

SCIENTIFIC RESEARCH METHODOLOGIES AND TECHNIQUES

Unit 12: ROADMAPING AND FUTURE PLANNING (I)

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REMEMBER: Types of grantseekers

Reactive Grantseekers

- ◆ Wait for a grantseeking opportunity to present itself.
- ◆ Attempt to develop an innovative, creative, well-organized approach to solving a problem while they are in a state of frenzied confusion.
- ◆ Difficult to develop a successful approach while under the pressure caused by acting reactively.

Proactive Grantseekers

- Begin with a **need** or **problem** they wish to solve through grant funding.
- In order to determine the projects to pursue, they **outline** the opportunities in advance. Outlining opportunities does not entail writing down all solutions.
- By generating a **list of needs** (problems, areas of interest, and so on) they begin to develop a proactive system based on **locating funding sources** that are interested in the same problems ... therefore likely to invest in their solutions.

HOW TO PREPARE A
STRATEGIC RESEARCH
AGENDA?

1. *FUTURES* RESEARCH

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What is it?

Futures research - the science, art and practice of postulating possible, probable, and preferable futures.

It includes analyzing the sources, patterns, and causes of change and stability in the attempt to develop foresight and to map possible futures

With our choices we can shape the future.

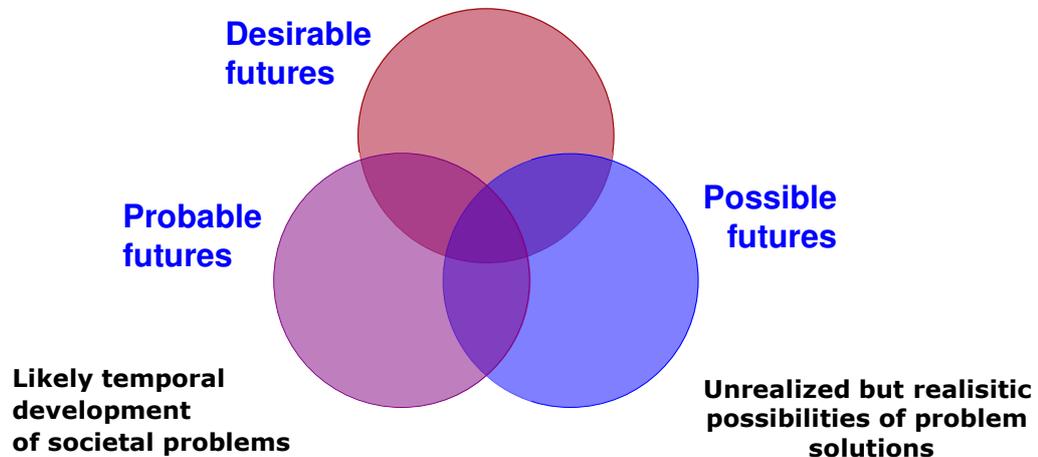


Some methods:

- Delphi method
- Trends identification and analysis
- Scenario development
- Roadmapping
- ... *and many more*

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Long-term notions of the good society



Not so much on **forecasting accuracy**, but rather on **planning and opening minds** to consider new possibilities and changing the policy agenda

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Vision: A global foresight network of Nodes, information, and software, building a global collective intelligence system recognized for its ability to improve prospects for humanity. A think tank on behalf of humanity, not on behalf of a government, or an issue, or an ideology, but on behalf of building a better future for all of us.

<http://www.millennium-project.org/>

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The Millennium Project

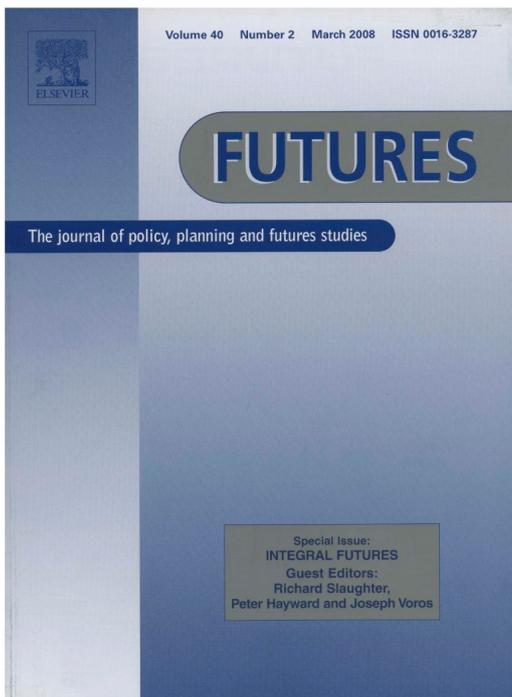
Futures Research Methodology

Version 3.0

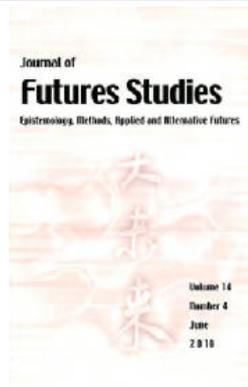
Editors Jerome C. Glenn and Theodore J. Gordon
With support from the Rockefeller Foundation

- | | | |
|---|---|---|
| 1. Introduction to Futures Research Methodology | 14. Substitution Analysis | 27. Using Vision in Futures |
| 2. Environmental Scanning | 15. Statistical Modeling | 28. Normative Forecasting |
| 3. Text Mining for Technology Foresight | 16. Technology Sequence Analysis | 29. S&T Road Mapping |
| 4. The Delphi Method | 17. Morphological Analysis | 30. Field Anomaly Relaxation |
| 5. Real-Time Delphi | 18. Relevance Trees | 31. Agent Modeling |
| 6. The Futures Wheel | 19. Scenarios | 32. Chaos and Non-Linear Dynamics |
| 7. The Futures Polygon | 20. A Toolbox for Scenario Planning | 33. Multiple Perspective Concept |
| 8. Trend Impact Analysis | 21. Interactive Scenarios | 34. Heuristics Modeling |
| 9. Cross-Impact Analysis | 22. Robust Decisionmaking | 35. Causal Layered Analysis |
| 10. Wild Cards | 23. Participatory Methods | 36. Personal Futures |
| 11. Structural Analysis | 24. Simulation and Games | 37. State of the Future Index |
| 12. The Systems Perspectives | 25. Genius Forecasting, Intuition, and Vision | 38. SOFI Software System |
| 13. Decision Modeling | 26. Prediction Markets | 39. Integration, Comparisons, and Frontiers of Futures Research Methods |
- ISBN-978-0-9818941-1-9

