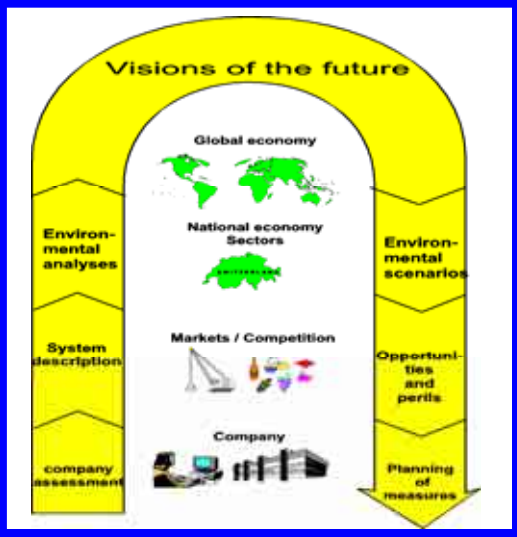


Source: Following van der Heijden (1996), p. 92

The broad field of prospectives



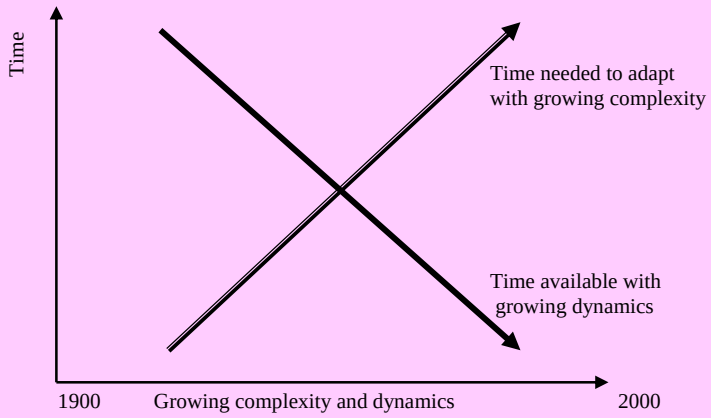
System view and path of analysis: bottom up and top down



The Challenges in 6 Dimensions

- Demographic Development
- Social Fundamentals
- Political Framework
- Technological Progress
- Ecological Sustainability
- Economic Trends

Time Constraint



Source: Bleicher, K. (Konzept), p. 39

Changing Frameworks

- **Division of Labour vs. Regionalization**
- **Knowledge Society vs. Specialization**
- **Community of Values vs. Narcism**
- **Sustainability vs. High Living**

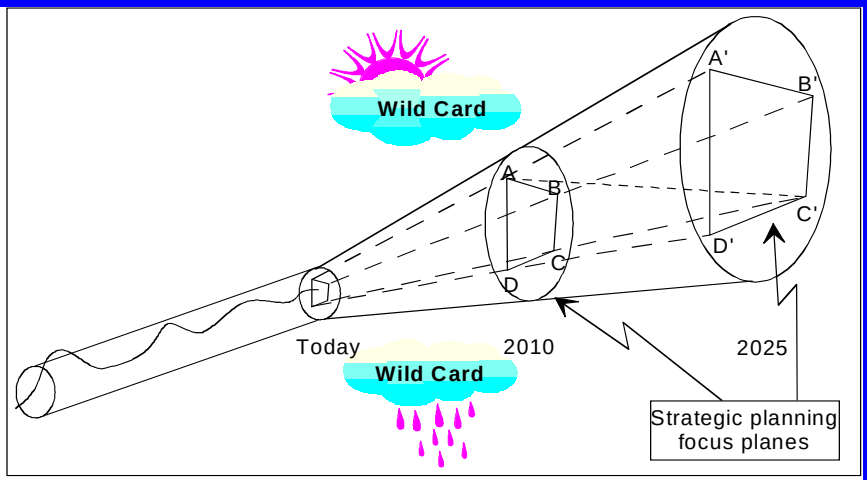
What are the prospects?

Where do we want to go?

Inevitable Surprises

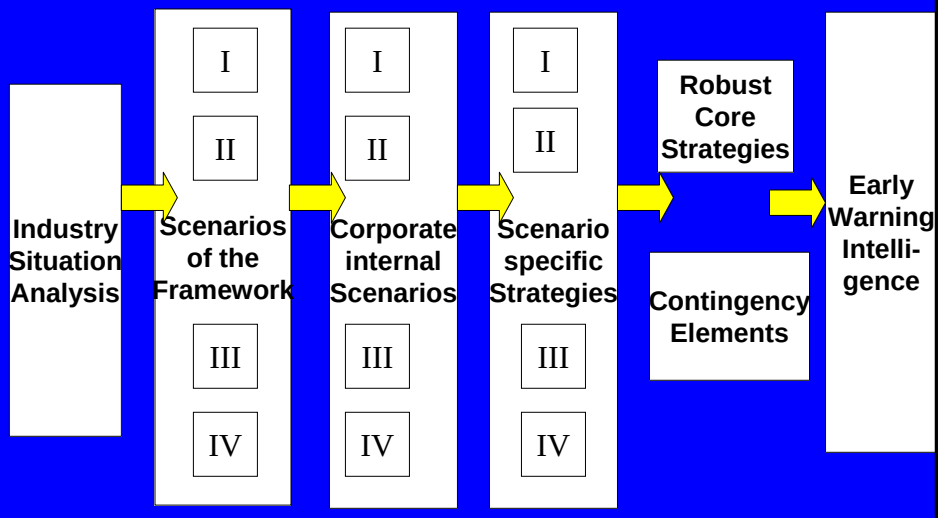
- A World Integrated with Elders: Ageing vs. Self-Responsibility.
- Migration: The Great Flood of People. Ghettos vs. Integration.
- The Return of the Long Boom: Globalization vs. Poverty.
- A Thoroughly New World Order: The US as rogue Superpower vs. ROW.
- Rising Tensions and Disorder: Terrorism; Crime; Disease; Famine vs. UNO.
- Technological Breakthroughs: Nano, Bio, ICT, Energy vs. Acceptance.
- A Cleaner, Deadlier World: Pollution diminishes; Global Climate Change

Space of plausible scenarios



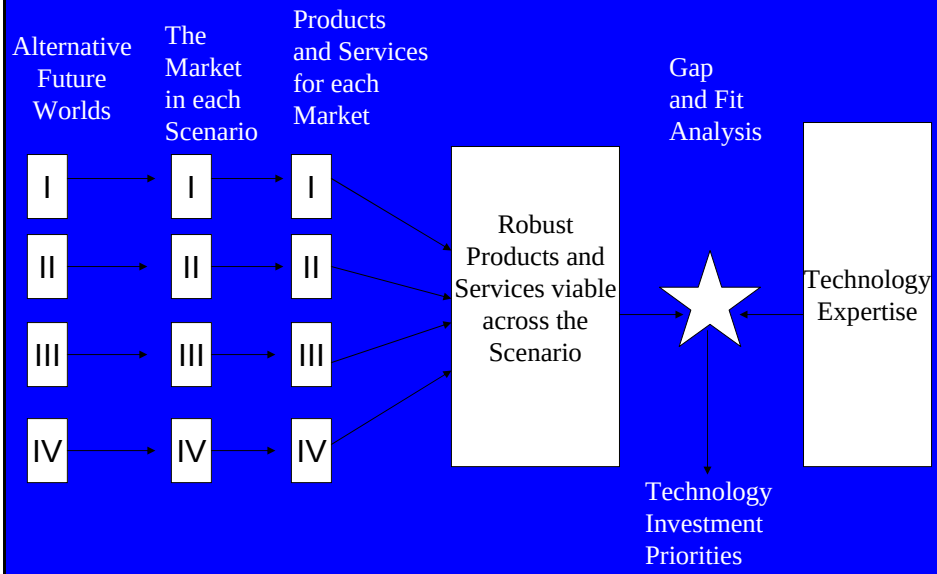
Source: Adapted from Taylor, C.W. (World Scenarios), p. 4

Scenarios to Develop Long-Term Strategy



Source: Perrottet, C.M. (Testing), p. 122

Technology Needed for Future Products



Source: Thomas, C.W. (Planning), p. 254

Required Technological Capabilities

Production Capabilities

- Production Managment (oversee operations)
- Production Engineering (optimizing efficiency)

Project Excecution

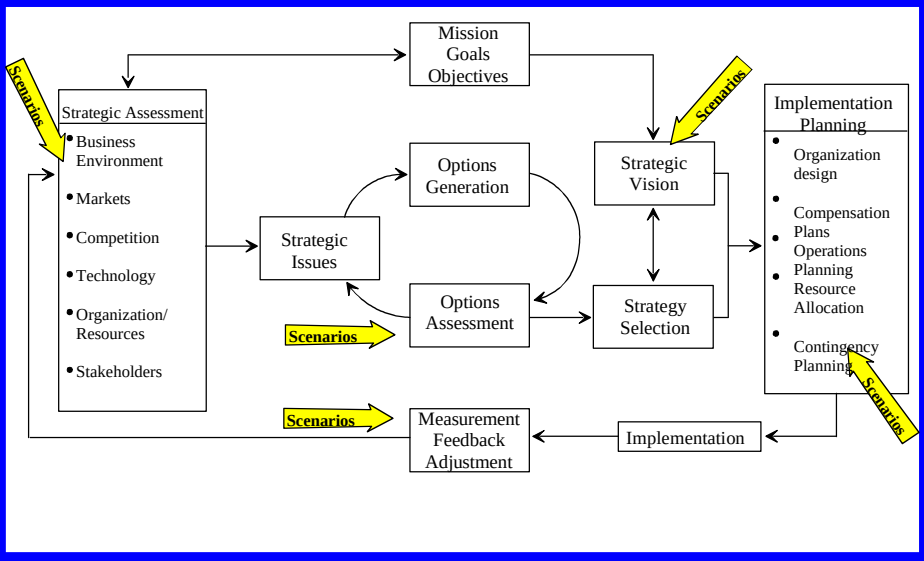
- Preinvestment feasibility studies (alternative strategies)
- Personel training („learning organization“)
- Project execution (establish/expand facilities)

Innovation Capabilities

- New Markets / new Clients
- New Products / production processes
- New Competences / Production Factors

Source: Adapted from Amsden, A.H. (Rest), p. 4

The Use of Scenarios in Strategic Management



Source: Wilson, I. (Implementation), p. 358

Prof. Dr. Hans Georg Graf, professor em. for political economy, has specialized in scenario-technique and economic forecasting. He has been professor for economics and fore-casting at the University of St. Gallen (HSG), Switzerland, and member in various Federal Commissions of Experts. As Lecturer on macroeconomics and prognostics for MBA-Curriculae he works for different universities.

Research Areas

Futures Research / Scenarios
Long-term Economic Development Trends
Competitiveness in the World Economy
Policy and Strategy Consulting
Construction and Building Industry

Prof. Graf has worked extensively in the scenario field since 1970. As a consultant for the Swiss Federal Government he has prepared long-range scenarios on the worldwide framework for the Swiss economy. Additionally, scenarios on demographic and economic trends as well as sectoral development have been developed. Planning of long-term policies of the Swiss Government has been widely based on scenarios developed by Prof. Graf and has been used extensively in the preparation of energy-, transport-, social security-, health- and education-policies. His work includes also scenarios for the construction industry. He is Director of the “SGZZ”, The Centre for Futures Research in St. Gallen, consulting business and public bodies mainly in Switzerland.

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Recent publications

In English:

- Economic Forecasting. Possibilities and Limitation, Quorum Books, Westport CT, 2002
- Global Scenarios. Megatrends in Worldwide Dynamics, Zürich 2002

In German:

- …. und in Zukunft die Wissensgesellschaft?, Zürich 2003
- In die Zukunft führen. Strategieentwicklung mit Szenarien, Zürich 2004
- Economics & Management. Zusammenhänge der Wirtschaftswelt, in Vorbereitung.

Idea Generation

Halka Baláčková

Idea Generation and Other Creative Problem Solving Methods

Halka Baláčková
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Summary

Creativity and new ideas generation are not a peripheral luxury of a few eccentric companies any more but a daily necessity of all businesses and organizations. However, it can be a difficult process for many reasons: fear, criticism by colleagues, negative thinking or simple lack of appropriate creative problem solving methods. So how can managers introduce a creative way of thinking into their organizations or teams? Brainstorming, brainwriting, mind mapping, using pictures and Edward de Bono´s thinking tools are good methods to start with.

Brainstorming is a widely used method, which was originally developed by Alex F. Osborn in the thirties of the last century. It is a group session led by a moderator, during which people try to collect as many ideas to the chosen topic as possible.

The main rules of brainstorming are:

- all members must feel free
- no criticism or judgments are allowed during the session
- it is quantity what matters, not quality
- all ideas are welcome and put on the flip chart
- evaluation is postponed after the session

All these rules can be applied also to other creative problem solving methods. They release the human mind from the analytic mode of thinking and increase its capacity to find new solutions. At the same time, they help build a better atmosphere in the team and support the acceptance of outcomes during the implementation phase.

The necessary prerequisites for a successful brainstorming session are: its preparation, wise conduct and well-done evaluation. The constraints of this method are that it does not help us rank the ideas, select important ones or check solutions. Therefore it needs to be supplemented with other decision-making methods.

Brainwriting is a form of brainstorming using first individual listing of the ideas on a piece of paper. Individually, it helps us generate ideas for any of our work or project, following the same rules as above. In group, it can be used to deal with more sensitive issues such as what motivates/demotivates us in our company. People can first list their ideas on PostIt 3M papers, and only then work with the anonymous papers as a group. It maximally enhances the participants´ feeling of safety and brings better and more open answers than traditional brainstorming.

Sometimes, a time restriction of about 1 – 2 minute can highly enhance our thinking capacity and effectiveness. **The method 90 s**, suggested by Vera F. Birkenbihl, uses this principle.

Mind mapping can be seen as a method additional to the two ones mentioned above. It uses an explosive, symbolic way of making notes rather than the traditional linear way. It is fast, holistic ad extremely stimulating way for preparing lessons, to do lists, daily schedules and generating ideas.

A guru of management creativity, **Edward de Bono**, developed many other methods of creative thinking, such as PMI, Six Hats or Po. His inspiring books offer a great inspiration for managers and companies all over the world and are highly recommended to all participants as a valuable source of information for further reading.

IDEA GENERATION –
brainstorming and other creative problem solving methods

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Session objectives

- What is idea generation
- Why it matters and when to use it
- Brainstorming - how to organise and lead a successful session, what mistakes to avoid
- Other creative problem solving methods (brainwriting, 90 s, mind maps, working with pictures)
- Creativity in companies

What is idea generation

„The best way how to have a good idea is to have many ideas“

- Alex F. Osborne, 1939, father of brainstorming
  - **method of thinking** up solutions, concepts, ideas in problem solving
  - using the ***brain*** to ***storm*** new ideas **in groups**
  - *„It is easier to turn down a wild idea than to think up a new one.“*

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Why it matters

- **no longer a luxury** for any company or manager
- **successfull companies** use it widely (3M, Nokia, Easyjet, Roche, DuPont, IBM, Olympus)
- **cheapest way of use and getting value** from existing assets
- **not a mysterious talent** but a skill that can be learned

Edward de Bono

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Problems in practice

- the creative process is **not always easy** (problems of fear, criticism, no existing solutions yet)
- one person has a **limited capacity**
- people **tend to judge** new ideas immediately and **tend to refuse them**
- a change is **difficult for a human being** unless it is well supported and managed

Creative thinking requires appropriate tools !

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Creative thinking methods

- **BRAINSTORMING**
- **BRAINWRITING**
- **90 S**
- **MIND MAPS**
- **PICTURE DRAWING**
- **Edward de Bono methods**

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1. BRAINSTORMING

- in a **group of people**
- **free associations** to the topic given
- **relaxed and friendly atmosphere**
- **deferred judgements –** release the human mind

As many ideas as possible, no matter how crazy they are

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Brainstorming - The key rules

1. **relaxed atmosphere - completely free**
2. **no criticism or judgements**
3. **quantity matters**
4. **all ideas legitimate**
5. **all ideas put on the sheet of paper**
6. **evaluation only after the session**

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UNIDO - Technology Foresight for Practitioners - Training course, October 2004, Prague

BENEFITS of brainstorming

WIDER PICTURE

FUN

QUICK

CHEAP

TEAM BUILDING

GREATER ACCEPTANCE

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When to use it

Well specified question:

- *How can we promote our products?*
- *What can our company do in 5 years hence?*
- *What can we do to solve the problem XY?*
- *How can we improve co-operation of A and B?*
- *What do our customers really want?*
- *What opportunities do we have this year?*
- *How can we have more fun at work?*

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BRAINSTORMING CONSTRAINTS

- does not rank the ideas
- cannot help you select the important ones
- does not suggest the best solutions
- must be amended by other methods

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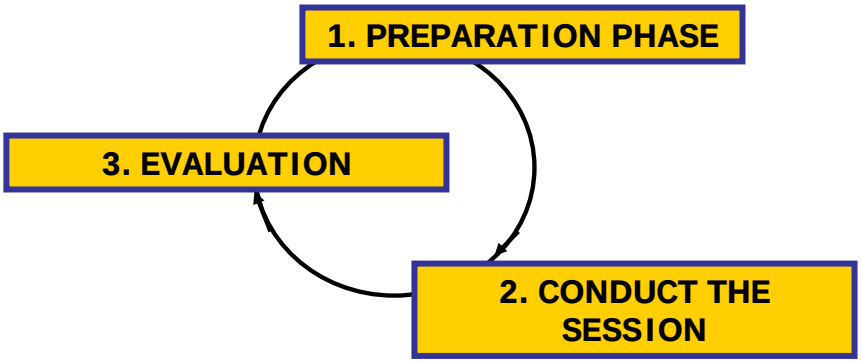
Organising a session?



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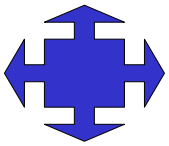
1. PREPARATION PHASE

Specify the problem

What do we really want?

Invite people

make sure they have time



Select the right people

up to 10 – 12 different positions

Decide when and where

place and time matters
„U“ layout of the room

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2. CONDUCT THE SESSION

1. **Specify the objectives** – make sure that everybody is happy with the central question.
2. **Decide the roles:** - leader, recorder, panel.
3. **Explain the rules** (or make sure that everybody knows them. Eventually – a warm-up exercise for fun). You can let people to jot down a few ideas before starting.
4. **Begin** by going around, after some rounds, open the floor.
5. **Record** the ideas **exactly**, clarify only in the end.
6. **Suspend judgements !**
7. **Encourage the ideas,** even the most radical and far-fetched. Allow the late coming ideas, do not hurry.
8. **At the end** – eliminate duplicates, clarify, thank the participants.

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3. EVALUATION PHASE

- **Put the evaluation off** / next day
- **Add newly born ideas to the list**
- **Group similar ideas together**
- **Select the best or most interesting suggestions**
- **Create teams which will work on them further**
- **Inform people about the results**

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Mistakes to be avoided

- **people are negative** in advance (it will not work anyway)
- **too many brainstormings** in the company
- **bad atmosphere** in the beginning
- **bad experience** with the method
- **judgements occur** during the session
- **any criticism** and **personal attacks**

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2. BRAINWRITING – A. INDIVIDUAL

When?

- *When you need to solve some problem alone, and you do not have a group to work with*

How?

- *A piece of paper (can be big and colourful to stimulate your thinking).*
- *Jot down all ideas linked with the issue.*
- *!! Do not judge yourself !!*
- *further steps as in brainstorming*

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BRAINWRITING – B: IN GROUP

When?

- *in a group of people, sensitive topic (eg. What do we like / dislike about our managers, company?)*

How?

- *a **set of papers / person** (smaller pieces, A4/3 or 3M), colours as needed, for example yellow and green*
- *people **individually note their opinions** on the cards, one idea per card, yellow – positive, green – negative*
- ***glue the cards on the flip** chart, grouping immediately similar opinions together, negative on the left, positive on the right*
- *let people see and **discuss the results***
- *brainstorming on **What can we do about it?** can follow*

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3. METHOD „90 s“

- **time restriction supports good thinking !**
- the method developed by **Vera F. Birkenbihl**
- **thinking is more focused** – the results are surprisingly much better
- think of a given subject **only from 1 to 2 minutes**
- **ask other people to think this time for you**

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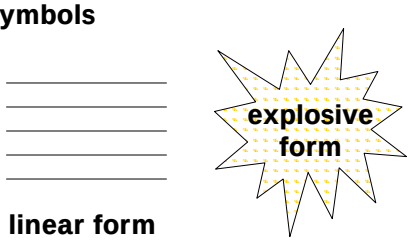
4. MIND MAPS*

WHAT is it?