Other sources



Elsevier
Started in 1968
IF: 1.111



Tamkang University, Taiwan
Started in 1996



Inderscience
Started in 2004



SAGE
Started in 2007



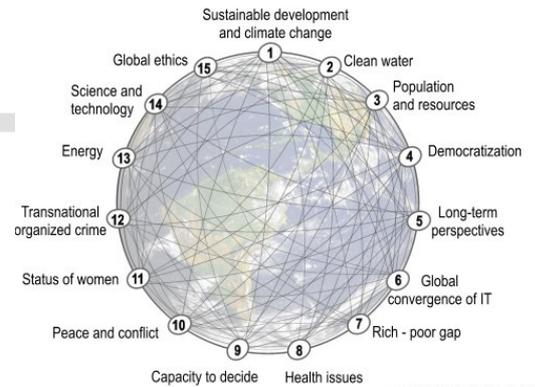
Emerald
Started in 1999



Springer
Started in 2013

“Macro” Examples

15 Global Challenges facing humanity



by The Millennium Project
www.millennium-project.org

http://www.iff.org/uploads/media/map_of_the_decade_2008_sm.pdf

HOW TO USE THE 2008 MAP OF THE DECADE

There are lots of ways to talk about the future. Often we speak of driving forces, signals of change, trends, or disruptions. This year we add our language a bit. We seek a more biological vocabulary of the future—for a future that depends more on our biological savvy.

Signals are the bridge. Cells, when they divide, light up the signals. So think of the cells on our map as signals that are flourescing. The signals show where the activity is right now, today. But when we step back a bit, we can see that the cells are also signaling a larger pattern—clusters of activity that add up to complex being systems. These systems are the critical structures, the focal points for our strategy.

Such structures do not exist in isolation, of course. They are mapped on a grid. Just as an embryonic cell maps its own position and function, front and backside build its fate map, the cells of our future line up on a matrix of rows and columns. Think of the columns as the resource energy that will coalesce individual cells into an integrated ecology. Think of the rows as distinctly human lenses that help us see the ecology from different points of view: people, practices, and tools.

WORKING THE MAP:
Foreight to insight to action

As always, our process starts with foresight that leads to insight, and ultimately, action.

FOCUS: on the clusters—the systems built forward. Find two or three of the clusters of signals that have the greatest potential impact on your own organization, your industry, or your nation's projects. Read the short descriptions on the back of the map. Then consider our Perspectives, or create your own. Use different perspectives to challenge your assumptions about where you and your organization stand.

TRACE: a path through the map to provide insight. Sometimes the most important insights come from seeing how several signals connect across the map. Draw a line through the cells that seem most important, and tell that story to your colleagues.

REARRANGE: the signals to uncover more insight. This year's Real-time Forecast makes it easy to work with individual signals. Choose the signals that you think are most relevant to your work and cluster them in new ways to provide new focal points. Use the assemblies on the TTY Signal Cards to go deeper into the signals, to find out what they look like today, in real life.

CREATE: your own grid to stimulate action. Turn the columns into initiatives, or audiences, or impact zones. Place the TTY Signal Cards in your new grid to create new clusters. Add your own signals.

DIASPORAS: THE NEW EMERGING ECONOMIES
As mobility and migration grow, the real emerging economies are the new diasporas of people who leverage shared identities to create new value and generate wealth.

CIVIL SOCIETY: THE EVOLUTION OF CIVIC INFRASTRUCTURE
Civil society—the spaces and activities that exist between the world of governments and the marketplace—will undergo a renaissance as new platforms for social connections and cooperation proliferate.

FOOD: THE FLASHPOINT
As global climate change, population growth, and health and safety issues threaten the global food supply, everything from housing, fuel, and water to health and politics will be linked to food politics and practices.

ECOSYSTEMS: MANAGEMENT IN THE CONTEXT OF LIFE
After a half century of scientific research—and in the face of growing ecosystem failures—ecosystems will begin to redefine the way individuals and institutions manage the complex ecologies within which every human activity takes place.

AMPLIFIED INDIVIDUALS: THE EXTENDED HUMAN REALITY
As people extend their biological capacities with devices and pharmaceuticals—and as their individual expressions are amplified in an extended digital world—human reality will be recast by analytics and experience alike.

NVA
NOVA SCHOOL OF
SCIENCE & TECHNOLOGY

Futures research: UN Agenda 2030

TRANSFORMING OUR WORLD:
THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

<p>1 NO POVERTY</p>	<p>2 ZERO HUNGER</p>	<p>3 GOOD HEALTH AND WELL-BEING</p>	<p>4 QUALITY EDUCATION</p>	<p>5 GENDER EQUALITY</p>	
<p>6 CLEAN WATER AND SANITATION</p>	<p>7 AFFORDABLE AND CLEAN ENERGY</p>	<p>8 DECENT WORK AND ECONOMIC GROWTH</p>	<p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>10 REDUCED INEQUALITIES</p>	<p>11 SUSTAINABLE CITIES AND COMMUNITIES</p>
<p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p>	<p>13 CLIMATE ACTION</p>	<p>14 LIFE BELOW WATER</p>	<p>15 LIFE ON LAND</p>	<p>16 PEACE, JUSTICE AND STRONG INSTITUTIONS</p>	<p>17 PARTNERSHIPS FOR THE GOALS</p>

<https://sustainabledevelopment.un.org/post2015/transformingourworld/publication>

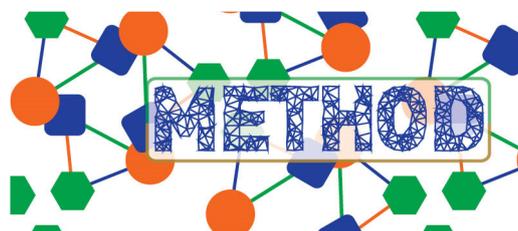
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Conventional Business Thinking	Futures Thinking
Immediate term	Depth of vision
Own business focus	Cross-disciplinary
Attention to detail	Broad vision
Techno-economic trends focus	Trends and emerging issues
Problem approach	Systems approach
Less attention to connections	Interactions and cross-impact
Continuity assumption	Wild cards and discontinuities
Bottom line focus	Strategic focus
Undiscussables	Speak the unspeakable
Short term focus	Long term orientation
A single future	Alternative futures
Mainstream thinking	Mind changers
Past and present dominate decision making	Future dominates decision making



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Attempts to define **systematic processes** to deal with this difficult subject – strategy planning with very incomplete and uncertain information ... often in disruptive environments.



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“The Delphi Method is based on a **structured process** for collecting and distilling knowledge from a **group of experts** by means of a series of questionnaires interspersed with controlled opinion feedback “

“The Delphi method is a systematic interactive forecasting method for obtaining forecasts from a panel of independent experts “

“A means of eliciting and combining expert judgments while avoiding the pitfalls of conference room confrontations.”

[Glenn, 2008]

Software example:

<http://armstrong.wharton.upenn.edu/delphi2/>

1. Formation of a team to undertake and monitor a Delphi.
2. Selection of one or more panels to participate in the exercise.
Customarily, the panelists are experts in the area to be investigated.
3. Development of the first round Delphi questionnaire
4. Testing the questionnaire for proper wording (e.g., ambiguities, vagueness)
5. Transmission of the first questionnaires to the panelists
6. Analysis of the first round responses
7. Preparation of the second round questionnaires (and possible testing)
8. Transmission of the second round questionnaires to the panelists
9. Analysis of the second round responses
(Steps 7 to 9 are reiterated as long as desired or necessary to achieve stability in the results.)
10. Preparation of a report by the analysis team to present the conclusions of the exercise

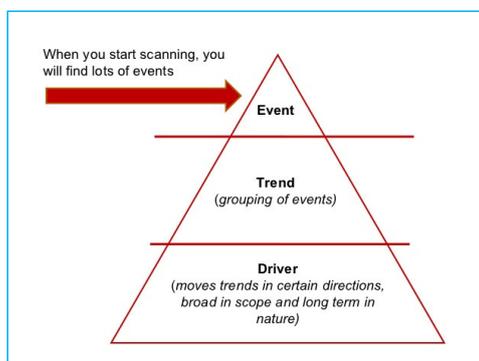
A variant: Real Time Delphi

A kind of “roundless” Delphi: “The respondents participate by filling out an online questionnaire, and the results — both numerical and qualitative — are updated as responses are recorded in “real time. Respondents can — and are encouraged to — revisit the questionnaire as many times as they want. Each time, they are shown their own responses as well as the updated answers of the others, and they can revise and change their own inputs based on this feedback.”

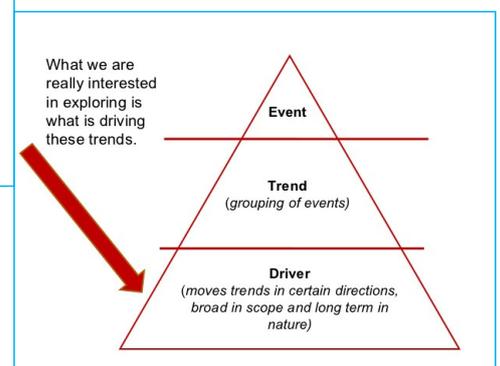
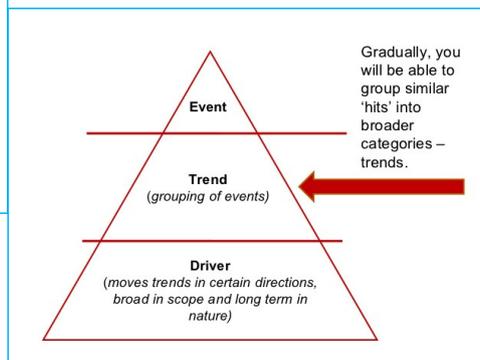
<http://www.millennium-project.org/rtd-general/>

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“The study and interpretation of the political, economic, social and technological events and trends which influence a business, an industry or even a total market”
(Kroon 1995)



Environmental scanning is the art of systematically exploring and interpreting the external environment to better understand the nature of trends and drivers of change and their likely future impact on your organization (or “system”)



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<http://www.slideshare.net/mkconway/environmental-scanning-what-it-is-and-how-to-do-it>

STEEP FACTOR	EXAMPLES OF AREAS FOR SCANNING
Social	Demographics, population shifts, migration, generations Standards of living Value systems Socio-economic conditions Education (although you might want to make this a separate classification) Ethic/religious factors Crime, safety and security Family Health Attitudes to work and employment Leisure Lifestyle changes Consumer attitudes and opinions Fads and Fashions
Technology	Technology for service delivery Technological developments generally, including emerging technologies Convergence, competition and dependencies Nanotechnology Information and communications Technology legislation
Economy	All aspects of economic activity, global, national or organisations. Work and employment, occupations Consumer behaviour Globalisation
Environmental	All natural factors Physical and geographical conditions Ecosystems Resources Sustainability
Politics	Often includes legal issues. Global connections National factors

Some steps:

- **What to Look For: Focusing your Scan**
- **Where to Look: Sources**
- **Knowing When a Scanning Hit is Useful**
- **Counter Trends and Wildcards**
- **Recording your Scanning Hits**
- **Interpreting and Reporting Your Scanning**

E.g. events, innovations, policy shifts, social developments and changes in the way people use technology

Low-probability, high-impact events



<https://static1.squarespace.com/static/580c492820099e7e75b9c3b4/t/5855070359cc6826e11c5fa8/1481967382883/ES+Guide+July+13+%282%29.pdf>

	2007	Short term	2008	2009	Medium term	2011	2012	Long term	2015	
Trends & Drivers	Social:									
		1. Education & Skills (Technical)				MRSA		17. Demographics / Aging Population		
			4. Public Opinion & Sector Perception						Attracting Talent to UK	
		3. Education (Leadership & Entrepreneurship)			Attract talent in / to UK					
				20. Safety		Patient Power		Lifestyle Therapies		
Technological:										
	7. Speed Time to Market							10. Personalised Medicine		
			15. Cross-Industry Knowledge Transfer				Cell as the product			
				9. Increased use of Vaccines (due to Economic Drivers)			19. Synthetic Biology			
	18. Product Innovation						Bio-Generics	Nano		
				11. Productivity → Integration of R&D & Process Development				Bio-Pharming		
Environmental:										
		Environmental Legislation								
				Growth of BioFuels (Spin-off Markets / Technologies)						
							Sustainability			
							Reduce waste in disposables			
Economic:										
	Weak \$			2. Funding & Fiscal Environment						
		6. Lack of Critical Mass of Bio Sector in UK				13. Manufacturing Location → Low Cost Economies				
		16. Demand for Lower Manufactured Cost of Goods						Globalisation of R&D		
	Strong UK CM base			14. IP & Patents			12. New Business Models / Scale Reduction			
								Global Growth Opportunity		
Political & Legal:										
		8. Need for Improved Regulation				5. R&D & Approvals Costs to Market				
				20. Safety						