- **alternative way of making notes and mapping any issue**
- many **well-known thinkers** used some form of it (Leonardo da Vinci)
- **does not use linear form of notes**, but **EXPLOSIVE**
- using **colours, pictures and symbols**

WHY?

- uses natural brain processes
- stimulate thinking, fun, joy



* eg. Tony Buzan, The Creative Intelligence

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How to use it

architecture

history

capital city

PRAGUE

culture

transport

restaurants and good food

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When to use it

- to make a **daily schedule**
- **notes** of the lesson, books, articles
- holiday **planning**
- **shopping list**
- **to do** list

- ✓ every day, as often as possible, be creative, develop your own style with time, have fun
- ✓ also in groups after brainstorming session

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5. PICTURE DRAWINGS

- **the value** of pictures sometimes higher then words – **hits our sight and heart**
- people express **underlying thoughts and emotion** that are otherwise difficult to formulate
- stimulates and uses the **right hemisphere**
- **use: SWOT** analysis**, company vision, team building etc.**
- **new, refreshing, fun**

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6. Edward de Bono methods

- many inspiring thinking tools
- improving perception, idea generation, decision making, problem solving
- thinking about thinking
- examples: PMI, time zones, Po, Six hats etc.
- strongly recommended to read – fun!

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SUMMARY

- **creativity is not born by itself**
- creative methods must be **consciously introduced and developed** in organisations
- **people must be encouraged** to use them, with no fear to make mistakes, prized for new ideas
- **support from top management** needed
- good **preparation and patience**

Have fun and all the best !

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End of Presentation

- Thanks for attention – questions welcome

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UNIDO - Technology Foresight for Practitioners - Training course, October 2004, Prague

Halka Baláčková completed her Master of Business Administration studies in Great Britain, at Durham University of Business School in 1994. Since that time she has been working as a manager, consultant and lecturer in the area of management training and development.

She was working for companies such as Apple Computer, Botanicus, Andersen Consulting, Zeneca and CS-Project. Since 2000 she has been working as a freelance lecturer and consultant, and closely co-operates with several main Czech education institutes and agencies (Masaryk Institute of Advanced Studies, Studio W etc.)

In 1998 she successfully completed her Certificate in Training Practice awarded by the Chartered Institute of Personnel and Development, UK and became an associate member of this acknowledged organisation. For several years, she also was teaching this programme at MUVS CVUT.

During her carrier she worked on numerous consulting and educational projects, for example Training the Trainers for Philip Morris, Russia, systematic management development programme for Vychodoceska energetika (East Bohemian Power Distribution Company), FOMA Bohemia, training seminars for Robert Bosh, ING Bank, Deloitte&Touche, KPMG, Komercni Bank Czech Republic, Preciosa and many others.

Since 2000 she has been closely co-operating with one of the biggest Czech advertising and communication agency, Ogilvy Group (Ogilvy&Mather, OgilvyOne), as a lecturer and couch in management skills.

In her free time she practises Aikido and Yoga.

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Using Expert Panels in Foresight

Michael Keenan

Using Expert Panels in Technology Foresight

Michael Keenan

PREST, University of Manchester, Manchester M13 9PL , United Kingdom

Summary

This presentation covers perhaps the most ubiquitous of all Foresight methods, the expert (and/or stakeholder) panel. Panels are used for a variety of purposes in foresight, and also take a variety of forms. The presentation explores some of these, after which we consider some of the practical issues associated with using panels to include: specification of a panel's mandate; challenge of identifying and assembling panel members; how to get started and how to organise a panel's work; generating consensus and priorities; and reporting and dissemination. A case example, taken from the national Technology Foresight Programme in the UK, is used to demonstrate some of the issues and questions raised earlier. The presentation is rounded off with some general open questions for debate.

Using Expert Panels in Foresight

UNIDO Foresight Training Course
Prague, October 2004

Dr. Michael Keenan
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Outline

- What are panels?
- Why are they used?
- Defining a panel's mandate
- Panel profile
- Identifying panel members
- Panel costs
- Getting started
- Organising and managing a panel's work
- Producing outputs and action
- Some case examples from the UK

What are panels?

- Many shapes and sizes – from 'BOGSAT' to online public forums
- Expertise profile – Expert / Stakeholder
- Face-to-face / Remote
- High / Low no. of members
- Public / Private
- Focus and Time – Tight framework / Standing group

Why use panels?

- Ubiquity of panels in foresight studies – why?
  - Foresight is a participative, discursive activity – panels are ideal for opening up the foresight process to hundreds of people and allow for meaningful debate and knowledge exchange
  - Availability of expertise 'on tap' within the exercise
  - Easily complement (and even necessary to) other foresight methods
  - Authority, credibility, legitimacy
  - Incubators for foresight 'champions'
- 'Process centres' for foresight
- Dangers of over-dependency on panels?

Defining a panel's mandate

- Be clear on why panels are being used – benefits of scoping foresight design
- Terms of Reference
  - Distributed to panels at the outset
  - Provides background on and rationales for exercise
  - Sets out:
    - What needs to be achieved
    - How the panel should conduct its work
    - Series of milestones for deliverables
    - How the panel works fits into the overall foresight study
    - Details of resources available to panel
  - Allows for accountability and transparency

Panel profile

- Composition
  - What sorts of expertise and/or experience does the exercise require?
  - Does this need to be represented on the panel?
- Balance
  - Within panels and/or within individuals
  - Perspectives
  - Biases and interests
  - Transparency
  - Methodological support
  - Wide consultation

Identifying panel members

- Personal contacts
- Nominations
- Co-nomination
- How many individuals to each panel?
  - 12-20 the norm
  - Sub-groups and online fora
- Panel chairperson
  - Standing
  - Time
  - Interpersonal skills

Panel costs

- How many panels to appoint?
- Honoraria
- Facilitators and secretaries
- Technical support
- Travel costs and other overheads

Getting started

- Provision of background information
- Training
- Panel plan, including agreement on approach, deliverables and milestones
- Identify knowledge gaps and information needs
- Articulate and develop a shared understanding of the expectations of target audience
- Set-up sub-panels (optional)
- Early immersion - brainstorming

Working practices

- Difficult to generalise – depends on panel's remit (wide / narrow)
- Consider (often conflicting) challenges:
  - Avoiding 'BOGSAT'
  - Short-termism (failure to look forwards of back)
  - Evidence-based – collecting and digesting data
  - Getting people to act as individuals rather than representatives
  - Instilling creative thinking
  - Unfamiliarity with some foresight methods
  - Awareness of and openness to different perspectives
  - Time management
  - Ensuring sustained attendance at meetings
- Progress reports and transparency

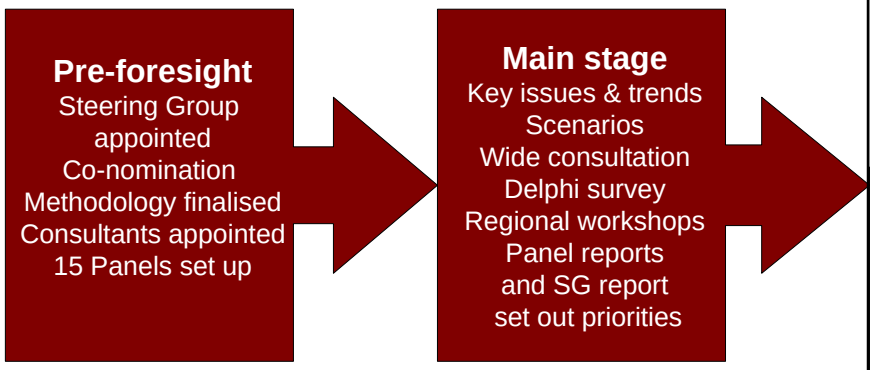
Closure and Reporting

- Reaching ‘closure’ – priorities and recommendations
- Findings – audit trail – coherence and integrity
- Preparation of written reports and briefings
- Measuring success and quality
- Dissemination strategy – role of panels?

UK Technology Foresight (1993-98)

- Announced in 1993 S&T White Paper
- 15 Panels and a Steering Group - all volunteers
- Delphi survey and other methods to ensure wide consultation - techniques of ‘discipline’
- Managed by OST, with consultants facilitating
- Main phase took 18 months (1993-95)
- 10-20 year time horizon
- Followed by proactive dissemination and priorities implementation phase (1995-98)
- Second round of Foresight launched in 1999, followed by a third round in 2002

Phase 1: Stages to report production (1993-95)



Foresight Panels

- ANRE
- Chemicals
- Communications
- Construction
- Defence & Aerospace
- Energy
- **Financial Services**
- Food & Drink
- **Health & Life Sciences**
- IT & Electronics
- Leisure & Learning
- MPBP
- Materials
- Retail & Distribution
- Transport

Panel Goals for Phase 1

Essentially, to produce a report that outlined:

- the factors the panel considered important in future markets, including some assessment of their relative importance;
- an assessment of the most promising opportunities for matching new technological advances to future markets;
- the panel's perceptions of the strengths and weaknesses of the UK industrial, scientific and technological base, as identified during wide consultation and in the benchmarking work; and
- a set of priorities and recommendations

Panel Ground Rules - Phase 1

- Appointment of Chair, Secretary, Facilitator, and SG Assessor
- Consideration of Trends and Issues (April-August 1994)
  - using cross-programme survey plus bespoke methods
  - cross-panel contacts 'encouraged'
  - US$15,000 for each Panel to pay for information gathering
- Using this information,
  - produce a preliminary report on possible market and technological developments over 10-20 years *(comparability & monitoring purpose)*
  - generate Delphi topic statements
- Wider Consultation, through Delphi and Regional Workshops (Sept-December 1994)
- Constructing Priorities using criteria endorsed by the SG
- Writing a Panel Report against a template provided by OST Programme Managers (January-February 1995)

Panel Make-up

Financial Services

- 7 industry, 4 academia, 4 government = 15 members
- Chaired by senior industrialist
- Wholesale financial services rather than retail
- Few members had knowledge of S&T
- London bias in membership

H&LS

- 10 academia, 7 industry, 4 government + others = 21 members
- Chaired by senior academic
- Life sciences predominated at expense of medicine
- Members drawn from all over the UK

Identifying Trends & Issues

Financial Services

- 8 full Panel meetings
- Techno focus at outset
- Began with brainstorming to generate initial topic list
- Co-nomination failure
- High response rate to Trends & Issues survey
- 26 'expert witness' interviews using survey
- S&T inputs sought from ITE Panel's 'Roadmap' report
- List of 12 trends and issues used to construct Delphi topic statements
- 3 iterations of topic statement drafting

H&LS

- 4 full Panel meetings
- Began with brainstorming to generate initial topic list
- 13 small working groups
- Cross-panel connections
- Co-nomination uneven
- Medium response rate to Trends & Issues survey
- Consultation using postal survey + interviews around 10 'Hypotheses' - focus on the corporate rather than individual
- Time management problems led to Delphi topic statements being drafted in a single afternoon

Wide Consultation & Prioritisation

Financial Services

- 5 full Panel meetings
- Delphi response rate 20%
- Delphi described as being like 'black magic', but results extensively used by Panel
- No Regional Workshops
- Benchmarking study contracted out
- Prioritisation criteria applied sparingly
- 'Assumptions' drawn up in order to frame priorities
- 5 recommendations identified, intended to be additional
- 5-year time horizon apparent

H&LS

- 4 full Panel meetings
- Delphi response rate 32%
- Delphi 'too early' and validity of results called into question - results barely used by Panel
- 5 Regional Workshops
- Benchmarking studies contracted out
- Prioritisation criteria applied in an ad hoc manner
- 11 priority areas identified in descending order - quite generic although intended to be additional

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Panel Priority Areas (1995)

Financial Services

- IT Education
- Financial Engineering
- Detection & Prevention of Fraud
- Telecommunications Regulation
- Standard Financial Qualification

H&LS

- Infrastructure for the development and exploitation of the life sciences
- Integrative Biology
- Neurosciences
- Age
- Genetics in Risk Evaluation
- Drug Creation & Delivery
- Recombinant Technology
- Diagnostics
- Immuno-compatibility
- IT in Health Services
- Clinical Research and Research Training

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Some questions . . .

- Impact of panel make-up (interests and knowledge)?
- Importance of panel support (chair and facilitator)?
- Role of disciplinary and surveillance techniques?
- Accountability of panels?
- Possibility of quality control?
- Cross-panel challenges
- Attendance of members and other time management issues?

Questions and Comments?

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Scenario Planning

Ian Miles

Scenario Planning

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Summary

The term "scenario" is used in many ways, and scenarios themselves can make various contributions to Foresight studies. We see scenarios as efforts to systematically explicate visions of future possibilities – of "prospective histories" and their outcomes at points in the future. To cover a wide range of different activities, even within Foresight programmes. They may be **exploratory** -focusing on what might happen under various circumstances. Normative or **aspirational** scenarios, in contrast, examine how specific futures can be achieved (or avoided). The ways of producing scenarios vary immensely - from the outputs of simulation models, through the work of small expert teams, to workshop activity (and methods involving even larger sets of people). The presentation will consider some of the different types of scenario and ways of developing them, but will focus specifically on issues raised in the context of organizing effective scenario workshops.

What are the roles of scenarios in Foresight? Most basically, they may be used more as an element of the Foresight **process** as **products** of the activity that can be circulated to broad audiences. In the latter case, the scenarios are liable to be mainly **presentational** devices that can communicate Foresight results to wider publics, and perhaps dramatize issues and make the case for action. Process-oriented scenario work can contribute to the exchange and further development of visions. This can help the deepening of linkages in networks. They may thus be used as **inputs** to kick-start discussion and idea generation in panels, as **tools** for working groups to marshal their arguments and test the robustness of policies.

This paper will discuss these issues and approaches, drawing on examples of how scenarios have been used in recent Foresight studies. It will pay particular attention to the approaches used in scenario workshops. Lessons will be drawn as to the application of scenarios within Foresight exercises.

The lecture of Ian Miles on Tuesday, 2 p.m. to 6 p.m. will be organized as follows:

a) lecture on principles and purposes of scenario analysis (2-2.45)
b) discussion of organisation of a scenario workshop (2.45-3.15)
c) examination of how a particular workshop was conducted (3.15 – 3.30)
d) experiential elements – practice sessions in taking part in scenario workshop like the one described (4-5.30)
e) final discussion, conclusions (5.30-6.00)

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SCENARIO PLANNING

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Outline:

- What are Scenarios?
- Why Use them?
- Varieties of Scenarios
- Ways of Producing Scenarios
- Scenario Workshops – principles and examples
- Using Scenarios

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Defining scenarios

Many definitions – Kahn, Schwartz, etc.

- *"Systematic, explicit vision of possible future"*
- *Image of the Future* vs *Future History*
- Scenarios, Vignettes, Profiles

EXPLORATORY (outward) and NORMATIVE (inward) SCENARIOS

- **Huge Variety of Methodological Approaches:** EXPERT (desk based), WORKSHOP, PARTICIPATORY…

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Multiple scenario analysis

Why?

- To illustrate alternatives, indicate a range of plausible developments (not one inevitable future path).
- To stimulate reflection on underlying assumptions.
- To assess robustness of strategies.
- To give insight into contexts and outcomes (intended or otherwise) under which actions may be undertaken, events may happen, objectives may be realised.
- To help identify turning points, key decisions, indicators, early warnings of change.

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Multiple scenario analysis

Common to use 3 or more scenarios:

- Mainly because this is usable by sponsors
- Should thus be structured so as to capture MAJOR variations – parameters, drivers – not usually Wild Cards (elaborate scenarios from these is a separate task)

- But some work, e.g. Canadian studies, uses many more. In Canadian Foresight, one scenario (set) per major driver.

- Some "multiple scenarios" are just canonical variations on a theme, while others are just vignettes within a standard framework

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Scenario Generation & Analysis -Methods

- Genius forecasts
- Expert Groups, deskwork,
- "Modelling" tools like simulation, cross-impact; gaming
- Surveys, clustering articulated viewpoints
- Workshops

- .. Beginning to see computer support in several ways inc. (a) modelling
  (b) group support (F2F and virtual)
  (c) viewpoint analysis

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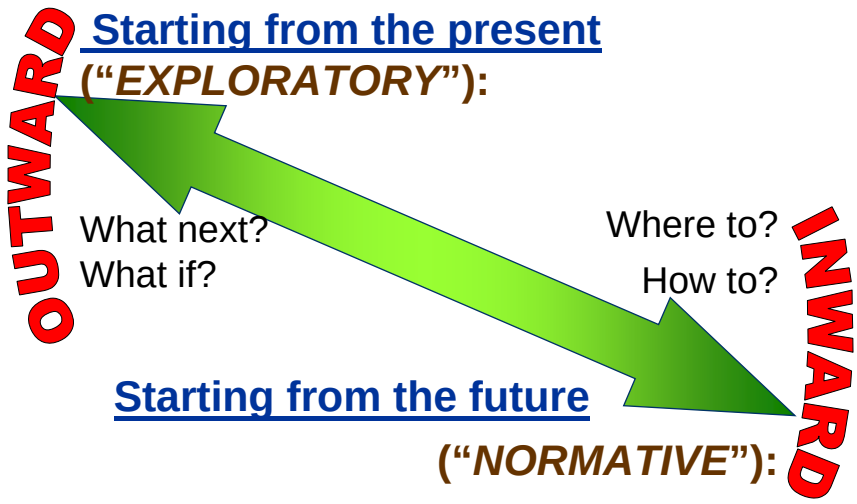
Exploratory and Normative Scenario Analysis



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Outward Scenarios – Common Workshop Approach

•STEEPV framework is often used for workshop and expert groups to:
- systematically analyse "drivers and shapers",
- group trends and events

- Social
- Technological
- Economic
- Environmental
- Political
- Values

Pathways diverge according to varying Events/Trends

Select alternatives by major uncertainties/ groups of drivers?

A

B

C

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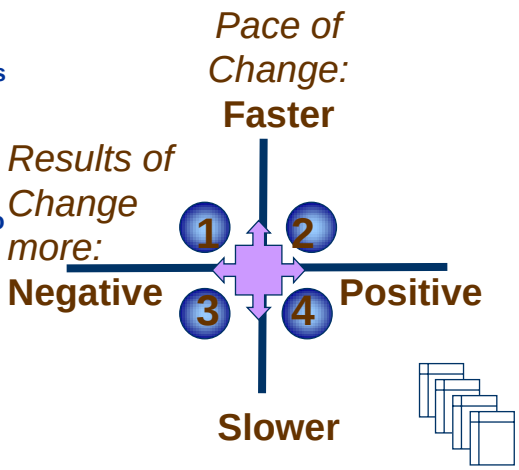
Outward Scenarios – from survey analysis

Survey asked a series of questions about how far IT applications and implications would have developed over next 10, 20 years.
- Results factor analysed to obtain simplified structure
- First two components led to four scenarios, with numerical estimates, etc.

Corresponded with literature review

IT Futures Surveyed



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Inward Scenarios – from Desk-based analysis to a workshop in FISTERA

Scenario 1

Progress and polarisation

Competitive and Dynamic Knowledge Society:
- rapid growth in IST use
- economy-driven innovations
- uneven development

Scenario 2

Catch Up and creative

Cohesive & Integrated Knowledge Society:
- rapid growth in IST use
- economy-driven innovations
- much reduction in disparities across EU

Challenged Knowledge Society:
- slow and very uneven growth in IST use
- innovations in specific areas
- major concerns about technology & market

Challenged and contested

Scenario 3

Sustainable & Inclusive Knowledge Society:
- new paradigms of IST use
- social & community-driven innovations
- environmental and other objectives

Doing things differently

Scenario 4

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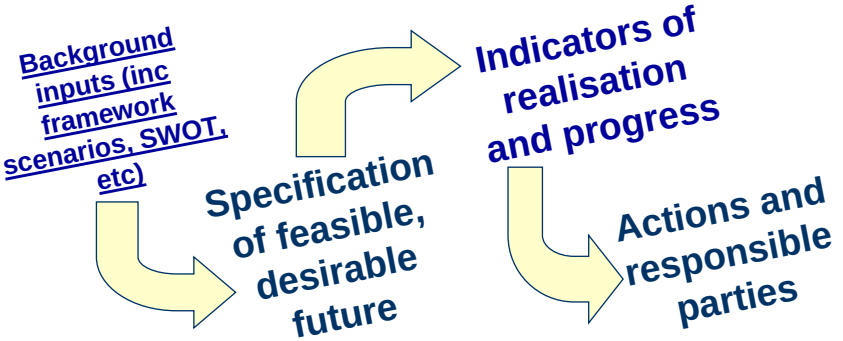
"Success Scenarios" – Workshop Approach

A desirable future of particular interest to users - the aspirational SUCCESS SCENARIO (may use multiple scenario analysis at the outset, but then the workshop process aims to define how to get to a desired future)



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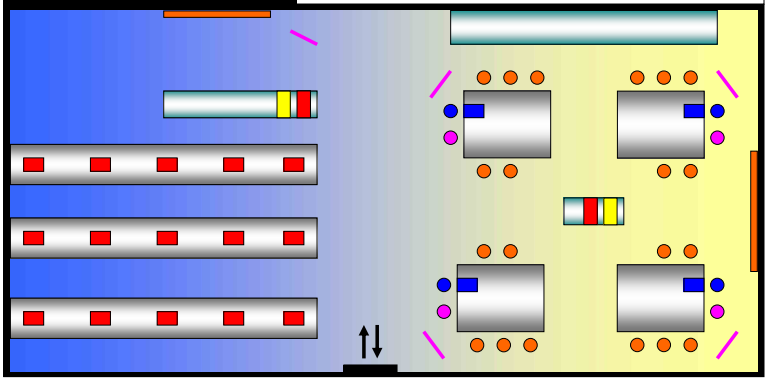
FISTERA Set-up

FISTERA IST Trends Workshop

The following diagram represents the design of the working environment:
- ***people zone***
- ***info zone***

PREST facilitators' table
Flip charts
Participants
Participant *rapporteur*
FISTERA *chairman*
Table for participants
Laptop
Computer with Internet
Beamer
Area for projection



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FISTERA Structure

Introductory session

Major IST trajectories identified by FISTERA

Brainstorming on potential applications increasing functionality of IST
(4 groups working on 8 of the 12 key application areas)

G1 G2 G3 G4

- Social / family relations
- Cultural diversity
- Transport
- Ageing
- Health
- Social welfare / public services
- Leisure and recreation
- Security
- Education and learning
- Government
- Management
- Work organisation

Scenario workshop
- 4 'desk' scenarios
- 10 positive drivers
- 11 negative drivers

FISTERA Delphi
- R&D and social needs
- EU goals & IST areas
- 8/12 'Panoramic' Delphis

Groups feedback & concluding remarks

Evaluation of the workshop from participants

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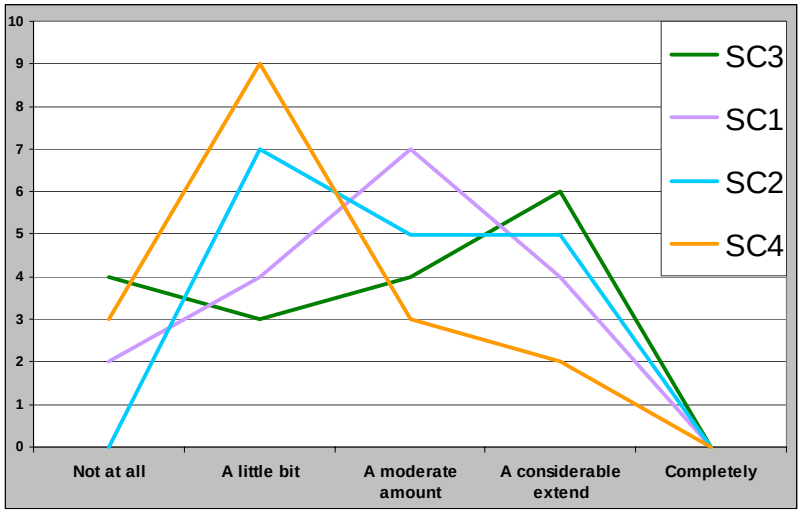
Examples from FISTERA

Extent to which scenario is reflected – not probability!



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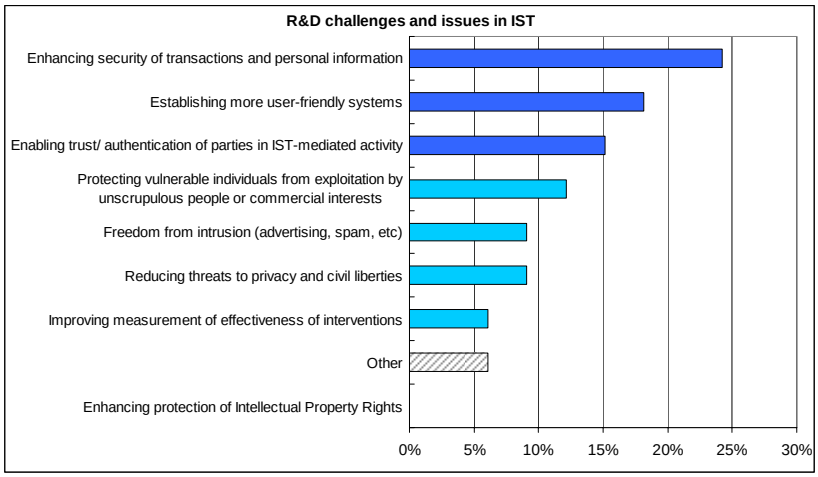
Examples from FISTERA

Final judgements as to R&D priorities



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Planning the Scenario Process

- Define **objectives** – illuminating a specific issue – or providing general strategic intelligence for an organisation?
- **Preparation** required – "design workshop" or steering group useful. Can help embed scenario work, fostering "ownership"
- **Technical facilitators** valuable (whether posters or PCs).
- **Planning team**, drawing on relevant expertise (within and outside organisation)
- **Background Material** for common information base
  - "starter scenarios"
  - SWOT, benchmarking and relevant statistics
  - Useful analyses
  - Orientation
    - But don't overhwelm or rely too much on this! Prepare presentations
- **Workshop Material**
  - Presentations
  - Instructions
  - Equipment, software, pencil and paper tools, etc.

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Presentation

HISTORIES

- "Flow charts"
- Trend analysis
- Signposts (indicators and events – useful for scanning)
- Narratives (press reports; historian's reflections…)
- Strategy games – good for analysis of options, plans…

IMAGES

- Comparative Tables
- Charts
- Narratives (press stories; diaries, vignettes …)
- portrait of organisation/ market/ actors... policy outcomes

How to deal with wildcards??

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Scenario Assessment
~ *the scenarios/outputs need to be:*

Useful → *Not too numerous,detailed or ambiguous – expressed in terms relevant to user capabilities and interests*

Robust (*not* Accurate as such) → *Reflect the range of potential future conditions, challenges, for the topic/users*

Novel/ Stimulating → *Stretch thinking, include surprises*

Provocative/ Challenging → *Confront the difficulty, ambiguity, and significance of the topic; Scope for thinking the unthinkable, transgressing boundaries, while not triggering kneejerk controversy*

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In Summary :

- Scenarios are potentially very useful
- Have to be appropriate to purposes, audience, etc - product and/or process contributions; insight vs networks vs planning orientation.
- A combination of expertise and craft – neither science nor magic. Gurus not necessary, but preparation and training are!
- Capable of being produced in many different ways.
- There are better and worse ways for a given situation, but **not** one all-purpose best way.
- *Sometimes* fun to produce; *sometimes* fun to read, *usually* hard work to create (OK); *often* hard work to use (this is not OK)!

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End of Presentation

Thanks for attention – questions welcome

Ian Miles is Professor of Technological Innovation and Social Change at the University of Manchester. He is CoDirector of PREST (Policy Research on Engineering, Science and Technology) and one of the founding Directors of CRIC (Centre for Research on Innovation and Competition). These two groups are part of the Institute of Innovation Research at the University of Manchester. Before moving to Manchester in 1990 he was a Senior Fellow at SPRU (Science Policy Research Unit, University of Sussex).

He was a panel facilitator for the Transport Panel of UK Foresight in the mid-90s, was earlier a Consulting Editor to the journal FUTURES, is now on the editorial board of FORESIGHT, as well as TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE, and INTERNATIONAL JOURNAL OF FORESIGHT AND INNOVATION POLICY. Recently leader of study for European Foundation on "Knowledge Society Foresight".

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Some "futures" publications (See website: http://les1.man.ac.uk/cric/ian_miles for full bibliography and links to online publications; also see http://milesblogs.blogspot.com/)

- I Miles, H Rush, K Turner and J Bessant 1988 **Information Horizons: the long-term social implications of new information technology** Aldershot: Edward Elgar
- S Cole and I Miles 1985, **Worlds Apart: Technology and North-South Relations in the Global Economy** Brighton: Wheatsheaf
- "Why the Future is Fortean" **Foresight** February 1999 vol 1 no 1 pp 73-90
- Cyberspace as Product Space" **Futures** Vol 29 no 9 pp769-790 November 1997
- D Loveridge and I Miles, with Michael Keenan, Rafael Popper & Duncan Thomas 2004 **European Knowledge Society Foresight: The EUFORIA Project Synthesis Report** European Foundation, Dublin available at: http://www.eurofound.eu.int/publications/files/EF0404EN.pdf
- M Keenan, I Miles, Jari Koi-Ova 2003 **Handbook of Knowledge Society Foresight** European Foundation, Dublin, available at: http://www.eurofound.eu.int/transversal/foresight.htm
- **Practical Guide to Regional Foresight in the United Kingdom** 2003 (versions of this report are published in every EU15 country except Luxembourg) Luxembourg, European Commission, EUR 20478, ISBN 92 894 4682 X all versions online at: http://www.cordis.lu/foresight/CGRF.pdf and versions for accession countries and some Latin American countries are in preparation
- Advisory Group On Nanotechnology 2002 (text actually prepared by D Jarvis and I Miles) **New Dimensions for Manufacturing: A UK Strategy for Nanotechnology** London:DTI http://www.dti.gov.uk/innovation/nanotechnologyreport.pdf
- FOREN Network (IPTS, PREST, CMI and SI) 2001 **A Practical Guide to Regional Foresight** IPTS, Seville EUR 20128 EN 121pp available at: http://foren.jrc.es/Docs/eur20128en.pdf
- **Clicks and Mortar, the new store fronts** London, Department of Trade & Industry Available online at http://www.foresight.gov.uk/
- **Technology Foresight: Implications for Social Science** CRIC, University of Manchester, Working Paper no 3 ISBN 1 84052 002 7 Online at http://les1.man.ac.uk/usercgi/cric/cricpaperdl.asp?paper=wp3
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- I Miles and M Keenan 2003 "Two and a Half Cycles of Foresight in the UK" **TECHNIKFOLGENABSCHÄTZUNG: Theorie und Praxis** *(ITAS journal on technology assessment)* Vol 12.Nr. 2, Jahrgang – Juni 2003 pp41-49 available at: http://www.itas.fzk.de/tatup/032/inhalt.htm
- C Bezold and I Miles 2002 "Social Science Research Priorities Related to Genomics: The "Bottom Line" for the ESRC Genomics Scenarios Project" pp36- 42; M Harvey, A McMeekin, I Miles 2002 "Genomics and Social Science: Issues and Priorities" pp13-28 **Foresight** vol 4 no 4 ISSN 1463 6689 online to subscribers at www.emeraldinsight.com/fs
- I Miles and M Keenan 2002 "Bringing It All Back Home: Linking National and Regional Foresight" **IPTS Report** no 61 February 2002 pp29-35 *online at http://www.jrc.es/*
- M Keenan, I Miles, F Fahri and D leCoq, 2001 Creating Vision in the Regions: a framework for organising Regional Foresight **IPTS Report** no 59 Nov 2001 pp6 –12 *online at http://www.jrc.es/*

Services and Foresight **Service Industries Journal** vol 19 no 2 pp 1-27 April 1999

Delphi Surveys

Kerstin Cuhls

Foresight tools – Delphi surveys

Dr. Kerstin Cuhls
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Breslauer Str. 48, 76139 Karlsruhe, Germany

Summary

Delphi surveys are a specific survey method with feedback to gain judgements about topics of the future. After the definition, principles and types of Delphi surveys (postal vs. on-the-spot; paper vs. online; opinion vs. decision, etc.), it is described how to conduct a Delphi survey. The question is raised, if or in which cases Delphi can be considered a relevant tool for a given foresight programme. The design of a survey is discussed in more detail: How are statements and questions formulated? Who are the participants? What are the resources needed? What is the best timing, the budgeting and management of a survey? In the end, some results are presented to give a feeling for the usability and implementation of Delphi surveys.

Foresight tools – Delphi surveys

(Dr. Kerstin Cuhls)

- What are Delphi procedures?
- Principles, Process, panels, questionnaire design
- Group activity
- Who is involved? Who is an expert?
- Dimension of a study, resources needed
- Analysis and Implementation of results (with examples)

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What is Delphi?

- Delphi is an expert survey in two or more "rounds".
- Starting from the second round, a feedback is given (about the results of previous rounds).
- The same experts assess the same matters once more - influenced by the opinions of the other experts
- important: anonymity

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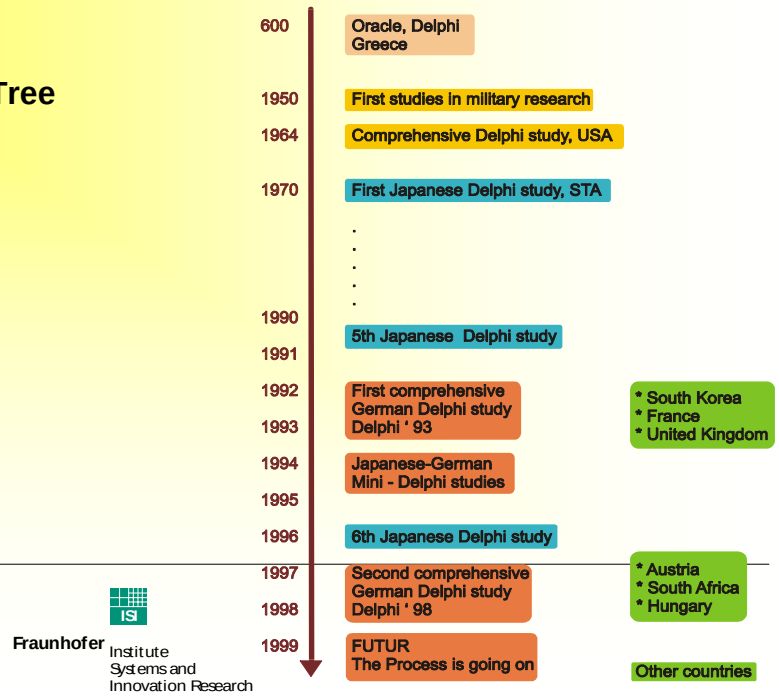
Genealogical Tree



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Before you start your foresight, ask yourself

- What is my objective?
- How many resources (manpower, money...) do I have?
- Is Delphi the right choice?
- How can I formulate the statements?
- What are my questions?

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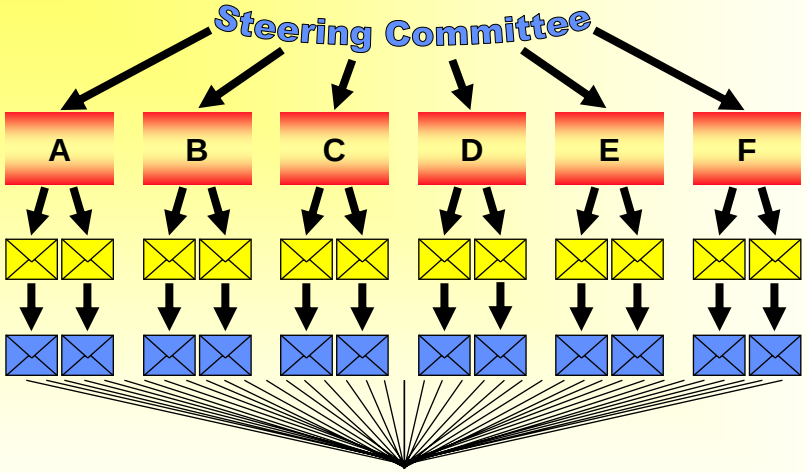
Organisation of a Delphi Process



Expert Panel,
100 Persons

12 Questionnaires/
7000 Adressees

1. Round
2400 Persons

2. Round
1900 Persons

Results, Analysis, Discussion...

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Fields Delphi '98

- Information & Communication
- Service & Consumption
- Management & Production
- Chemistry & Materials
- Health & Life Processes
- Agriculture & Nutrition
- Environment & Nature
- Energy & Resources
- Construction & Dwelling
- Mobility & Transport
- Space
- Big Science Experiments

Define your fields or find a way to define them!

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How to define your fields

- ➔ in a steering committee
- ➔ by the financiers/ sponsors/ ministries/ associations/ others who are involved
- ➔ by the organisors/ management team
- ➔ by doing a brainstorming and then grouping and structuring the generated topics
- ➔ in workshops/ working groups
- ➔ by using standard classifications (from patent lists to economic indices)
- ➔...
- ➔ Or: no field definition

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Example: Service & Consumption

Structure your fields!

New services (based on new media)

- Teleshopping
  - electronic supermarkets
  - biometric techniques for the authentication of trade transactions
- Finance services
  - digital money for electronic money transactions
  - permanent monitoring as deterrence against money-laundering and fraud
  - robot-leasing
- Leisure
  - pay-TV
  - virtual reality for journeys, sports events, film shows etc.

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Finding and Formulation of Topics

Organisation/ management has to be clear

- Panels/ working groups
  - workshops
  - creativity methods
- Survey
  - open questions
- Analyses
  - literature
  - patents
  - bibliometrics
  - trend analyses
  - others

Create a process to define your themes and topics!

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Some Topics

Create a process to define your themes and topics!

Wide range of possibilities, but have to be kept short, clear, and unambiguous.

- Various micromachines which can move independently in the human body are applied *in clinical use* (e.g. for blood diagnosis and thrombosis therapy).
- Flexible, robust displays are *available*.
- Space factories *are built* to produce new materials, utilising high-vacuum and weightlessness.
- High-efficiency geometrical optics for analyses of radiating equipment, e. g. substances under the earth, using electron or positron storage rings with a radiation emittance under 1 m pGy are *in use*.

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Examples for misunderstandings

Create a process to define your themes and topics!

- ☹ A high number of cars have catalysts.
- ☹ A sleeping capsule is developed in which you get younger when you are sleeping.
- ☹ Micro machine elements are developed, they are used in medical equipment.

Why assessing topics? Why experts?

- a lot of information available
  - ➔ how to differentiate
  - ➔ what is interesting for you
- we do not know much about the future
  - ➔ especially in science and technology developments, „experts“ should know (question of who is an expert remains)
  - ➔ hypotheses: more persons know more
  - ➔ find out if there is consensus about the assumptions we have
- different assessments necessary: time of realisation, importance - and important what for, degree of certainty, desirability, ...

Who is an expert?

Broad definition versus high expertise

- Define how broad your expert definition is
  - ask them in the questionnaire about their expertise
  - laymen for crosschecking?
- Define where your experts are from
  - which sectors
  - branches
  - thematic fields or disciplines...
- Define how many experts you need
  - sample must be large enough for the analyses planned
  - the more you need, the more expensive it will be

Think about your experts!

What to judge? How to assess?

Different possibilities, example:

- Expertise of the participants
- Time of realisation
- Measures to be taken
- Who leads in R&D
- Importance for
  - economy
  - environment
  - education
  - ...

Define your questions!

What do you need to know?

What does your questionnaire look like?

New possibilities:

- printed questionnaire
  - postal delivery
  - fax...
  - design: quality
- electronic questionnaire
  - online: Internet
  - offline: word questionnaire, e-mail...

Decide on the design of your questionnaire!