An old example by now ... but it illustrates a representation style



Lighting Market Trends and Drivers

Sustainability Emphasis	Legislation and Rising Energy Costs	Product Innovation	Requirements
<ul style="list-style-type: none"> • LEED • Green building strategies and codes • Reduction in energy consumption of building systems • CO₂ reduction efforts, corporate carbon footprint reduction initiatives • Corporate social responsibility 	<ul style="list-style-type: none"> • Federal, state, local, and utility programs to promote lighting upgrades • Rising energy costs • Environmental safety and compliance • Building and lighting code compliance • Legal restrictions on the manufacture of non-energy efficient products 	<ul style="list-style-type: none"> • Energy efficient product options: Linear Florescent, Induction, LED • Total light management controls solutions • Longer product life and reduced maintenance costs • Global manufacturers entering market (LG, Toshiba, Panasonic) 	<ul style="list-style-type: none"> • Reduction in energy usage and maintenance costs • Energy management services • Full turnkey capabilities • Supply chain optimization • Limited capital budgets • Quick ROI pay back

WESCO Position and Foundational Strength					
WESCO lighting specialist team	Strategic supplier relationships	Global Accounts customer base	Industry-leading LEAN value creation programs	Turnkey alliances with ESCO's	Synergies across WESCO groups

...energy efficiency provides a catalyst for lighting growth

Scenarios planning

A **scenario** is a story with plausible cause and effect links that connects a future condition with the present, while illustrating key decisions, events, and consequences throughout the narrative.

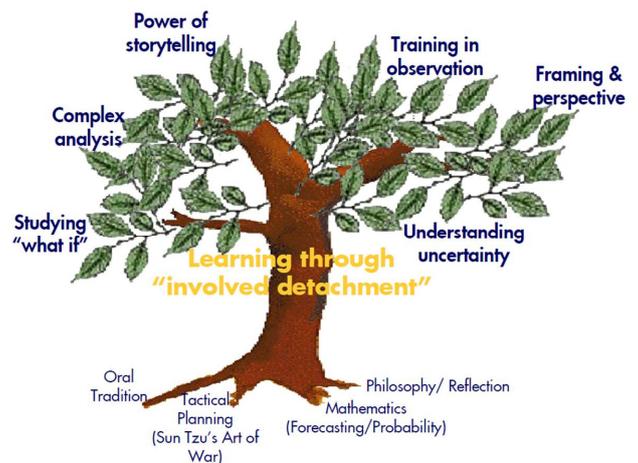
Scenario planning is a method for learning about the future by *understanding the nature and impact of the most uncertain and important driving forces affecting our world.*

Scenarios resemble a set of stories, written or spoken, built around carefully constructed plots.

Scenarios: examples

<http://www.shell.com/energy-and-innovation/the-energy-future/scenarios.html>

[Glenn, 2008]



Roots of scenario thinking [Davis, 2002]



What are Shell Scenarios?

Shell has been a pioneer in developing scenarios to explore the future and deepen its strategic thinking for almost 50 years.

A scenario in active ageing

José is apprehensive today. In fact he has been worried lately. Everything was different two years ago when he and his friend had this idea for an innovative low consumption air conditioning device and started their FreshAir company. The two engineers soon developed the new equipment thanks to their dedication and enthusiasm. But now they are facing difficulties. They don't know much about marketing or internationalization, although they understand the need to target a global market. Unfortunately they spent all their resources in the start-up phase and now cannot afford to get assistance from one of those big consultancy companies ... Either something happens or may have to close and fire their employees soon...

Three weeks later ...

José and his colleague are having a meeting with Carlos and Ana, two members of the local branch of the Regional Development Agency (RDA). After some initial contacts, Carlos and Ana spent some time in the company making an analysis of its problems and today they are presenting their conclusions. The diagnosis seems logical to José. It is clear that FreshAir needs some coaching and specialized guidance in two crucial areas – focused marketing and internationalization. But they cannot afford the high costs of such specialized assistance. RDA, an organization funded by the local government and that aims to promote local businesses, made the analysis for free. Unfortunately they do not have the expertise to help in the next phase ... Guessing the worries passing through José's mind, Ana told them that there is a potential solution. Then she mentioned the ActiveSeniors association ...

Pedro is a retired professional, member of ActiveSeniors. Based on his specific expertise and experience in marketing, he was invited to join a team involving 2 other members of ActiveSeniors with competencies in internationalization and air conditioning. Together with Carlos and Ana from RDA, this team started a temporary collaborative network with people from FreshAir. After 3 months the first results are starting to show up. The ActiveSeniors team not only provided technical assistance and guidance, but also helped FreshAir establish some contacts with a new market in India. Now the business prospects for the young company started to seem brighter...

Pedro is quite satisfied for having this opportunity to work on a topic where his experience was a real added value. He very much appreciated the diagnosis and preparatory work done by RDA, which allowed him and his senior colleagues to focus on the core issues. Working in a team was a great experience. The small payment Pedro received is also great to complement his pension and give him some better living conditions. FreshAir and RDA could mobilize some resources to pay a small fee to the 3 members of ActiveSeniors, a value much lower than the typical consultancy prices that could never be afforded by FreshAir. Carlos and Ana got a special recognition from their boss at RDA for being successful in helping a local company and thus creating better economic prospects for the region. José and his friend re-gained their enthusiasm and they really appreciated the value of this collaboration endeavor with RDA and ActiveSeniors. They certainly plan to keep the contact and look forward to using again this amazing pool of expertise and experience available at ActiveSeniors.