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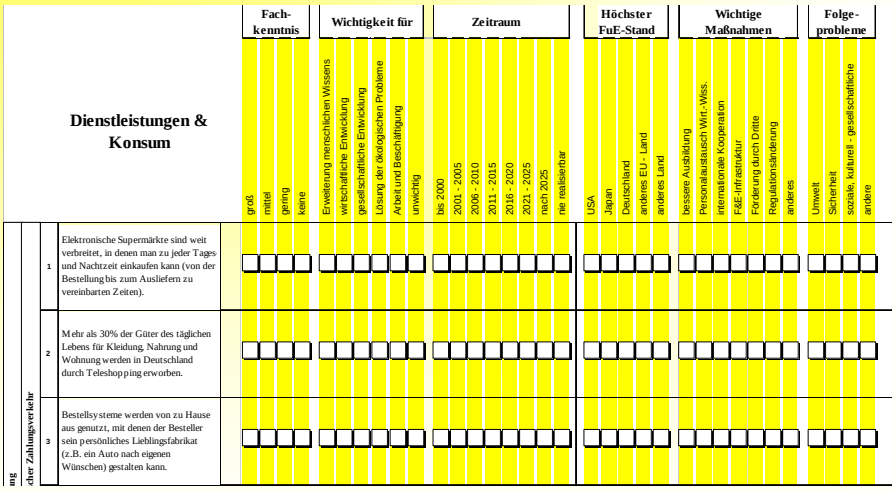
Decide on the design of your questionnaire/ Example Delphi '98



Source: Cuhls/ Blind/ Grupp: Delphi '98

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Electronic versus conventional

- **Postal Delivery/ Fax** (printed questionnaire)
  - Expensive: printing and typing the results
- **Offline electronic** (e.g. Word questionnaire via e-mail)
  - Relatively inexpensive
  - Expensive: Programming for filtering out the results or typing
  - Security problems
- **Online electronic** (Internet)
  - Expensive: programming
  - Fast feedback and fast analysis possible
  - Many possibilities to design, to ask and to guide the participants

Group activity

Formulate Delphi statements and write them down.

can be funny and creative

Criteria:

- must be somehow realistic
- time horizon: at least 5 years, up to 30 years
- must be clear and unambiguous
- if possible use standard verbs: is clarified, is developed, is in widespread use

Megatrends

Megatrend	Agree-ment	Time Frame	Disagree-ment
In industrialized countries over 1/3 of the population will be older than 60 years.	89	2008 - 2019	7
The unemployment rate will increase permanently in the developped countries.	74	1999 - 2006	22
World population will surpass the 10 billion border.	72	2010 - >2025	19
Germany will again become an internationally attractive location for investment.	61	2003 - 2009	27
Women will at least keep one-third of all executive positions in business.	57	2008 - 2020	32
Rationing of energy consumption for private households will be enforced.	54	2011 - >2025	41
Increasing environmental problems will negatively affect the health of most people.	53	2003 - 2015	42
A European government will be developed that will substitute national sovereignity.	52	2010 - 2024	42
Increasing individualization hamper the functioning of representative democracies.	49	2003 - 2012	33

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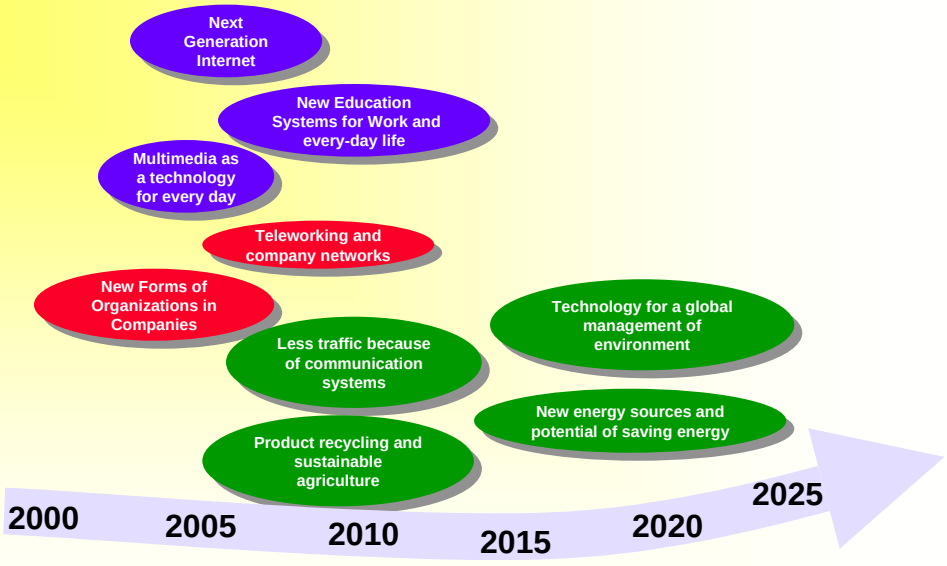
Source: Cuhls/ Blind/ Grupp: Delphi '98



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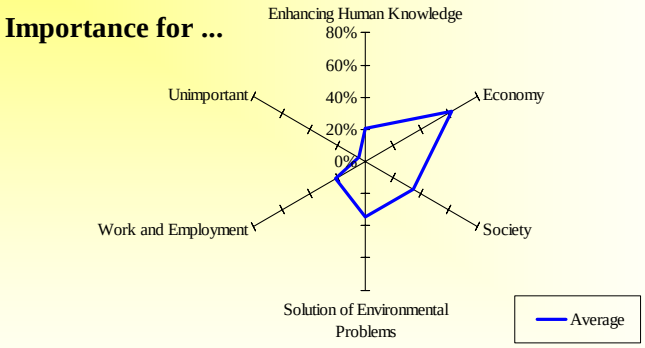
Source: Cuhls/ Blind/ Grupp: Delphi '98

Example of an analysis



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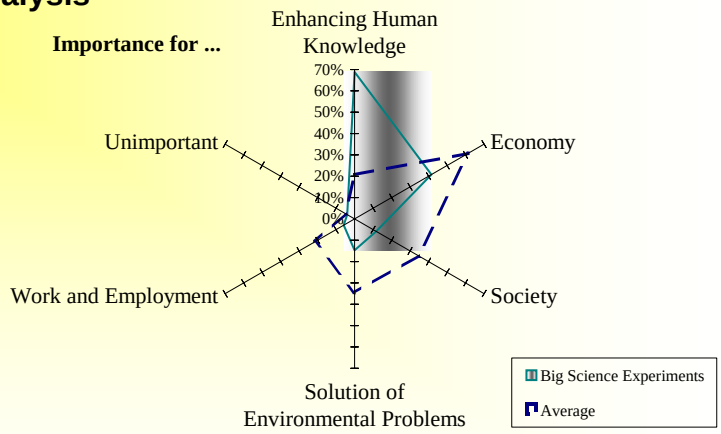
Source: Cuhls/ Blind/ Grupp: Delphi '98

Example of an analysis



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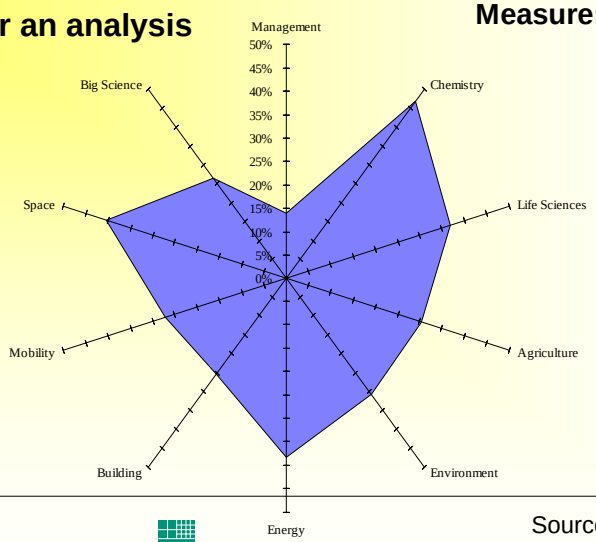
Source: Cuhls/ Blind/ Grupp: Delphi '98

Example for an analysis

Measure: Regulation



Source: Cuhls/ Blind/ Grupp: Delphi '98

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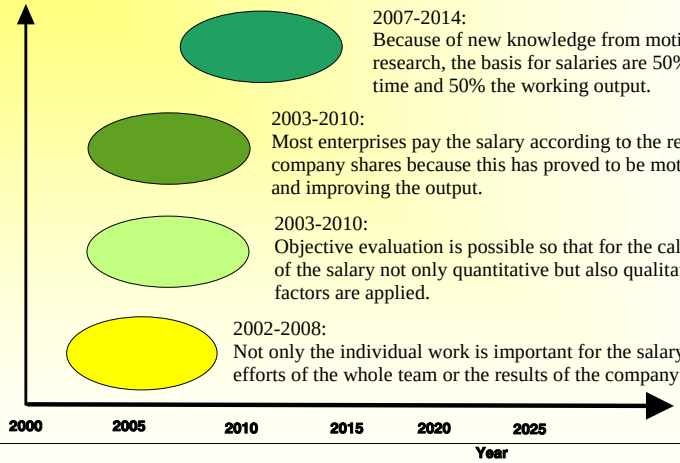
Analysis: What happens when - a „roadmap“



2007-2014:
Because of new knowledge from motivations research, the basis for salaries are 50% the working time and 50% the working output.

2003-2010:
Most enterprises pay the salary according to the results in company shares because this has proved to be motivating and improving the output.

2003-2010:
Objective evaluation is possible so that for the calculation of the salary not only quantitative but also qualitative factors are applied.

2002-2008:
Not only the individual work is important for the salary, but the efforts of the whole team or the results of the company.

Source: Cuhls/ Blind/ Grupp: Delphi '98

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Analysis: Comparisons

Agriculture & Food	Germany	Japan
	Importance for the economy	Importance for the economy
Plants which are specially cultivated for resistance to drought and salt and provide barriers to desertification are in practical use.	78,3	25
Cell fusion and gene technology will make possible the cultivation of new breeds of fish which are very suitable for fish farming due to their strong resistence to disease and fluctuations in water temperature.	93,8	56,3
The cloning of prize-winning, high-performance cattle by core transplantation is practised.	95,0	46,1
In order to achieve certain breeding goals (resistence to disease, fertility) in domestic animals, gene transfer to fertilised eggs or to early mammal embryos is practised.	91,3	44,4
Techniques are widespread, e.g. using microorganisms, which enable earth-bound phosphorus to be absorbed by cereals.	79,8	22,4
The use of transgenetic animals, into which genes that hamper or prevent the defensive reactions in xenotransplantations were transplanted, is widespread for the transplantation therapies of inner organs.	50,0	37,2

Source: Cuhls/ Blind/ Grupp: Delphi '98

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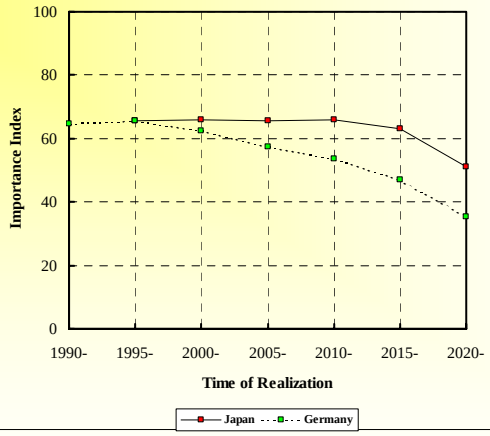
Analysis: Importance Index versus Time of Realisation



Source: Cuhls/ Blind/ Grupp: Delphi '98

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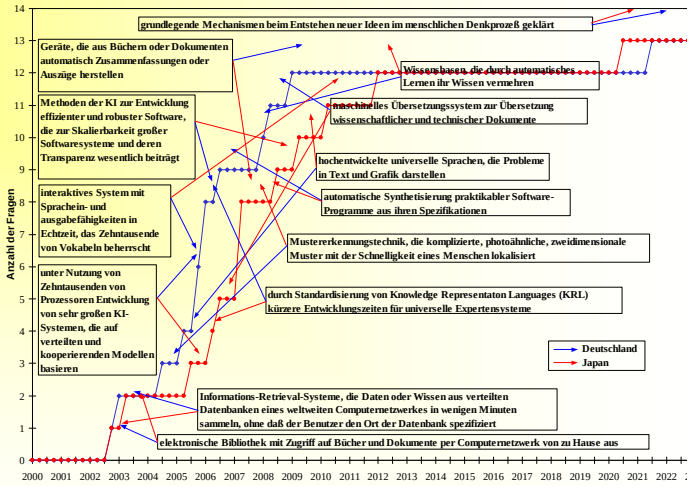
Analysis: Roadmaps/ Scenarios



Source: Cuhls/ Breiner/ Grupp: Mini-Delphi 1995

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Users of the German Delphi 98

Companies	- analyses - strategic planning - self-ranking - knowing own strengths and weaknesses
BMBF	- Information as such - some citations
FhG	- base of an external evaluation
Associations	- analyses - strategies - provide members with information
Media	- many citations - Millenium-Fever: to show future perspectives with an empirical background (data)

Source: Cuhls/ Blind/ Grupp: Innovations for our Future, 2001

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Planning your resources

- Do you intend many workshops? How many? They can be calculated easily.
- What do you intend to print? Do you need designers?
- How much programming is needed?
- How many participants do you have? This determines the number of questionnaires but also the number of persons to nominate and addresses you have to deal with in your database.
- Do you pay for participants?
- Do you need to type the results (e.g. from paper questionnaire)?
- What are the management costs? What are your salaries? And how many external persons contribute to the process so that they have to be paid, too?
- How much follow-up/ PR do you intend? How do you intend to present the end results? ...

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Pros and Cons

- Delphi is time-consuming and therefore expensive
- You need (external) experts
- Consensus effect in the second round, often artificial
- Group effects
- Always a mix of methods because you need topic generation procedure
- Not applicable in all fields or cases, because the topics have to be formulated in a short form
- Danger of regarding results as *facts*

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Pros and Cons

+ Forces persons to think about the future
+ Gives participants the possibility to judge twice and
+ Gather additional information between the rounds (psychological effect)
+ Shows if there is consensus or not
+ Psychological effect to write the ideas down in a short form
+ Communication effect
+ Judgement allows analyses, rankings, priority-setting
+ Generates information usable by many actors
+ Longer term thinking possible

Kerstin Cuhls, Dr. phil.

- studied Japanology, Chinese Studies and Economics/Business Administration at the University of Hamburg and one year in Japan (Kansai Gaikokugo Daigaku in Hirakata-shi near Osaka).
- 1990 four months at the National Institute for Metrology in Beijing, China.
- Since 1992 at Fraunhofer-ISI, Karlsruhe, Germany.
- 1993 four months at the National Institute of Science and Technology Policy (NISTEP) in Tôkyô, Japan.
- 1997 Dr. phil., University of Hamburg (Japanology).
- Scientific project coordinator for the German-Japanese foresight projects, especially the German national foresight study Delphi '98.
- Diverse scientific projects or advice for foresight projects and programmes internationally (e.g., Austria, Hungary, Egypt, Latin America…), nationally (e.g., Futur – the German Research Dialogue) and regionally (e.g., ZIRP - Zukunftsinitiative Rheinland-Pfalz, Foresight Trento etc.).
- Lecture at the Hochschule Bremen (University of Applied Sciences) 2000/2001 about Innovation and Innovation Management in Japan.
- Lecture for ESTO European Foresight Academy 2003 and lectures for UNIDO (Prague, Ankara) 2003 about foresight.

Special research areas:

Technology Foresight and international foresight concepts
Delphi and other foresight methodology
Innovation strategies
Management of research and development
Comparison of Japanese and German technology policy
Japan and Asia in general.

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Priority-Setting in Foresight

Kerstin Cuhls

Identification of priorities

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Summary

The principles, the focus and the objectives of particular foresight programmes as well as the outcomes are described: types of priorities, reports, process benefits. Setting priorities and identifying follow-up actions is not as easy as it seems, there are different roles of expert panels, steering group and sponsors (policy-makers) as well as other actors. Various inputs for priority-setting have to be considered: how to reconcile the results of panels' work, Delphi surveys, workshops with non-participating stakeholders, scenarios etc. And it depends also on the various levels of priorities: thematic (sectoral), regional, national, cross-border regions. Some examples are given and priorities in the broader strategic framework and the difficulties of harmonisation of government policies are explained.

Priority-setting in Foresight

Dr. Kerstin Cuhls

- **Objectives of Foresight**
- **Some Methods for Priority-setting**
- **Examples for “Rankings”**
- **Criteria for Priority-setting**
- **Who sets priorities?**
- **The larger framework of Priority-setting**

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Objectives of Foresight

- ➔ to enlarge the choice of opportunities, to set priorities and to assess impacts and chances,
- ➔ to prospect the impacts of current research and technology policy,
- ➔ to ascertain new needs, new demands and new possibilities as well as new ideas,
- ➔ to focus selectively on economic, technological, social and ecological areas as well as to start monitoring and detailed research in these fields,
- ➔ to define desirable and undesirable futures and
- ➔ to start and stimulate continuous discussion processes.

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Some methods for setting priorities

- rankings from (Delphi) surveys
- analyses from surveys, simulations, extrapolations and other futures' studies
- votings (online, offline, postal, fax...)
- listings according to a set of criteria (group work, panels, expert consultations, interviews...)
- consultation of single experts
- panel sessions with discussions
- workshops with different stakeholder groups
- structured interviews

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Megatrends

Megatrend	Agree-ment	Time Frame	Disagree-ment
In industrialized countries over 1/3 of the population will be older than 60 years.	89	**2008 - 2019**	7
The unemployment rate will increase permanently in the developped countries.	74	**1999 - 2006**	22
World population will surpass the 10 billion border.	72	**2010 - >2025**	19
Germany will again become an internationally attractive location for investment.	61	**2003 - 2009**	27
Women will at least keep one-third of all executive positions in business.	57	**2008 - 2020**	32
Rationing of energy consumption for private households will be enforced.	54	**2011 - >2025**	41
Increasing environmental problems will negatively affect the health of most people.	53	**2003 - 2015**	42
A European government will be developed that will substitute national sovereignity.	52	**2010 - 2024**	42
Increasing individualization hamper the functioning of representative democracies.	49	**2003 - 2012**	33

Source: Cuhls/ Blind/ Grupp: Delphi '98

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List of the most important topics for the Economy

1. Catalysators for the selective CH-activation in methan, to produce methanol from methan directly
2. A new raffination technology is developed, which makes the raffination of titan as cheap as that of aluminium.
3. In technical synthesis the reaction and separation is always integrated in one process and in one apparatus
4. A method (e.g. Health Monitoring) is developed to identify the condition or the reserve of metallic materials without destroying them in order to estimate the remaining “life expectancy” of the material
5. A technology is developed to sinter nanoscale particles with temperatures around 800°C to receive heat-resistant high capacity materials (e.g. ceramics) on the basis of SiC or Si3N4.

Source: Cuhls/ Blind/ Grupp: Delphi '98

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Key Technologies List

Topics and areas	Code	Topics and areas	Code
Advanced materials	***(-)***	Telecommunications	TEL
High-performance ceramics	KER	Broad-band communications	KOM
High-performance polymers	POL	Photonc digital technology	PHD
High-performance metals	MET	Advanced broadcasting (HDTV, DAB)	HDT
Gradient materials	GRA	Optical computing	OPR
Materials for energy conversion	ENW	***Mikro-systems technology***	***MST***
Organic magnetic materials	OMM	Micro-actuator technology	MAK
Organic electric materials	OME	Signal processing in micro-systems	SVM
Surface & film technology	ODT	Micro-sensor technology	MSE
Surface materials	OBW	Mounting & connecting techniques	AVT
Diamond layers & films	DIA	***Software & Simulation***	***(-)***
Molecular surfaces	MOO	Software	SOW
Non-classical chemistry	NCH	Modelling & Simulation	SIM
Meso-scale polymers	MES	Molecular Modelling	MMO
Organized supra-molecular systems	OSS	Bio-informatics	BIN
Clusters	CLU	Simulation of materials	WSI
Adaptronics	ADA	Non-linear dynamics	NDY
Multi-functional materials	MFW	Simulation in manufacturing	SIF
Lightweight construction	LBW	Cognitive systems (AI)	KIN
Composite materials	VBW	Fuzzy logics	ULO
Aerogels (solid foam)	AEG	Data network safety	DSI
Fullerenes	FUL	***Molecular electronics***	***MOE***
Material synthesis in standard shape	MSG	Bio-electronics	BEL
Implantation materials	IMP	Bio-sensor technology	BSE
Manufacturing of materials	FVW	Neuro-biology	NEB
Nano-technology	***NAT***	Neuro-informatics	NEI
Nano-electronics	NAE	***Cellular biotechnology***	***ZBT***
Single electron tunneling	SET	Molecular biotechnology	MBT
Nano-scale materials	NAW	Science-based medicine	MED
Manufacturing in micro- & nano-scale	FMN	Katalysis & bio-katalysis	KAT
Micro-electronics	***MEL***	Biological production systems	BPW
Information storage	INS	Bionics	BIK
Signal processing	SVA	Biomimetic materials	BMW
Micro-electronic materials	MIW	Biological hydrogen production	BWS
High-speed electronics	HGE	Renewable resources (biomass & agents)	NWW
Plasma technology	PLA	Environmental biotechnology	UMB
Superconductivity	SUL	Plant breeding	PFZ
High-temperature electronics	HTE	***Production & management technology***	***(-)***
Photonics	***PHO***	Management techniques	MAN
Opto-electronics	OEL	Modelling in manufacturing	MPR
Photonic materials	PHW	Control station technology	LST
Laser technology	LAS	Production logistics	PRL
Flat display technology	DIS	Lean-resource production	URP
Luminous silicon	LSI	Behavioural biology	VBH
		Ethics in science & technology	ETH

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Criteria set, Example I

- R&D infrastructure
- Scientific and technological constraints on implementation
- Human capital
- Innovation expenditures
- Interest of enterprises
- National competitive position (status quo ante)
- Public interest
- International division of labour

Source: Grupp, Technology at the Beginning of the 21st Century

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What characterizes lead visions?