[ePAL project, 2008]

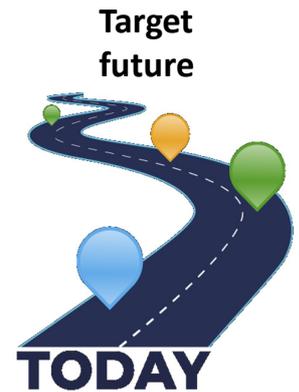
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2. ROADMAPMING CONCEPT

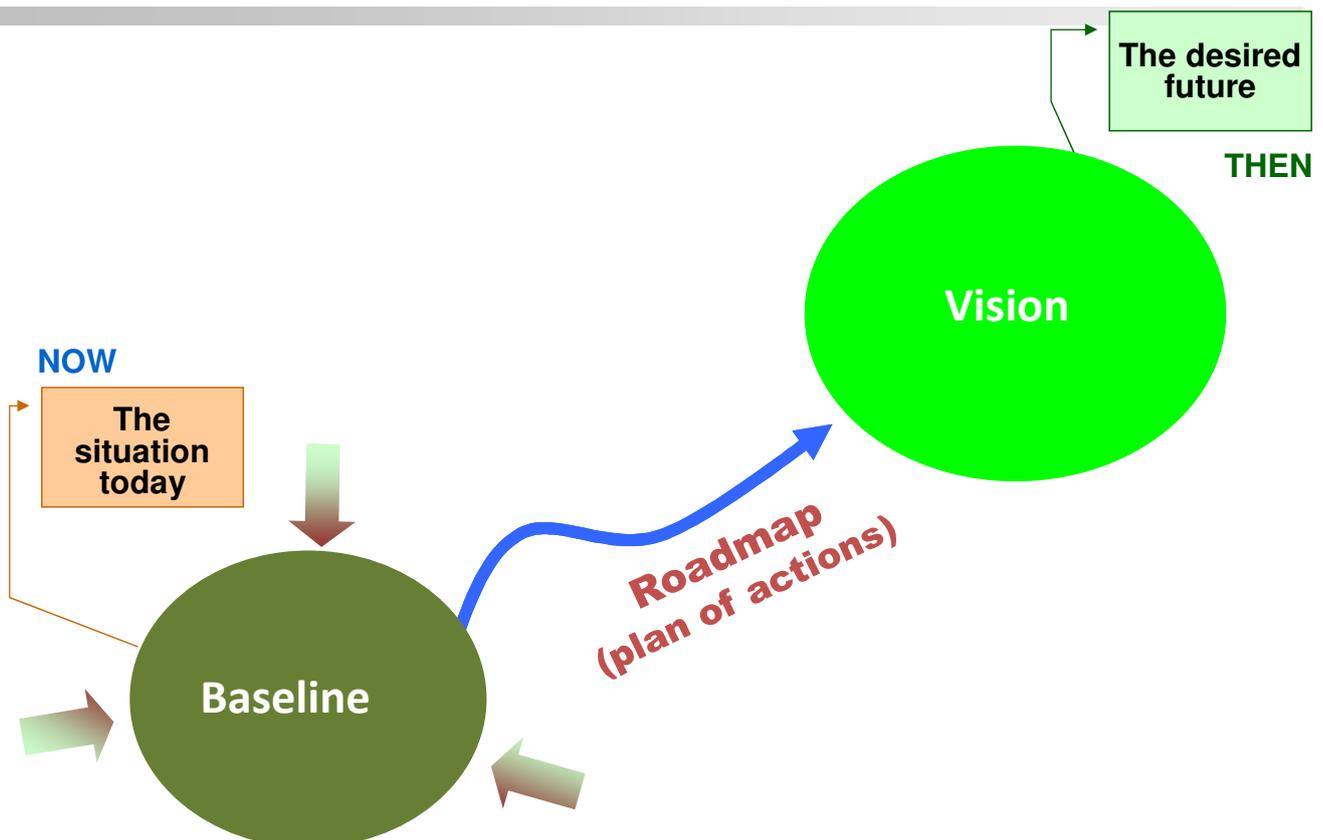
"A **'roadmap'** is an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field."

[Galvin 2002]

"**Roadmapping** is a popular metaphor for planning and portraying the use of scientific and technological resources, elements and their structural relationships over a period of time. The process of roadmapping identifies, evaluates and selects strategic alternatives that can be used to achieve desired objectives, and the resulting roadmaps summarise and communicate the results of key business decisions".



[Vähäniitty, et al. 2004]





- Science and research roadmaps ←
- Cross-industry roadmaps
- Industry roadmaps
- Technology roadmaps
- Product roadmaps
- Product-technology roadmaps
- Project and issue roadmaps