- Orientation towards *specific aim*
- Contribution to overcome an urgent *social problem.* Connecting *social demand with technological chances*
- high complexitiy, *interdisciplinarity. With respect to BMBF: overcoming the framework of individual programs*
- *implementable* as research projects
- contribute to strengthening Germany´s *economic prosperity*
- *„understandable for everyone“*

Criteria set, Example II, German Futur

- societal demand
- focus potential
- interdisciplinarity
- relevance for research

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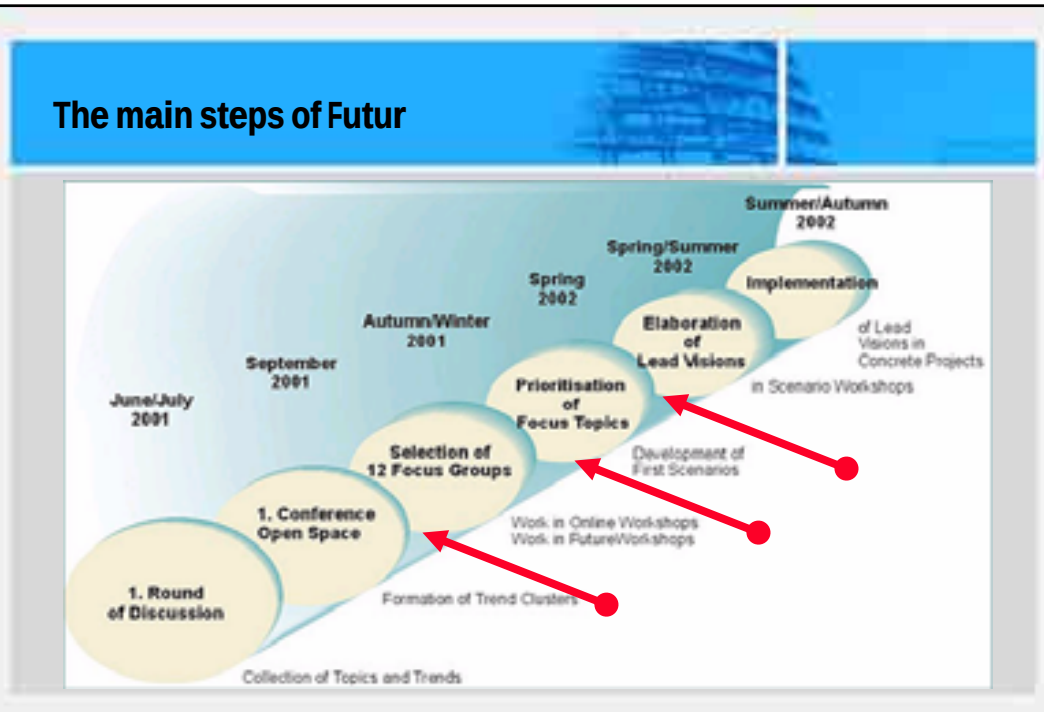
The main steps of Futur



Who sets priorities?

- Depends on the foresight activity, its objectives and methodology
- Examples:
  - the organisors/ managing group select(s) them by analyses
  - the steering group
  - additional working groups/ panels
  - high ranking persons (e.g. a minister)
  - mix of persons
  - „interested persons“ via voting
  - information are provided, every interested party picks out own priorities

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Various levels of priority-setting in foresight

- National
- regional
- communal
- sector/ issue-oriented
- cross-national, multi-national (e.g. EU wide...)
- company, research organisation, association..., whereever strategic planning is conducted
- media set and influence priorities
- ...

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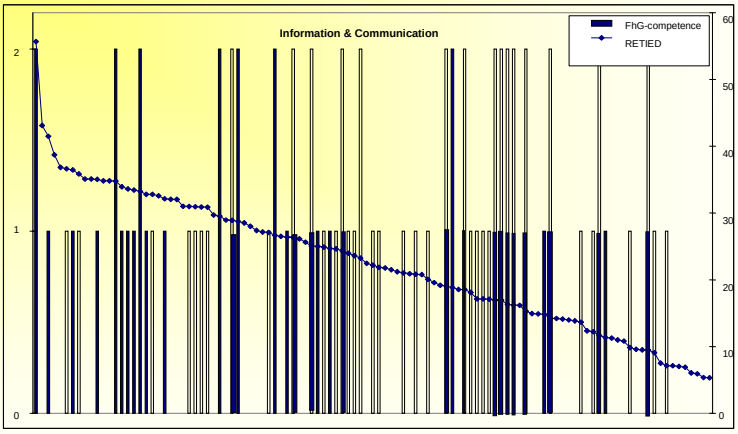
Making use of Foresight results in broader strategic framework, Example: Users of the Delphi 98

Companies	- analyses - strategic planning - self-ranking - knowing own strengths and weaknesses
BMBF	- Information as such - some citations
FhG	- base of an external evaluation
Associations	- analyses - strategies - provide members with information
Media	- many citations - Millenium-Fever: to show future perspectives with an empirical background (data)

Example: System Evaluation of the Fraunhofer Society



Planning your foresight

- What should be the breadth of the study?
- What are the objectives? Priority-setting? Communication?
- How many and which fields should I ask for?
- How will the organisation be? Who manages the process? Who is paid?
- Who will be invited to participate (active or non-active)?
- What results can be expected?

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Planning your foresight

- What are the questions asked?
- How is the questionnaire, scenarios etc. designed or workshops organised?
- What kind of analysis need to be possible?
- How do you intend to implement the results?
- Will there be follow-up activities (public relations, publications, workshops, presentations, conferences etc.)?

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No Blackbox

but TRANSPARENCY in Foresight Processes!

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Selection of Research Priorities – Method of Critical Technologies

Karel Klusáček

Selection of Research Priorities – Method of Critical Technologies

Karel Klusáček
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Summary

Identification of strategic research priorities having a high potential to contribute to a favourable economic development and to the fulfilment of social needs of the society, while optimally utilising limited public funds, is subject of numerous foresight studies. Various methods are applied to identify a limited set of national research priorities – this paper deals with the method of critical technologies, which is widely used in several countries, e.g. the United States, France and recently in the Czech Republic. The method consists in applying sets of criteria against which the "criticality" (importance) of a particular technology (research direction) can be measured.

This paper summarises the basics of the critical technologies method and it provides an example of its recent application in the Czech Republic in 2001 and 2003. The main objective of the Czech exercise was to select priorities for the new National Research Programme, which was launched in January 2004.

Critical Technologies

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Training course „Technology Foresight for Practitioners“
4-8 October 2004, Prague

Structure of this session

- **Background**
- **What are the „critical technologies“ ?**
- **Method of critical technologies**
  - **Objectives**
  - **Strengths and weaknesses**
  - **How to conduct the exercise (detailed description)**
- **Brief overview of selected foresight activities based on the method of critical technologies**
- **Case example – Czech Republic**
- **Prioritization („voting machine“) – practical exercise**

Background

- The subject of numerous foresight projects is to identify strategic (national) research priorities with a potential:
  - Contributing to a favorable economic development
  - Satisfaction of urgent social needs
  - Optimize using of (always limited) public funds
  - Sometimes national security issues
- Various methods possible
- Method of "critical technologies" is relatively fast and transparent – used for instance in USA, France, Italy, The Netherlands, Czech Republic
- The basic principle: the "criticality" of a particular technology is evaluated against a set of criteria – the list of critical technologies is produced (ranked according their criticality)

3

What is the "criticality"?

- Criticality corresponds to a "degree of importance"
- Technologies representing the most important driving forces are considered to be "critical"
- Sometimes wording "key technologies" is used

TECHNOLOGY ⟷ RESEARCH DIRECTION

CRITICAL ⟷ KEY

4

Critical technologies

Critical technology should further be:

- Policy relevant – feasible in a given political framework
- Discriminating – not every advanced popular technology should be included in the list, if aggregating different technologies hiding of non-critical technologies under a "critical headline" should be avoided
- Reproducible – procedures should be transparent, robust and publicly accessible

Term "critical" should not be mixed with other terms:

- Currently "popular" technologies
- Technologies for "national self-sufficiency" (often may be bought on the international market)

5

CT – the objective

The main objective is to prepare a list of critical technologies with a clear indication of related policy actions that should enable the implementation of the results

6

CT – when useful?

- Particularly useful if straightforward "discrete" recommendations for policy-makers are the prime objective
- Examples of specific questions:
  - What are the key areas of the R&D?
  - What kind of research should be preferably supported from public resources?
  - How to formulate the criteria for choosing critical technologies?
  - What are the most important political measures and interventions enabling the implementation of results?

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CT – potential weaknesses

- Relatively narrow group of participating experts
- Danger of focusing exclusively on technological aspects without considering socio-economic issues sufficiently
- Suitable design and careful management of the exercise reasonably eliminates both potential weaknesses

8

CT – structure of the exercise

Four typical steps

- Location and selection of experts
- ↓
- Initial list of technologies
- ↓
- Prioritization
- ↓
- Final list of critical technologies

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CT – step 1
Location and selection of experts

- Key initial step of any foresight exercise
- Narrow versus broad consultation schemes
  - Narrow - expert committees, fast, low-cost but biased opinions very likely
  - Broad – panels, needs more time, more expensive, sometimes "too democratic"
- Several months (2-6) needed for broader schemes to select „right people"
- Nomination & co-nomination

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CT – step 2
Initial list of technologies

- Several steps
  - Desk research – existing lists from previous foresight projects, economic analyses, …
  - Industrial interviews
  - Brainstorming sessions in expert panels – expansion

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CT – step 3
Prioritization - background

- Objective: reducing the initial list of technologies to a list of critical technologies that are the most relevant against the set of applied criteria
- The most difficult and risky step of the exercise
- Substantial number of technologies considered so far could be discarded
- “the winners” and the “losers”
- Lobbying, external pressures

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CT – step 3
Prioritization – how to do it?

- Usually some "voting procedure"
- Prioritization is not exclusively tied to the method of CT – all foresight techniques have to make a selection of priorities at a certain point
- The UK Delphi looked for a maximum of 2 objective functions: the "*wealth creation*" and the *"quality of life"*
- Australian CSIRO: *"attractiveness"* and *"feasibility"*
- Czech foresight: *"importance"* and *"feasibility"*

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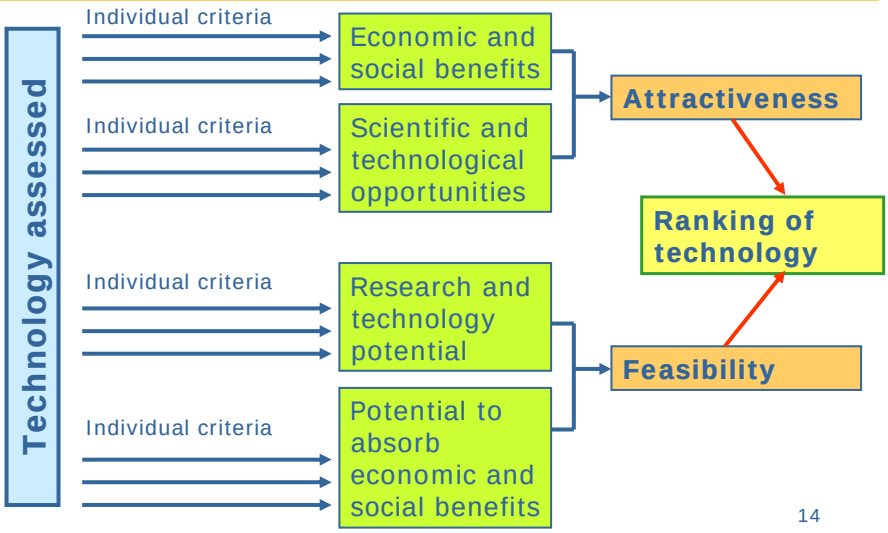
CT – step 3
Prioritization – the CSIRO scheme



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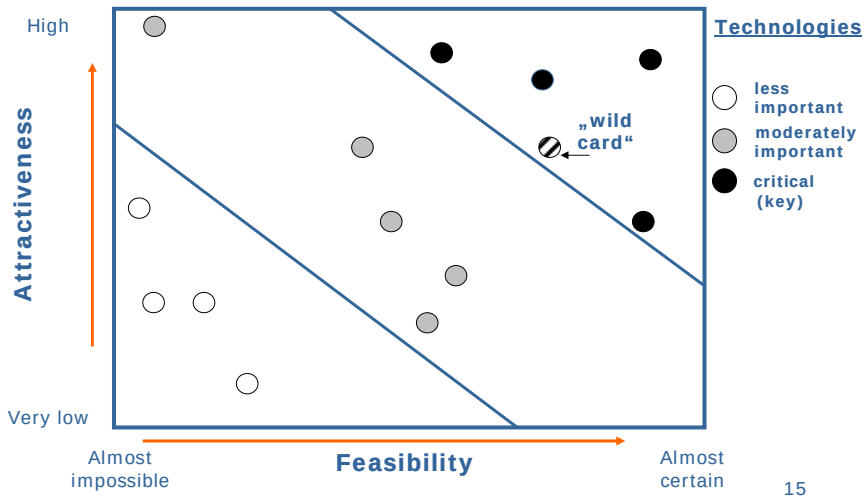
CT – step 3
Prioritization – ranking of technologies



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CT – step 4
Final list of critical technologies

- Results of voting should not be accepted automatically as the final outcome
- Thorough discussion of voting results in an expert group should follow
- In specific cases experts my suggest to change the standing of some technologies – detailed justification is an imperative otherwise the prioritization would lose its credibility
- ID sheets of identified critical technologies – main characteristics, application areas, problems to be addressed

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Case example – Czech foresight

- Project was ordered by the Czech government through the Ministry of Education
- The main objective:
  Setting research priorities for new National Research Program
- Two stages:
  1st stage: January-November 2001
  2nd stage: September 2003 – March 2004
- Project was managed by the consortium of the Technology Centre AS CR (principal contractor) and the Engineering Academy CR
- Based on a method of critical technologies

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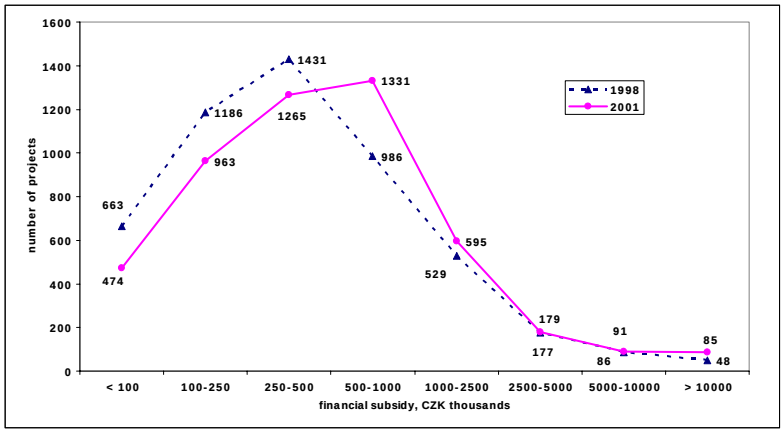
Why foresight?

- Large number of small underfinanced projects
- Too many research topics supported



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TF - panels

- Agriculture and Food
- Environment
- Health and Pharmacy
- Construction, Urbanism and Housing
- Information Society
- Materials
- Discrete Manufacturing
- Machinery and Equipment
- Devices and Instruments
- Chemical Products and Processes
- Transport Systems
- Energy and Raw Materials

- Socio-economic issues

- Human Resources for R&D
- Integrated R&D
- Regional and International Co-operation in R&D

- Management and Implementation of the National Research Programme

13 application sectors (panels)

3 cross-cutting panels

1 systemic panel

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Panels
creation

- one of the most critical points of the project
- typically 15-20 experts
- mixed background – research, industry, business, government
- chairperson – a respected „strategic thinker“ assisted by secretary
- members suggested by important stakeholders (institutions), individual recommendations, co-nomination
- about 300 experts of 1000
- panel members received a modest fee to compensate for travels and other expenses plus a reward for their homework

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Selection of priority themes

Activity	First panel meetings	First prioritization – voting procedure (importance and feasibility)	Second prioritization - using selected indicators	Third prioritization – evaluation of interest of private sector
Number of research themes	612	163	90	51

panels

project management team

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Voting details

- **Objective: reduction of the basic set of proposed themes (612 in total)**
- **A modified CSIRO approach**
- **Performed in panels - 171 of 188 panel members voted (91%)**
- **Importance vs. Feasibility analysis**
- **35 selection criteria in 5 categories**

IMPORTANCE
- »economy
- »society
- »environment & sustainable development

FEASIBILITY
- »absorption strength of an application sector
- »production strength of R&D

- **About 300,000 data points generated**
- **On-line (Internet) voting procedure**

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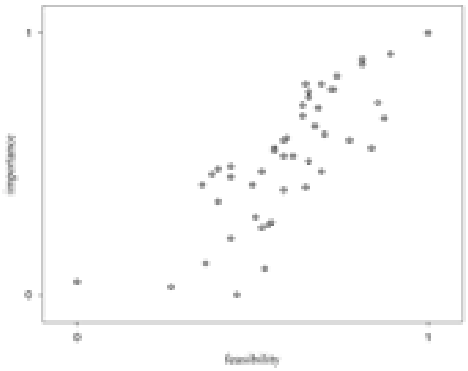
Voting

An example – Information Society

- 48 technologies considered, 11 of them selected
- The winner: Decision-making, control and diagnostic systems for industrial processes using artificial intelligence



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Result of the 1st prioritisation

- 612 themes reduced to 163
- furter reduction needed

- 163 themes agregated into 27 thematic clusters
- clusters evaluated against specific set of indicators

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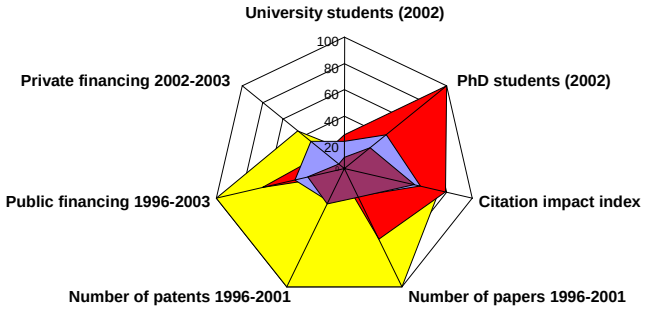
2nd prioritisation – using selected indicators

clusters of themes evaluated, not individual themes



Example of 4 clusters

- Chemistry for society
- Diagnostics, treatment and prevention of infectious diseases
- Non-traditional agriculture
- Safe food and healthy nutrition

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Result of the 2nd prioritisation

- **163 themes reduced to 90**
- **furter reduction needed**

- **interest of private sector (50% co-financing of research projects)**
- **205 companies interviewed**

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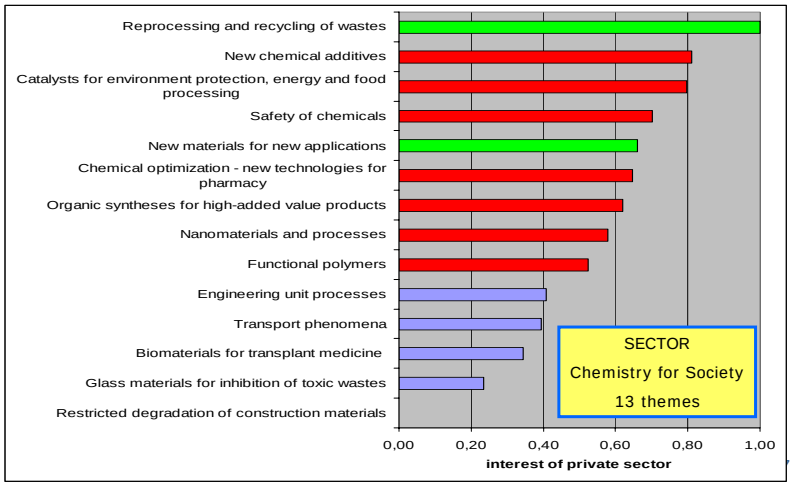
3rd prioritization - interest of private sector in co-financing of research projects

selected (■), excluded (■), transferred (■)



Result of the 3rd prioritisation

- 90 themes reduced to 51
- the number of themes corresponds to the budget foreseen
- structure of themes consensually accepted

National research program - thematic priorities

Thematic program (4)	Thematic sub-program (9)	Number of themes (51)
Sustainable prosperity	Energy for future	5
	Chemistry for society	7
	Progressive technical systems	7
	Sustainable transport	3
Quality of life	Non-traditional agriculture and healthy nutrition	4
	Molecular biology and nanotechnology for pharmacy and medicine	6
	Protection of environment	8
IT for knowledge society	Information technologies for knowledge society	5
Socio-economic development of the society	Socio-economic development of the society	6

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Final remarks (1)

- **Project '*pros*'**
  - **full commitment of the Government as a consequence of the Government demand**
  - **fully implemented results – National research program launched by January 2004 (preferred financing from public resources)**
  - **wide support of the research community**
  - **understanding in industry**
  - **mixed informatiom from a supply and a demand side**
- **Project 'cons'**
  - **insufficient time (16 months) – stressing conditions, each mistake was dangerous, no time for complex consensual discussions across the society**

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Final remarks (2)

- Positive consequences
  - foresight understood a useful strategic policy tool
  - permanent national foresight activity established

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Conclusions

- The method of critical technologies is very suitable for assesing various technologies if selection of prioroties is the major task of the foresight exercise
- The outcomes of the exercise do **NOT** constitute final decisions but they provide recommendations formulated by experts to policy makers
- Adequate attention should be paid to the socio-economic context and dimensions

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End of presentation

Practical exercise on the “voting machine” follows

Thank you for your attention

Further information at www.foresight.cz

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Technology Roadmapping

Robert Phaal

Fast-start technology roadmapping

Robert Phaal
Clare Farrukh and David Probert
Centre for Technology Management, University of Cambridge

Summary

Technology-driven innovation is of increasing importance to industry and nations, as a means of achieving the economic, social and environmental goals that lie at the heart of sustainable development. The effective management of technology is becoming more challenging as the cost, complexity and pace of technology change increase, in a globally competitive market. The management of technology for business and national benefit requires effective processes and systems to be put in place to ensure that investment in R&D, facilities and skills is aligned with market and industry needs, now and in the future.

The technology roadmapping method is used widely in industry to support technology strategy and planning. The approach was originally developed by Motorola more than 25 years ago, to support integrated product-technology planning. Since then the technique has been adapted and applied in a wide variety of industrial contexts, at the company and sector levels (for example, the International Semiconductor and UK Foresight Vehicle technology roadmaps). Technology roadmaps can take many forms, but generally comprise multi-layered time-based charts or tables, together with supporting text, that enable technology developments to be aligned with market trends and drivers.

This presentation and workshop provides an overview to the technology roadmapping approach, including both principles and practice. The method is illustrated by means of both industry and national sector-level applications. A practical workshop-based method is introduced that supports the rapid initiation of roadmapping ('T-Plan'), which has been developed over a number of years in collaboration with a wide range of organisations. A group activity provides participants with an opportunity to experience how roadmaps can be developed in a workshop environment.

UNIDO - Technology Foresight for Practitioners
Thursday 7th October 2004, 09:00-13:00

Fast-start Technology Roadmapping

Dr Robert Phaal
Engineering Department, University of Cambridge

Workshop aim

To provide:

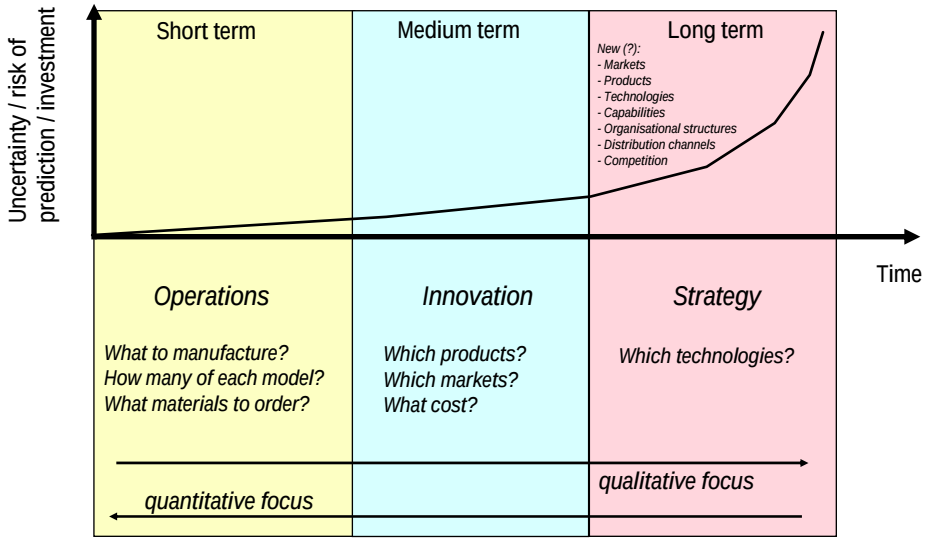
- An introduction to the theory and practice of technology roadmapping

Agenda

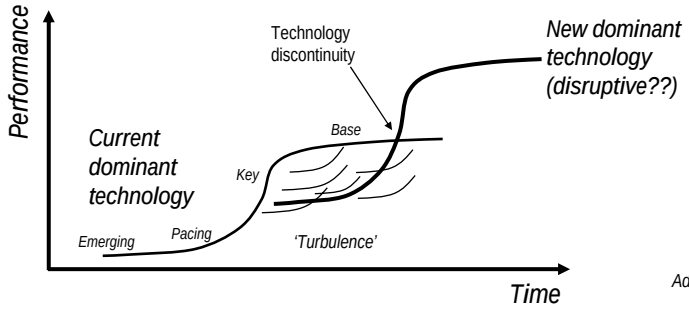
09:00	Overview
09:10	Technology roadmapping - principles & practice
10:30	*Break*
11:00	T-Plan 'fast-start' approach
11:30	Group activity - national research priorities
12:30	Feedback, discussion & questions
12:50	Conclusions
13:00	Close

Technology roadmapping - principles & practice

Time is a key dimension...



Technology as a dynamic resource



Technology 'S' curves

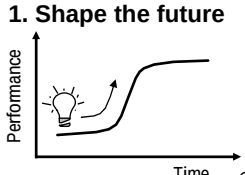
Shape influenced by:

- Market demand
- Scientific knowledge
- Investment / innovation

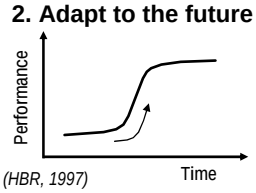
Adapted from Bower & Christensen, 1995

Strategic Postures

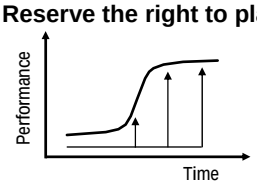
1. Shape the future



2. Adapt to the future

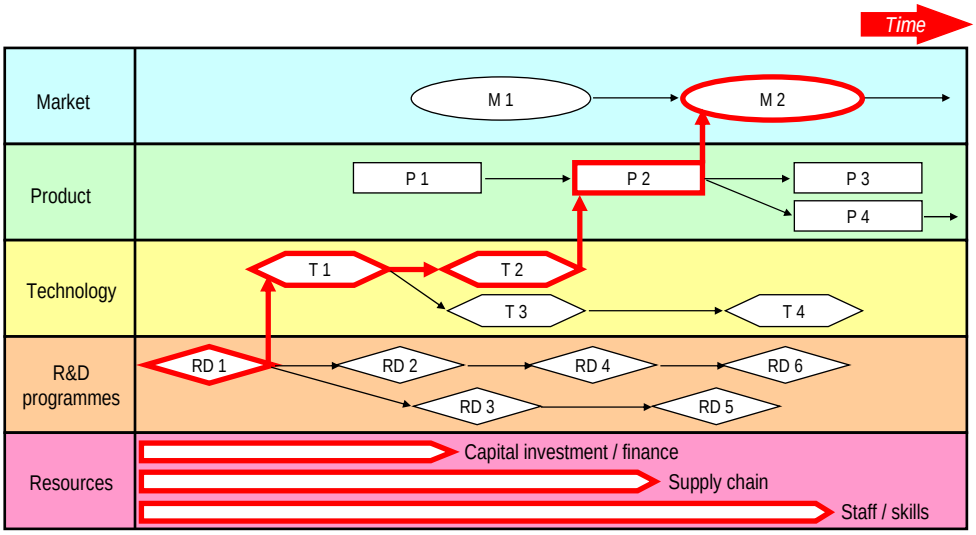


3. Reserve the right to play

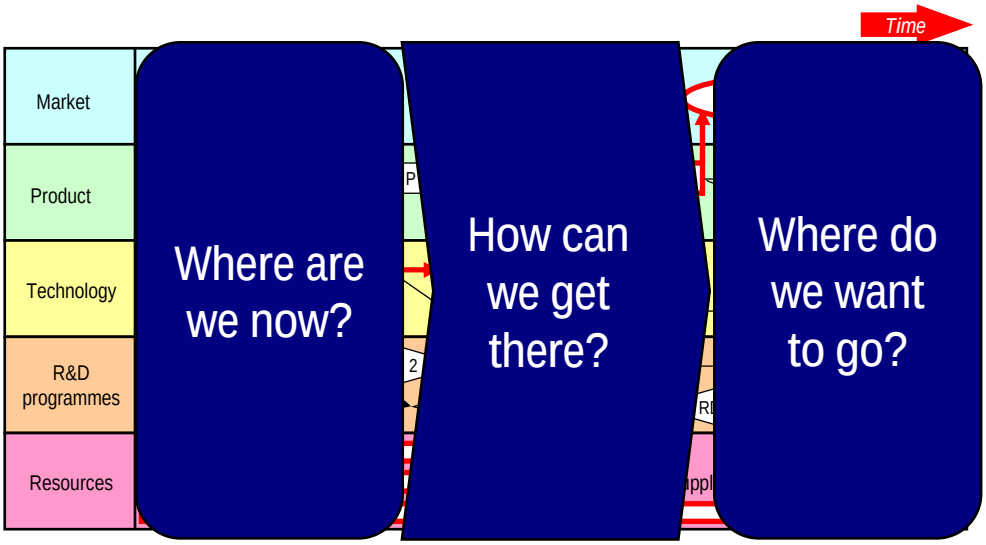


Courtney et al (HBR, 1997)

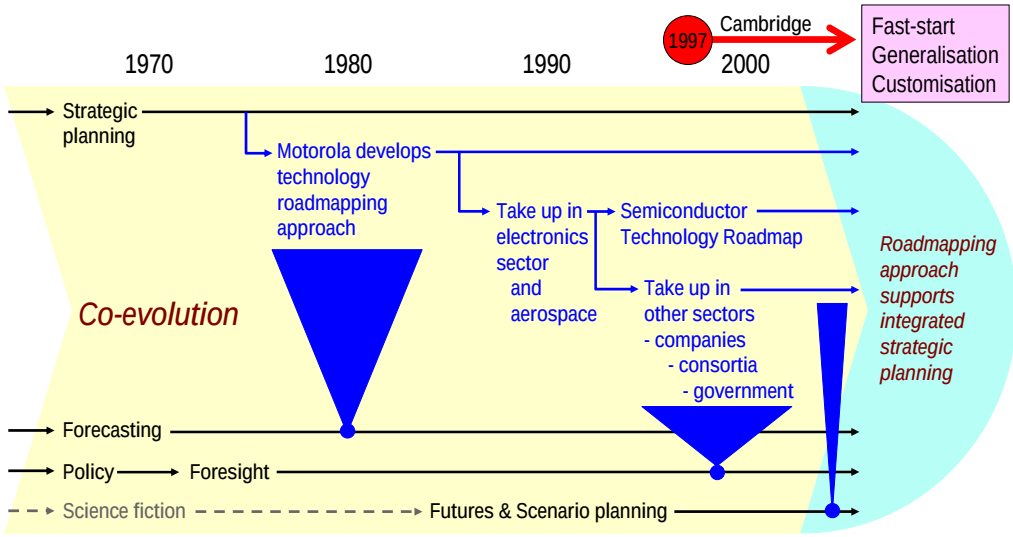
Roadmapping - Planning for the Future



Roadmapping - Links future to present



Evolution of technology roadmapping



Roadmapping "Google™ index"

	13/2/04	13/5/04	13/8/04
"technology roadmapping"	3,500	3,550	3,850
"technology roadmap"	52,400	56,800	63,300
"roadmapping"	12,200	14,000	15,400
"innovation roadmapping"	40	43	43
"innovation roadmap"	733	609	843
"business roadmapping"	122	149	171
"business roadmap"	6,740	4,810	4,550
"strategic roadmapping"	225	176	319
"strategic roadmap"	4,680	5,150	5,170
"technology route mapping"	24	25	47
"technology route map"	72	132	97

Roadmapping "Google™ index" #2

	13/2/04	13/5/04	13/8/04
"science roadmap"	-	-	674
"program roadmap"	-	-	714
"market roadmap"	-	-	488
"industry roadmap"	-	-	2,640
"customer roadmap"	-	-	111
"product roadmap"	-	-	26,800
"service roadmap"	-	-	803
"production roadmap"	-	-	154
"enterprise roadmap"	-	-	356
"application roadmap"	-	-	5,570
"process roadmap"	-	-	712
"design roadmap"	-	-	881
"engineering roadmap"	-	-	945
"policy roadmap"	-	-	1,690
"infrastructure roadmap"	-	-	587
"risk roadmap"	-	-	73
"investment roadmap"	-	-	403
"roadmap for peace"	-	-	9,850

Motorola Roadmap Matrix

- summary of product plans and technology forecast

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Tuning	Push button		Push button - Synthesizers			Touch pad - Synthesizers			Voice actuated	
Selectivity	Ceramic resonators			SAWs			Digital signal processors			
Subcarrier function	Stereo			Paging			Data		Maps	
IC technology	Linear	5u CMOS		3u CMOS			1u CMOS			
Display	LEDs		Liquid crystal				Fluorescence			
Vehicular LAN						Single wire		Glass fibre		
Digital modulation									500 kHz bandwidth	
PRODUCTS	RECEIVER 1 Stereo		RECEIVER 2 Plus: Scan Seek		RECEIVER 3 Plus: Personal paging		NEXT GENERATION Plus: Stock market Road information Remote amplifiers Remote controls		FUTURE GENERATION A NEW SERVICE Super Hi Fi Local maps	

Source: Willyard & McClees, 1987

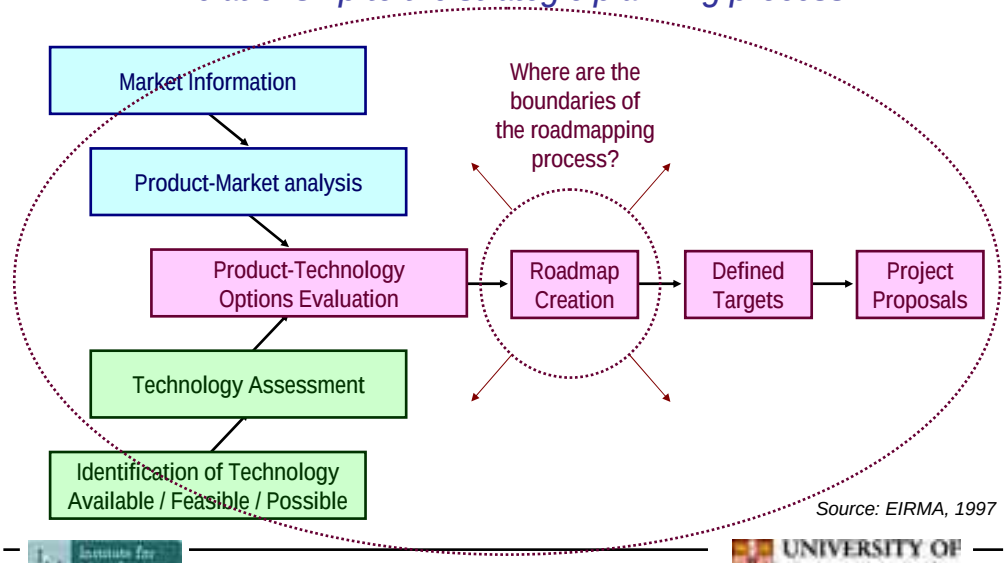
Technology roadmapping process

Benefits

- Facilitate the integration of new technology into the business
- Support for company strategy and planning processes
- Identify new business opportunities for exploiting technology
- Provide top level information on the technological direction of the business
- Support communication and co-operation within the business
- Identify gaps in market and technical knowledge
- Support sourcing decisions, resource allocation, risk management and exploitation decisions
- High-level integrated planning and control
  - a common reference / framework

Technology roadmapping

Relationship to the strategic planning process



Source: EIRMA, 1997

Technology roadmapping
Two extremes

1. Market 'pull'
   - How to reach a goal?

- Planning
- Market focus
- Assumes product market opportunity
- Deterministic
- Convergent
- Customer driven

2. Technology 'push'
   - What opportunities could arise?

- Technology focus
- Looking for opportunities
- Open ended
- Divergent

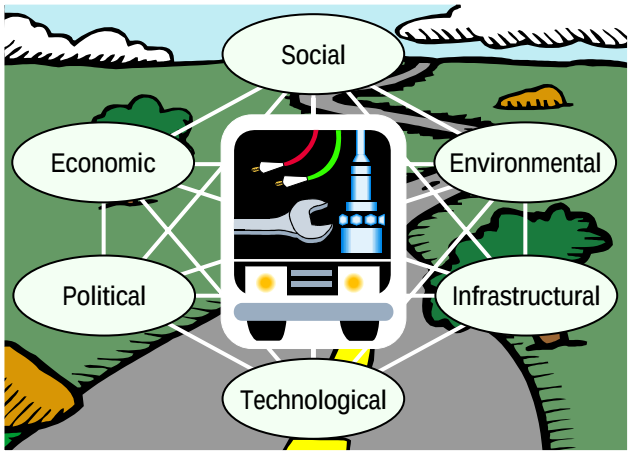
UK Foresight Vehicle technology roadmapping initiative

- The overall goal of the technology roadmapping initiative was to support the aims of the Foresight Vehicle consortium, providing a framework for ongoing investment in UK research partnerships, focused on achieving sustainable wealth creation and quality of life

- This required identification of market and industry trends and drivers that impact future requirements for road transport in the UK, and the associated technology needs and opportunities

- The roadmapping process encouraged communication and discussion within a creative workshop environment and the roadmap provides a framework for continuing this more broadly in the future

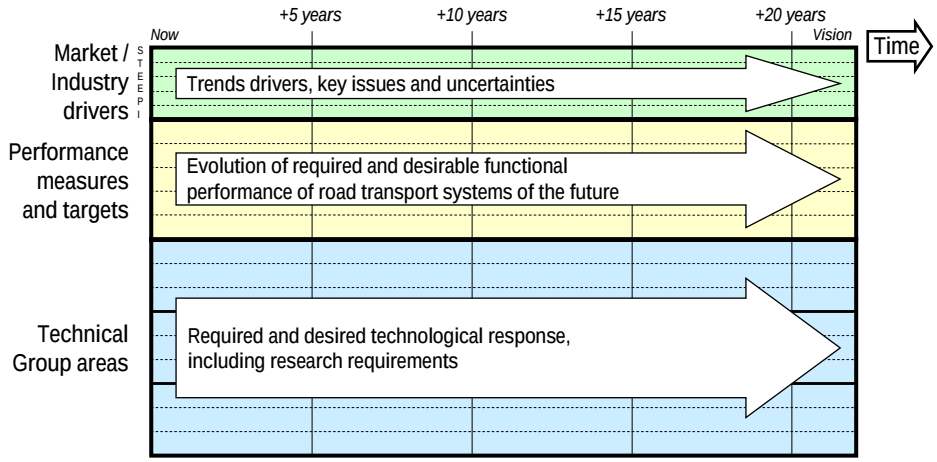
Road transport system: key themes



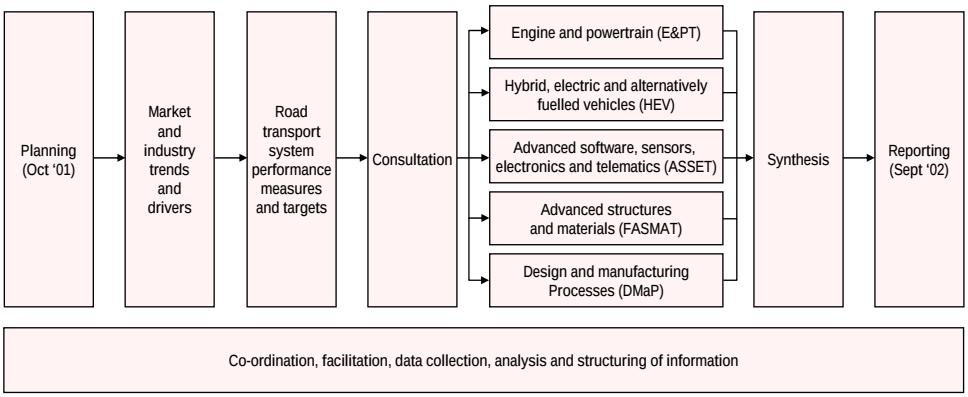
Social, economic and environmental drivers reflect the three cornerstones of sustainable development

Technology, policy and infrastructure enable or constrain progress towards the social, economic and environmental goals

Foresight Vehicle technology roadmap: architecture



Foresight Vehicle technology roadmap: process



- 10 month duration
- 10 workshops
- More than 130 participants
- More than 60 organisations