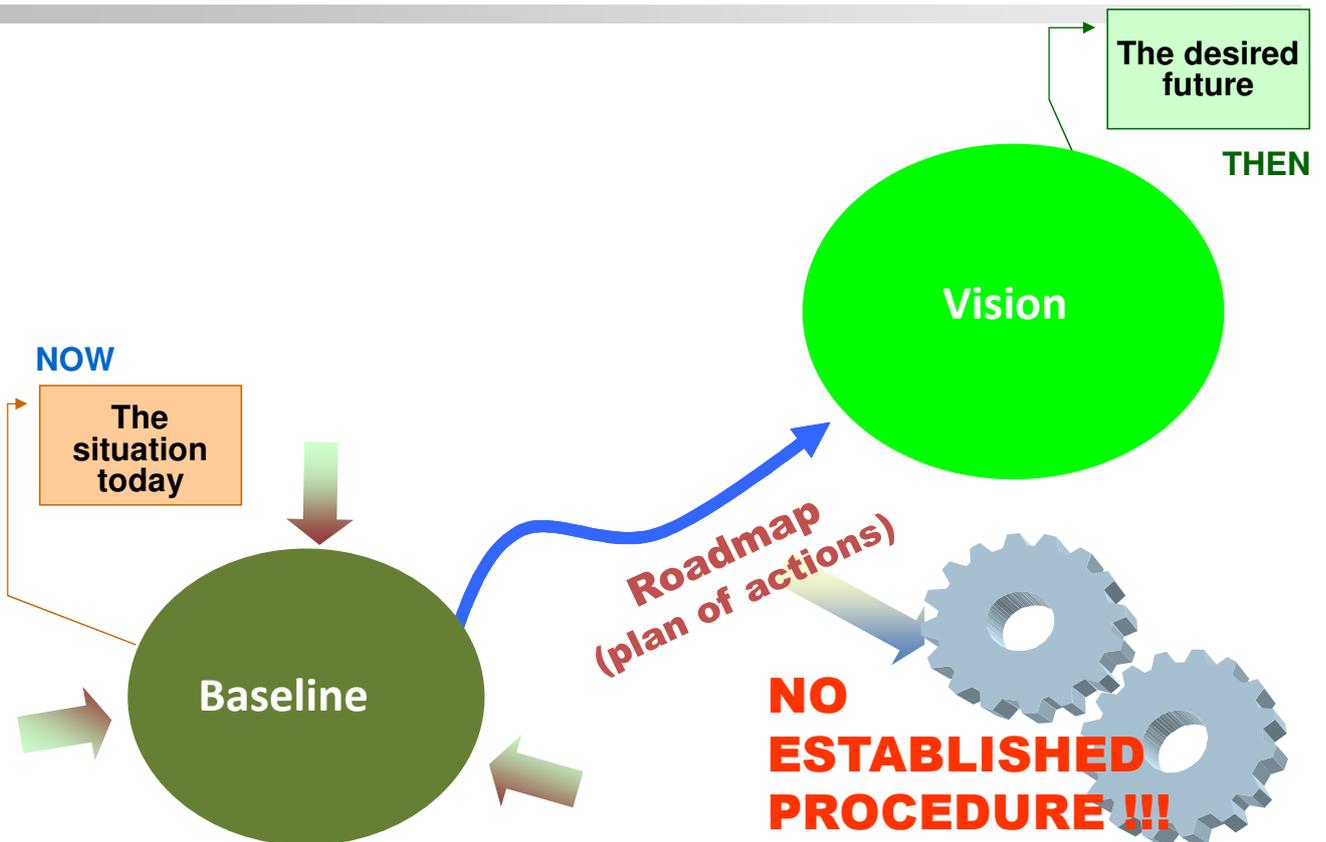
Roadmapping Topics

	Definition and Strategy "Know why" ↔	Direction "Know-what" ↔	Technology "Know-how" ↔	Action Plan "To-do"
Science and Technology Roadmaps	<ul style="list-style-type: none"> • Scope of the Field • Technology Applications 	<ul style="list-style-type: none"> • Technical Challenges • Architecture • Trends, Discontinuities, and Objectives 	<ul style="list-style-type: none"> • Technology Elements and Evolution • Competitive Technologies and Costs 	<ul style="list-style-type: none"> • Action Programs • Technology Investment • IP and Standards • Risk Roadmap
Industry and Government Roadmaps	<ul style="list-style-type: none"> • Industry Structure and Position • Customer Drivers • Industry Direction 	<ul style="list-style-type: none"> • Technical Challenges • Architecture • Trends and Disruptions • Learning and Targets 	<ul style="list-style-type: none"> • Technology Elements and Evolution • Technology Alternatives • Future Costs 	<ul style="list-style-type: none"> • Action Programs • Technology Investment • IP and Standards • Risk Roadmap
Product – Technology and Platform Roadmaps	<ul style="list-style-type: none"> • Market Structure and Size • Customer Drivers • Competitive Strategy 	<ul style="list-style-type: none"> • Product Roadmap • Architecture • Product Drivers and Targets • Feature evolution 	<ul style="list-style-type: none"> • Technology Elements and Evolution • Competitive Position • Target Costing 	<ul style="list-style-type: none"> • Action Programs • Technology Investment • IP and Standards • Risk Roadmap

3. ROADMAPPING METHODOLOGY

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Roadmapping procedure ?

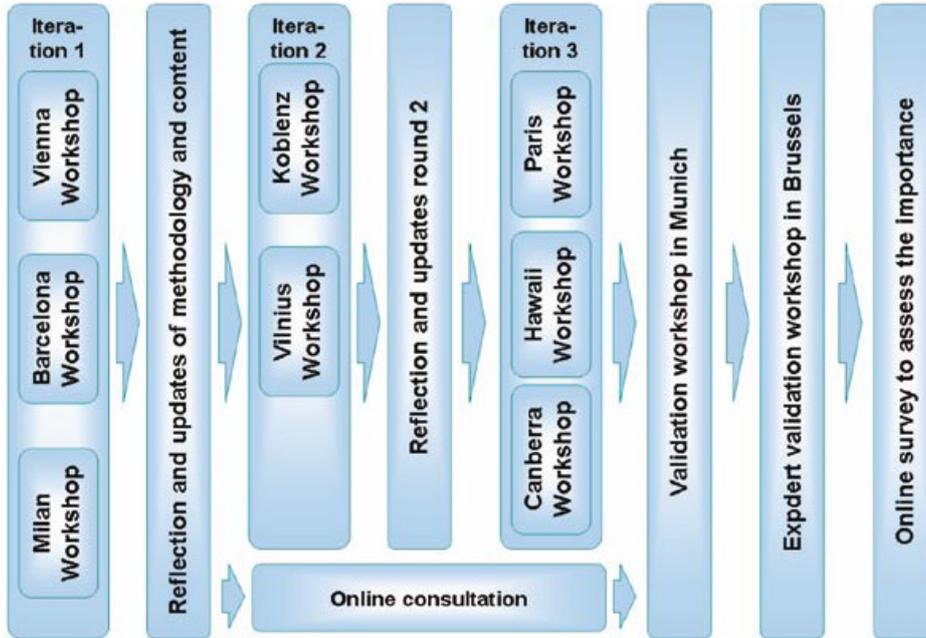


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Roadmapping procedure ?