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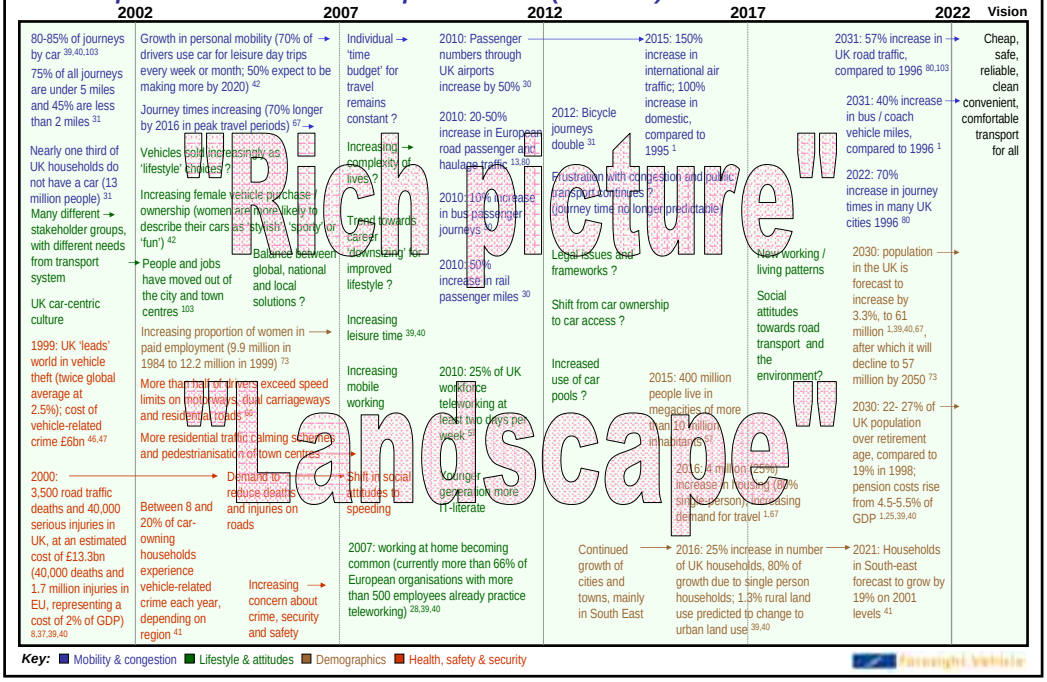
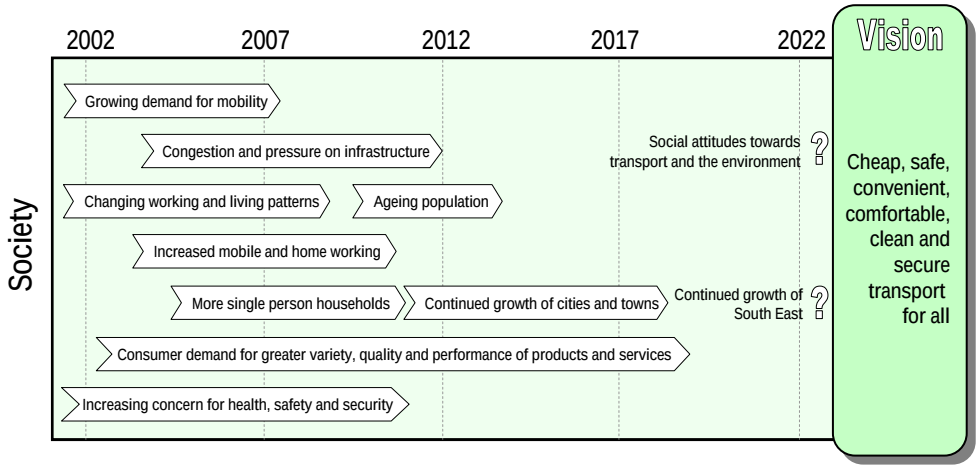
Example detailed roadmap content (1 of 28): Social trends & drivers



Example summary roadmap content: Social trends & drivers



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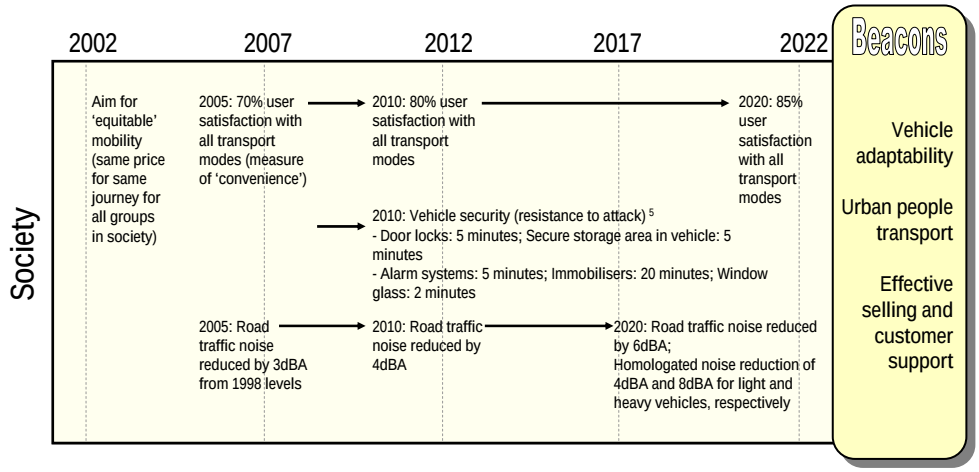
Example summary roadmap content: Social performance measures & targets



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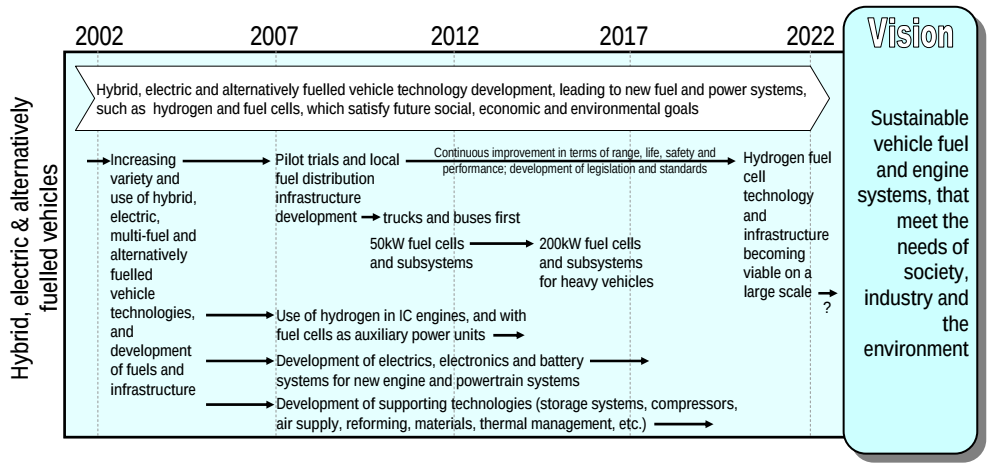
Example summary roadmap content:
Hybrid, electric and alternatively fuelled vehicle technology



Update:
Foresight Vehicle Technology Roadmap - Round 2

- 'Ownership' of Foresight Vehicle has shifted to Industry (SMMT)
- Roadmap has become a central 'reference point' for consortium
- Aims for Round 2:
  - Development of efficient low maintenance repeatable process
  - Increased (industrial) focus & prioritisation
- 6 half day workshops
- Version 2 of the Roadmap due to be published October 2004 (short report)

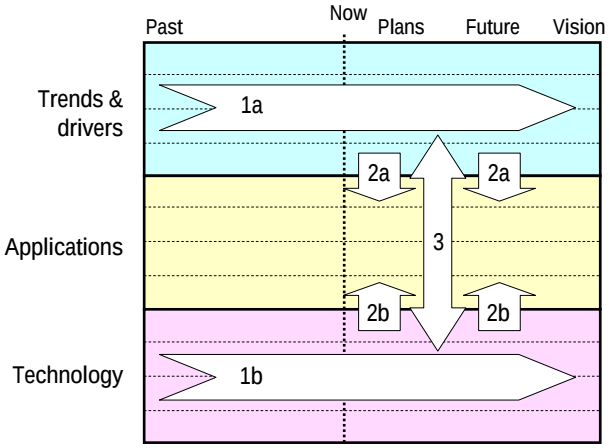
UK Faraday Partnership technology roadmapping

Aims:

- To develop a 'first-cut' technology roadmap for Faraday Partnership, bringing together industrial and research communities
- To collect, structure and share knowledge about recent and future developments in markets and technology, together with requirements and capabilities of future applications
- To identify key emerging strategic issues, research challenges, and way forward

Faraday Partnership technology roadmapping approach

Architecture



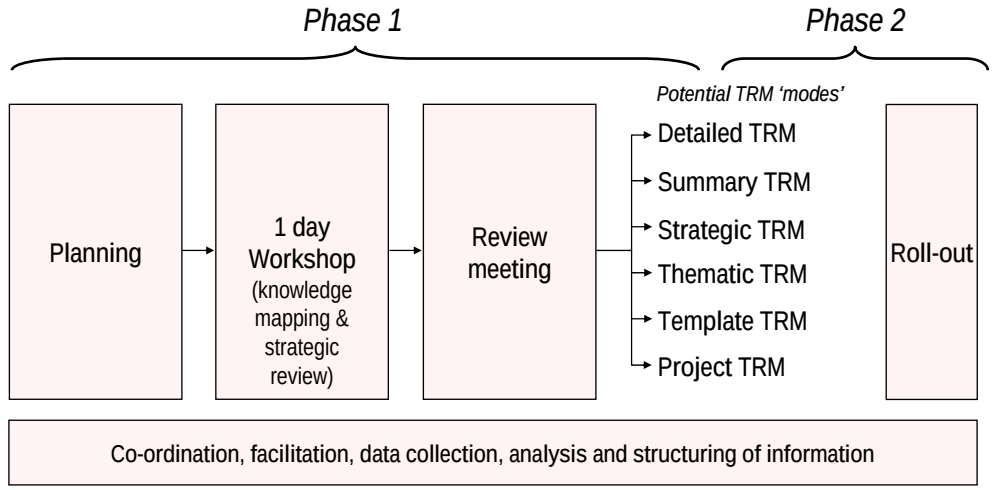
Process

1a) Map trends & drivers
1b) Map technology

2a) Application needs
2b) Application capabilities

3) Applications
- Map
- Research challenges
- Skills
- Way forward

Faraday Partnership technology roadmap process



Useful references

- Willyard and McClees (1987), 'Motorola's Technology Roadmap process', *Research Management,* Vol 30, No 5, pp13-19
- EIRMA (1997) 'Technology Roadmapping - delivering business vision', Working Group Report No 52
- Groenveld (1997) 'Roadmapping integrates business and technology', *Research Technology Management,* Vol 40, No. 5, pp. 48-55
- Kostoff, R.N. (1997), 'Science and Technology Roadmaps', Defense Technical Information Center, http://www.dtic.mil/dtic/kostoff/index.html
- Garcia & Bray (1997) 'Fundamentals of technology roadmapping', Sandia National Lab, http://www.sandia/gov SAND97-0665
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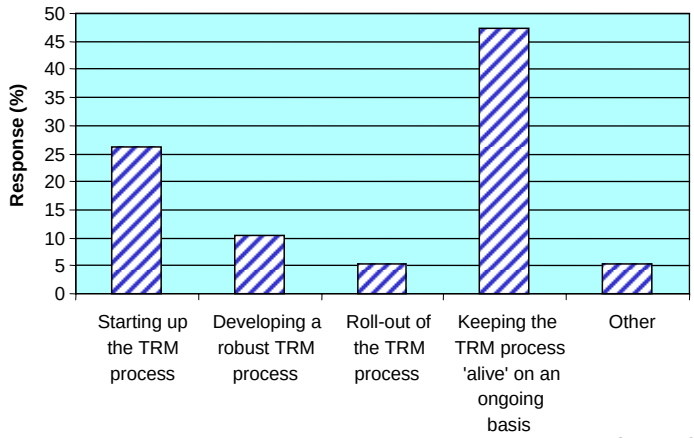
- Kappel (2001) 'Perspectives on roadmaps: how organizations talk about the future', *Journal of Product Innovation Management,* Vol 18, pp39-50
- *Research Technology Management* - special edition on technology roadmapping, Vol. 42, No. 2, March 2003 (5 papers, including Domino Printing Sciences, Lucent Technologies, Roche and Rockwell Automation experience) [Part 1; Part 2 to be published soon]
- *Technology Forecasting and Social Change* - special edition on technology roadmapping, Vol. 71, No. 1-2 , nine papers
- OEM Roadmaps - lots of links to (mainly) sector roadmaps: http://www.oemroadmaps.com
- US Department of Energy guide to applying science and technology roadmapping in environmental management (Draft), DoE-EM50, July 2000, http://emi-web.inel.gov/roadmap/links.html
- Australian guide to developing technology roadmaps - technology planning for business competitiveness, August 2001: http://industry.gov.au/library/content_library/ 13_technology_road_mapping.pdf
- Industry Canada - Technology roadmapping - a strategy for success, including a guide for government employees: http://strategis.ic.gc.ca/epic/internet/intrm-crt.nsf/vwGeneratedInterE/Home

Break

T-Plan ‘fast-start’ approach

Roadmapping challenges



Source: CTM survey, 1999

T-Plan aims

- To support the start-up of company-specific TRM processes
- To establish key linkages between technology resources and business drivers
- To identify important gaps in market, product and technology intelligence
- To develop a 'first-cut' technology roadmap
- To support technology strategy and planning initiatives in the firm
- To support communication between technical and commercial functions

T-Plan Applications

Sector / product

- Industrial coding (x3)
- Postal services (x10)
- Security / access systems
- Labelling software
- Surface coatings
- Medical packaging (x2)
- Automotive sub-systems
- Power transmission
- Railway infrastructure (x3)
- National infrastructure
- Building controls
- Road transport (x2)
- Technical consulting (x6)
- Automotive / Aerospace
- Academic (x3)
- Biochemicals
- Satellite navigation
- Food processing (x2)
- Pneumatic systems
- Emerging technologies

Variety of sectors, company sizes and types, products and services and technologies

Variety of strategic business goals and contexts

- Defence
- Satellites
- Food processing

Aims

- Product / technology planning
- Integration of R&D into business; business planning
- Product / technology planning
- Product / technology planning
- New product development process

ation

orporate co-operation and synergy
trategic planning

- Research priorities / network development
- Research priorities / network development
- Research priorities / network development
- Innovation strategy
- Research priorities
- Innovation opportunities
- Business and product strategy
- Global production strategy
- Research priorities
- Technology valuation
- Technology development & exploitation
- Sector level trends
- Asset management strategy
- Development of roadmapping system
- Innovation opportunities & synergy
- Product / technology planning

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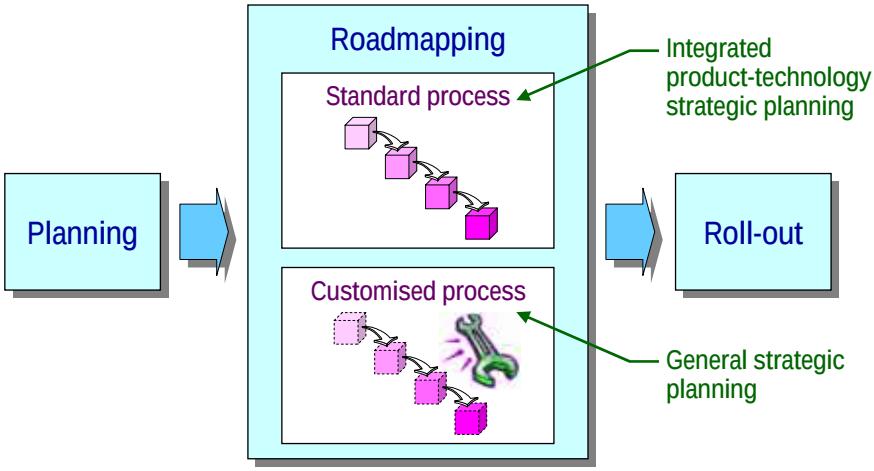
Standard and customised process



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T-Plan: multifunctional workshop approach - facilitation issues -

- Hints and tips captured in guide
- Need to keep flexible - expect the unexpected!
- Sometimes helpful to have an external facilitator
- Difficult if you haven't been a facilitator before - but only moderate skills required if planning is thorough
- Best to learn by doing, especially by working with someone else with facilitation/roadmapping experience

Facilitation hints in T-Plan

Softco case illustration

Workshops provide a central and useful part of most roadmapping initiatives, but generally will not provide the full solution... additional research, consultation and effort will be required to develop a good roadmap.

Standard process: 4 half-day workshops

Workshop 1 Market
- Performance dimensions
- Market / business drivers
- Prioritisation
- SWOT
- Gaps

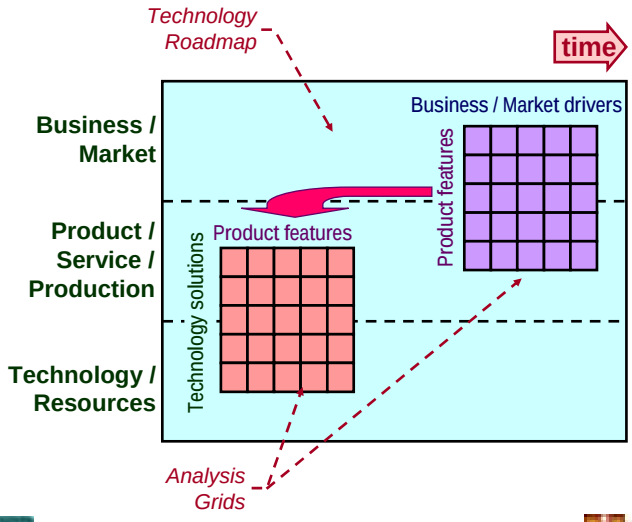
Workshop 2 Product
- Product feature concepts
- Grouping
- Impact ranking
- Product strategy
- Gaps

Workshop 3 Technology
- Technology solutions
- Grouping
- Impact ranking
- Gaps

Workshop 4 Roadmapping
- Linking technology resources to future market opportunities
- Gaps

- Setting up the process
- Managing the process
- Following on from the process

Roadmap structuring and prioritisation



Example Market-Product grid (Softco)

		Market								Softco				
Prioritisation: (scale of 10)	Major Pharmaceutical:	9	10	7	6	1	2	6	5	5	7	9	6	10
	CRO:	9	10	10	2	8	4	7	7					
Product Feature Concepts \ Market / Business Drivers		1. Time to market of drug	2. Integrity of trial	3. Cost of trial	4. Globalisation	5. Leading edge	6. Ease of use	7. Connectivity	8. Future proof	A. Reusability	B. No. 1	C. Time to market	D. Motivation of staff	E. Improving bottom line (1 year after release)
1. Security			√√√	√T	√					√	√√	X		√
2. Validated software			√√√	√	√				√	√	√√	XX X	√√	√
3. Compliance		√√	√√√	√√	√√	√	√√				√√√	X*	X	√√
4. Services		√T	√	√	√√		√	√			√√	X	√	√
5. Data management		√√√	√√	√√	√√√	√√	√√	√√	√	√√	√√	X XX	√	√
6. Labelling		√√√	√√√	√√T	√√	√√	√√		√	√√√	√√	X	√√	√√
7. Global solution		√		√	√√√√	√√	√	√	√√	√√	√√	X	√	X**
8. Flexible implementation		√	√	√	√√	√√	√	√√	√√√	√√	√√	XX	√√√	√√
9. Softco requirements				√						√		X	√	√
10. User friendly		√	√	√		√	√√√			√	√√	XX	√√	√

Major Pharmaceutical	CRO	Softco
5.5	4.8	4.5
4.7	4.2	1.1
8.7	8.3	4.9
5.0	4.1	3.8
10.0	10.0	3.0
9.6	9.9	9.5
5.9	5.8	2.5
6.8	7.5	10.0
0.7	0.8	2.7
3.2	4.2	5.2

Ranking:
√ = 1 X = -1
Σ Cell scores x Driver priority
Normalised: max score = 10

* 1 for difficulty, 2 for size ** Payback later

Example Product-Technology grid (Softco)

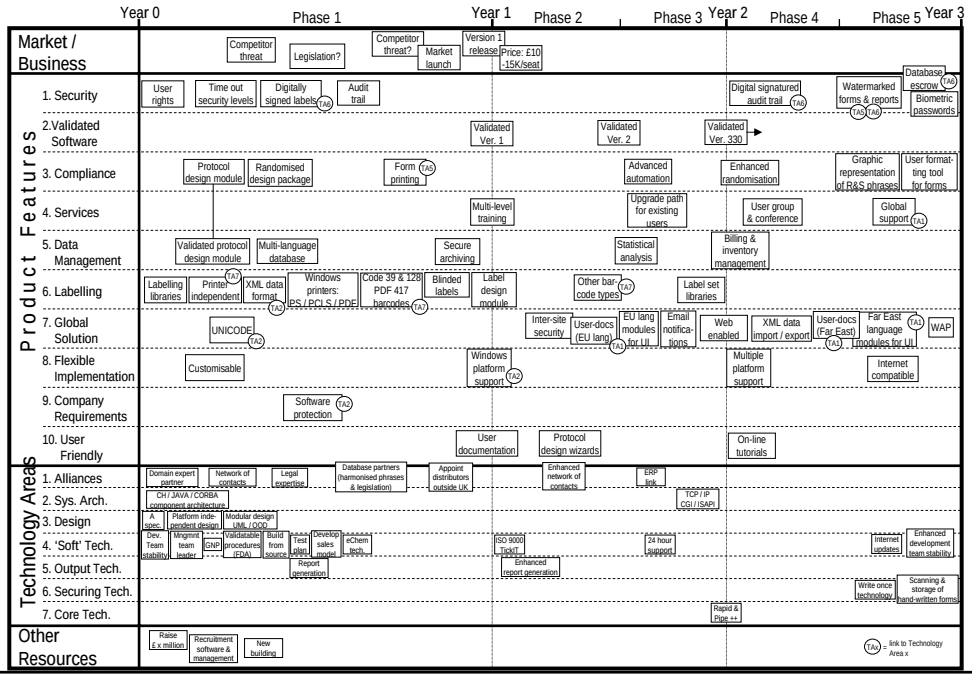
Prioritisation:	Major Pharmaceutical:	* 5.5	* 4.7	* 8.7	5.0	10.0	9.6	5.9	6.8	0.7	3.2
- from Grid 1	CRO:	4.8	4.2	8.3	4.1	10.0	9.9	5.8	7.5	0.8	4.2
(scale of 10)	Softco	4.5	1.1	4.9	3.8	3.0	9.5	2.5	10.0	2.7	5.2

Ranking:
√ = 1 X = -1
Σ Cell scores x Driver priority
Normalised: max score = 10

Technology Areas \ Product Feature Concepts	1. Security	2. Validated software	3. Compliance	4. Services	5. Data management	6. Labelling	7. Global solution	8. Flexible implementation	9. Softco requirements	10. User friendly	Major Pharmaceutical	CRO	Softco
1. Alliances			√√√	√√	√√		√√	√	√√	√	7.8	7.6	7.2
2. System architecture	√√	√	√√		√√	√√	√√	√√	√	√	10.0	10.0	10.0
3. Design		√√√	√		√		√√	√√√		√	7.1	7.2	7.1
4. 'Soft' technologies		√√√	√√	√√	√		√		√√	√√√	6.9	6.8	6.5
5. Output technologies	√√				√	√√√	√√				6.4	6.4	6.3
6. Securing technologies	√√√		√√		√√	√√	√	√		X	8.6	8.4	7.6
7. Core technologies (re-use)	√√	X √√ **		√	√√	√√√	√√		√		8.3	8.2	7.5

* must have
** -ve re-use past, + re-use future

Example first-cut technology roadmap (Softco)

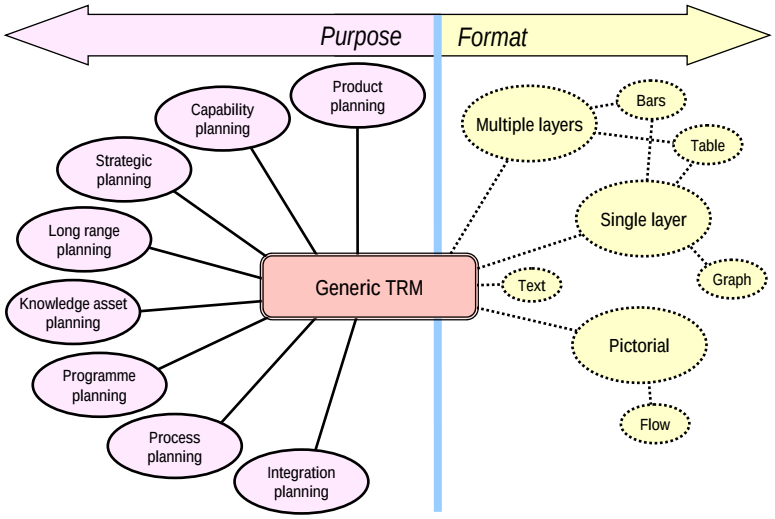


Flexibility of roadmapping

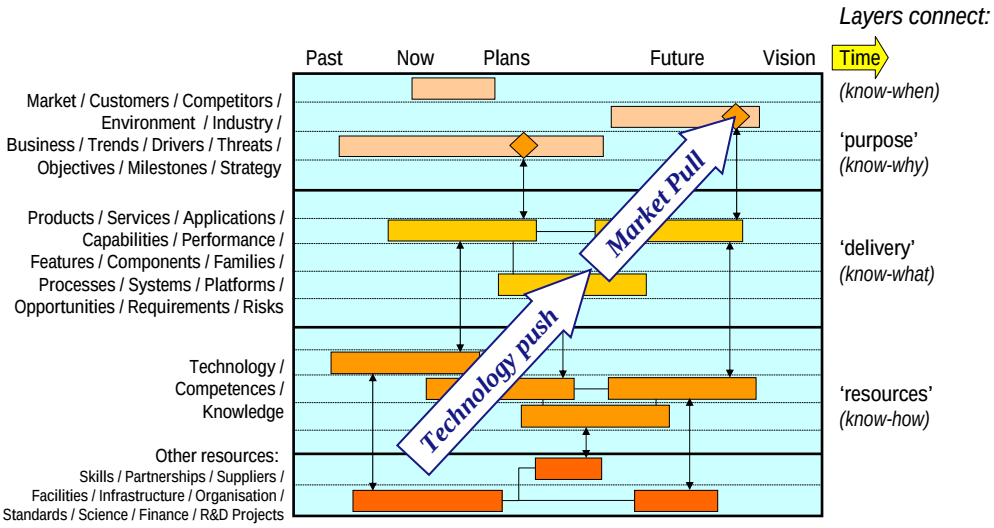
Flexibility is a key strength (and challenge) of the roadmapping approach, in terms of:

- The wide range of aims
- The timeframe (past and future)
- Adaptable structure (layers and sub-layers)
- Process to develop and maintain the roadmap/s
- Graphical format
- Integration with existing processes, tools and information sources

Types of roadmap: purpose and format



Generic roadmap - links resources to objectives



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Planning (customisation checklist)

- Context: focus, scope, aims and resources
- Roadmap architecture
- Process
- Participants
- Workshop scheduling
- Integration: systems, processes & information
- Preparatory work

- *Standard process:*
  - Follow the guide
- *Customised process:*
  - Creative and collaborative design activity

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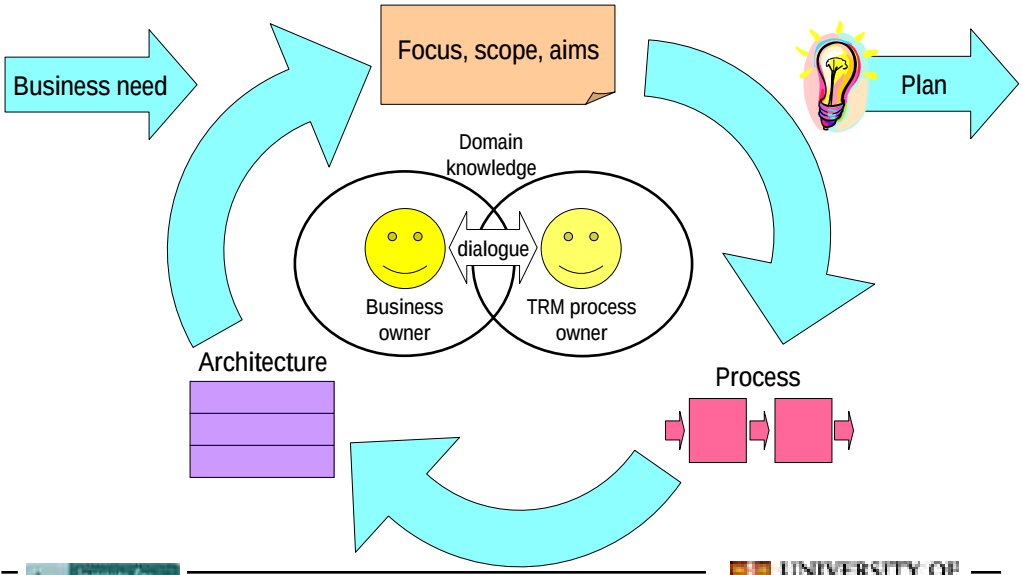
Roadmapping design: an iterative collaborative process



Planning checklist: Context

The nature of the issue that triggered interest in roadmapping needs to be explored and articulated, together with any constraints that will affect the approach adopted, including the following considerations

- *Scope:* defining the boundaries of the domain of interest (i.e. what is being considered, and what is not)
- *Focus:* the focal issue that is driving the need to roadmap
- *Aims:* the set of goals and objectives that it is hoped to achieve with roadmapping, in the long- and short-term (workshop). Three types of aims are typically included: 1) overt business aims, 2) organisational aims (e.g. communication), 3) process aims (i.e. learning about roadmapping)
- *Resources:* the level of resources the organisation is willing to contribute, in terms of people, effort and money

Planning checklist: Architecture

The structure of the roadmap needs to be defined:

- *Timeframe:* the chronological aspects of the roadmap (horizontal axis), in terms of the planning horizon and key milestones, and also whether past events and activities should be included
- *Layers:* the structure of the vertical axis of the roadmap, in terms of broad layers and sub-layers, which is closely related to how the business is structured and viewed (physically and conceptually). Characteristics of 'good' layers include:
  - Layers should fit with company approaches and 'language' (taxonomies)
  - Layers should be largely independent from each other
  - Layers should be fairly generic in nature (i.e. should hold true over time, so that the evolution / development can be mapped)
  - Layers should add value to the roadmap 'logic', driving lower layers & enabling higher layers
- *Metadata:* the elements shown on the roadmap, and the information that needs to be coded into the elements
- The best way to test if the structure makes sense is to test it... (strategic 'logic' / narratives)
- Within this architecture an hierarchical set of individual roadmaps can be defined...

Planning checklist: Process

The roadmapping process needs to be defined, in terms of the steps necessary to collect, structure, share and analyse relevant information, make decisions and agree actions, in terms of:

- *Macro process:* the broad steps needed in the short-, medium- and long-term that lead toward the end goal. Staging the process is sensible, breaking down the overall process into a set of semi-independent steps that each deliver value in their own right, but which connect logically to enable the end goal of developing a sustainable and ongoing process. In this way resource commitments can be managed and flexibility retained in what is an inherently exploratory process
- *Micro process:* the agenda that will guide the workshop/s. Typically the initial phase is devoted to gathering, structuring and sharing information using the roadmap template (essentially a structured and democratic brainstorming activity). The roadmap can then be used as a resource to identify key strategic issues for discussion, leading to an agreed action plan.

There is a trade-off between the level of resources committed and the quality of output...

Planning checklist: Other factors

- *Participants:* the people that need to be involved in the process and workshop/s, with the knowledge and expertise necessary to develop a well-founded and credible roadmap. Typically a multifunctional team is needed, representing both commercial and technical perspectives. The agenda and facilitation approach may need to be adapted to suite the group size (if there are more than about 10 then sub-groups may be required)
- *Workshop venue and scheduling:* often a logistical challenge... the venue should be suitable for workshops
- *Integration:* it is important that the roadmapping activity takes account of available information (although there is a practical limit to the quantity of data that can be accommodated in a workshop environment) and dovetails as far as possible with existing organisation systems and processes
- *Preparatory work:* logistics and briefing note... don't expect the participants to do too much pre-work - encouraging their active participation in the workshop is the key issue

Group activity:

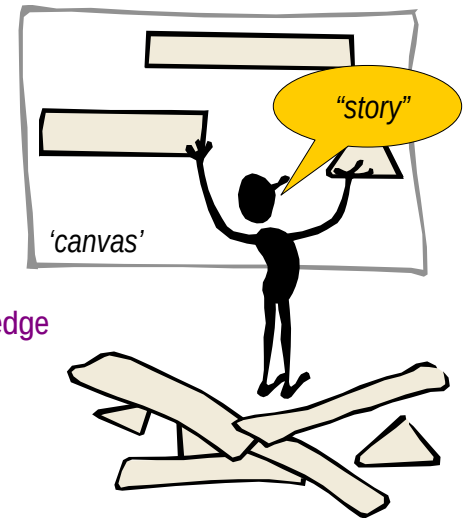
National research priorities

Roadmapping 'ethos'

'First-cut' roadmap

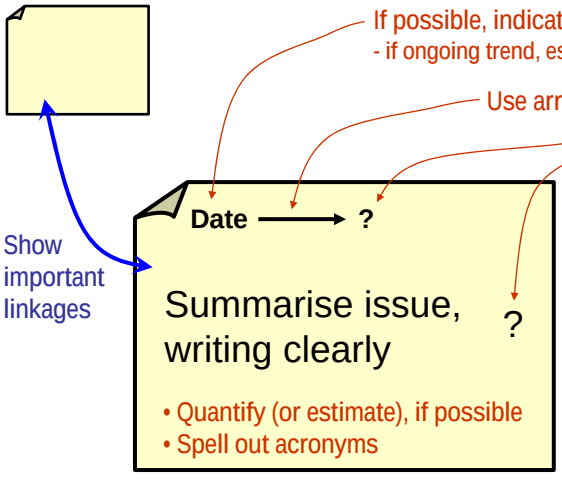
- Participatory
- Quick
- Exploratory
- Creative
- Active
- Capture, structure and share knowledge
  - *know-why*
  - *know-what*
  - *know-how*
  - *know-when*
  - *know-who*
  - *know-where*

Knowledge types:
- Explicit
- Tacit
- Implicit



>>>> plans, forecasts, issues, links, challenges, questions, speculation

Post-it 'protocol'



If possible, indicate known / likely date (or period)
- if ongoing trend, estimate when it is likely to become important

Use arrow to indicate ongoing trend

Indicate uncertainty or speculation with "?"

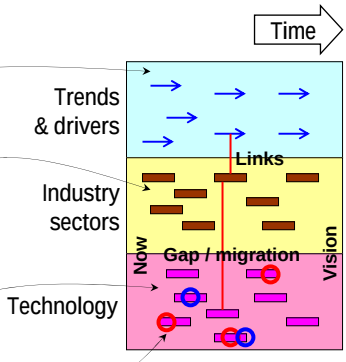
Show important linkages

Note:
- If an issue is (or is potentially) important then it should be on the roadmap
- There are no hard-and-fast rules about content or format
- The goal is to capture (and share) an effective and 'true' picture of the key aspects of the system

Instructions

'STEEP' = Social, Technological, Economic, Environmental & Political trends & drivers

1) Form into groups & briefly discuss task **10 min**
2) Use roadmap chart to 'post-it' brainstorm:
   - Brainstorm trends & drivers for industry in your countries ('STEEP') **10 min**
   - Brainstorm products, services and systems required from key industrial sectors to respond to the trends and drivers **10 min**
   - Brainstorm technology developments and actions needed to deliver industrial products, services and outputs **10 min**
   - Highlight key research & skills challenges (two 'arrow' post-it notes each) **10 min**
3) Prepare for feedback (highlight factors common to more than one country) **10 min**



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Feedback, discussion & questions

- What lessons have been learnt about roadmapping?
- Questions?

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Conclusions

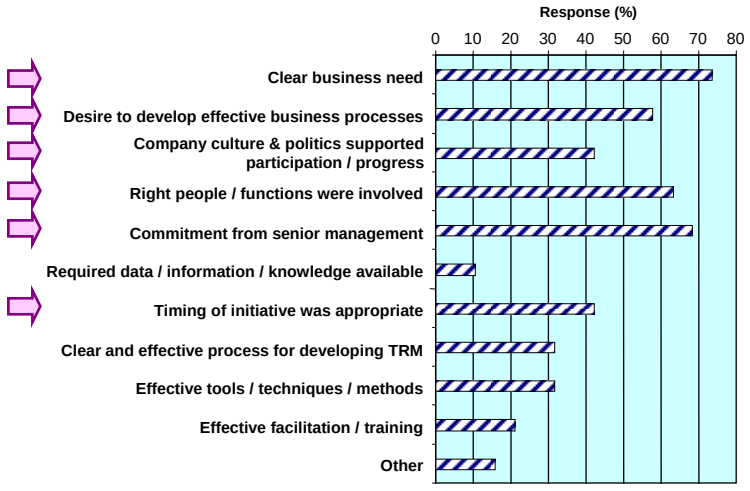
The effectiveness of technology roadmapping - building strategic vision

A study for the Dutch Ministry for Economic Affairs

- Study of 78 international 'supra-company' foresight applications
- TRM can be characterised by the following features:
  - it is a means of co-ordinating actors
  - It starts with the hypothesis that the future can be constructed and is not just 'happening' (creation of one shared vision is an important component... vs. scenario method)
  - It gives great importance to the involvement of all relevant actors / stakeholders
  - It gives great importance to iteration
- There is not one single definition or practice and lot of variety exists
- TRM sometimes serves as the basis for negotiation on R&D funding between industry and government
- Actors, especially industrial companies are willing to participate on an ongoing basis, aware of the importance of jointly developing R&D programmes at a time when funding is scarce. They enhance knowledge exchange, collaboration and create more durable networks amongst industries, and between industries and academia
- TRM supports integrated policy development and deployment
- Critical success factors identified...

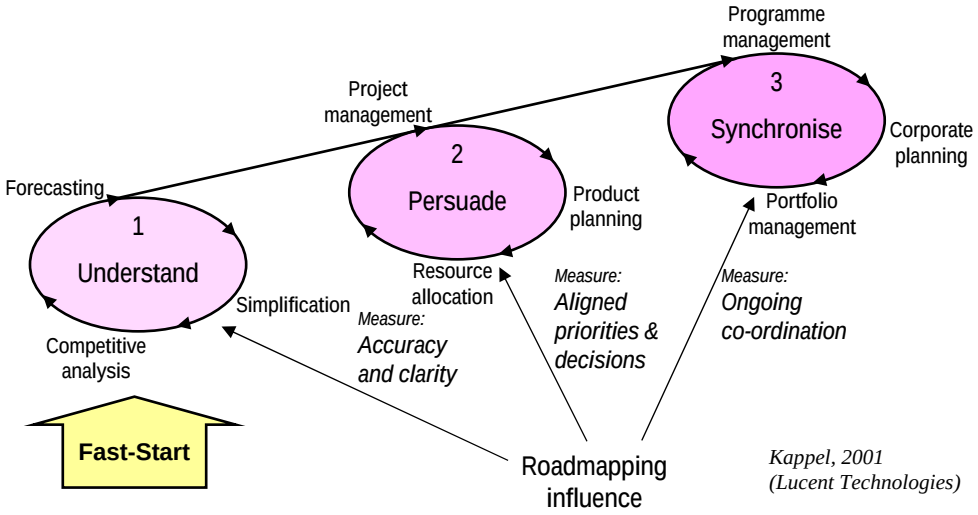
De Laat & McKibbin, 2003

Roadmapping success factors



Source: CTM survey, 1999

The 'fast-start' concept: roadmapping as an ongoing process



Kappel, 2001
(Lucent Technologies)

Conclusions

Benefits of roadmapping:

- A focus for integrated strategic planning
- Can be applied in a wide range of contexts
- Supports communication and network development

Challenges of roadmapping:

- Not a magic bullet - initially more questions than answers likely
- Maintaining the process - the real benefit lies in its ongoing use
- The process and roadmap typically need to be customised

Review

- Has the workshop met your expectations?
- Will you give roadmapping a try?
- Any questions?

Further support:

- *Contact us: Rob Phaal at rp108@eng.cam.ac.uk*
- *TRM User Group: http://www-mmd.eng.cam.ac.uk/ctm/trmug.htm*

Close

Dr Robert Phaal joined the Centre for Technology at the University of Cambridge in 1997, where he conducts applied research in the area of strategic technology management. Technology roadmapping is of particular interest, and Rob is co-author of the 'T-Plan' guide for supporting the rapid initiation of the method in firms. The approach has been applied more than 50 times do date, working with a wide range of company types and sectors. The focus currently is on understanding how the roadmapping approach can be customised to suit a range of different strategic contexts. Work has involved collaboration with organisations such as the UK Department of Trade & Industry, Ministry of Defence, BAE SYSTEMS, GKN, Vodafone, London Underground and the Royal Mail. Rob has a mechanical engineering background, with post-graduate degrees in applied and computational mechanics. Previously he worked at The Welding Institute for six years, including technical consulting, contract research and software development.

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