One frequent approach: Organizing activities around a series of workshops

Example: *eGovRTD2020 roadmapping workshops*



Difficulties:

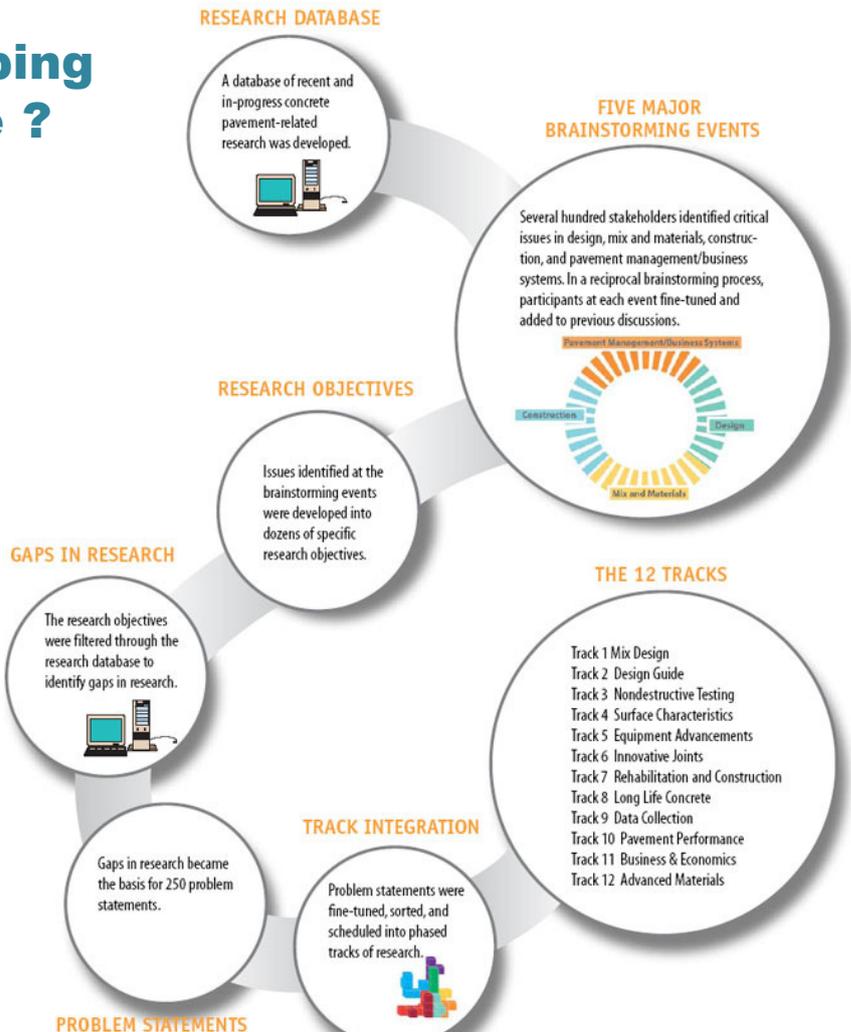
Without a preliminary study, initial workshops can be quite inefficient

Some participants may mislead the discussions



Roadmapping procedure ?

An example in
Concrete Pavement Road Map



VOmap aimed at identifying and characterizing the

- ➔ key research challenges
- ➔ required constituency
- ➔ implementation model

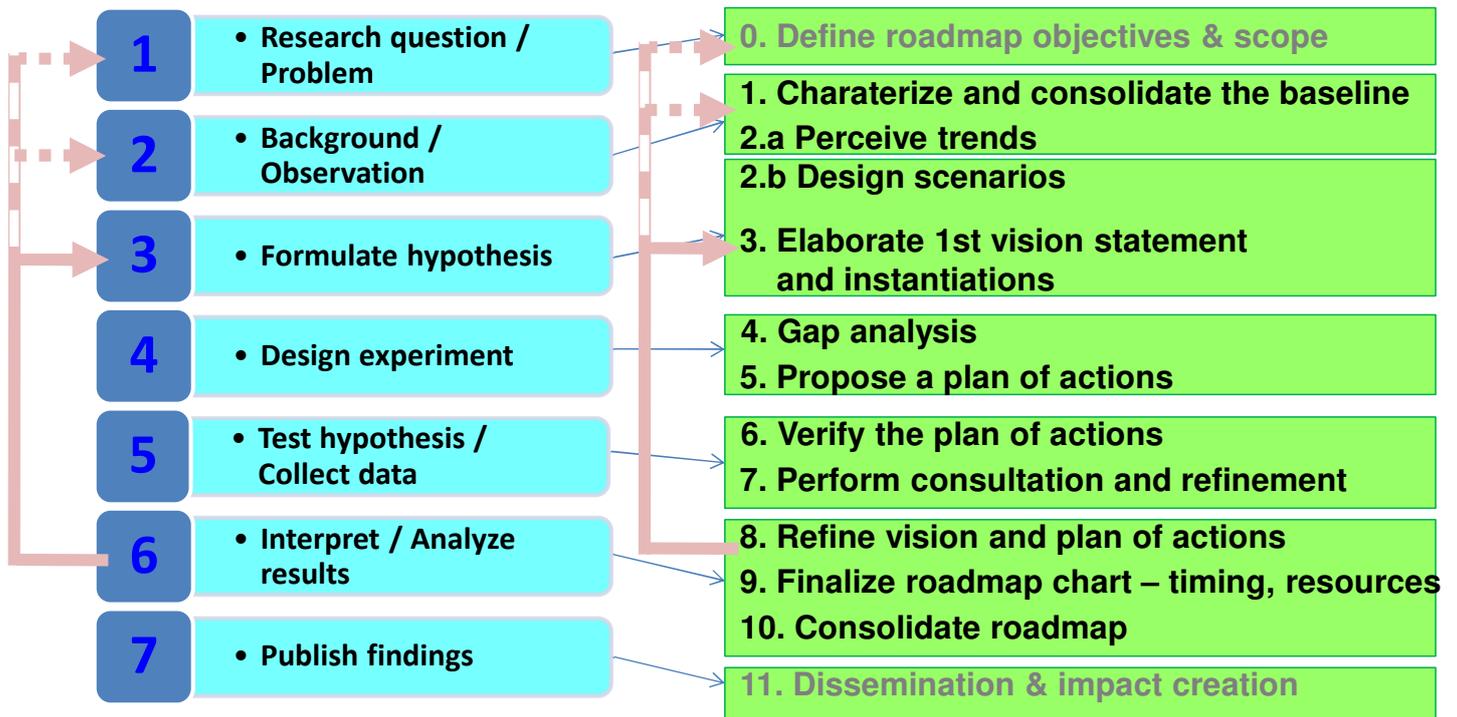
for a comprehensive initiative to affirm the European leadership on dynamic collaborative virtual organizations

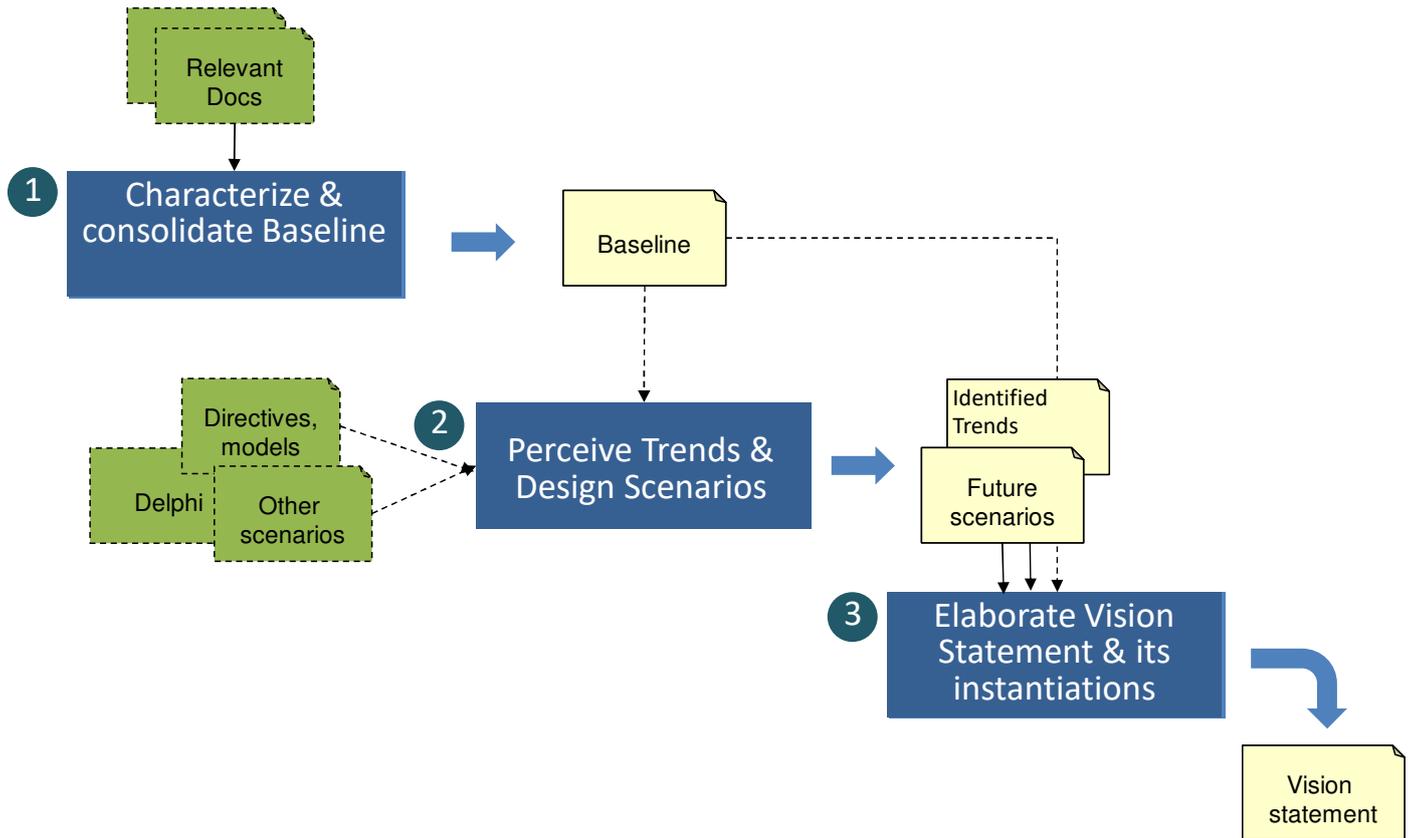
[2004]

Roadmapping method – A scientific approach

Classical scientific method

Adopted roadmapping method





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- ▶ **Building the Vision** is a main step in creating the **roadmap**
- ▶ **Roadmap** provides an **active plan** of how to reach the **desired Vision constellation for the future**

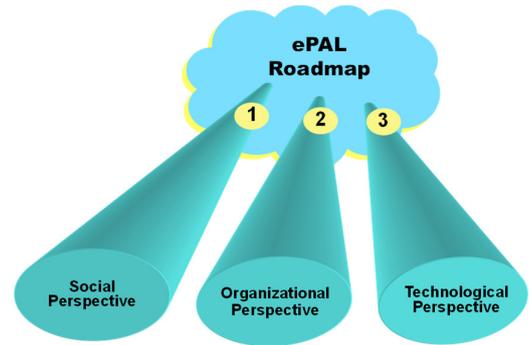
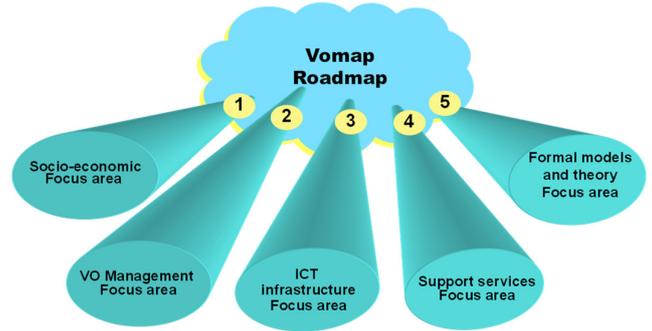
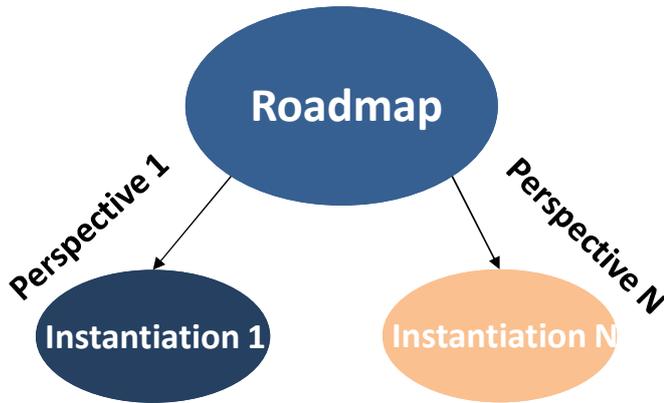
- Vision building is **not a mechanism to foresee the future !**
- **But to define the future state that we wish to reach**

To **establish a vision**:

- **Significant market and technology trends**
- **Expert's recommended requirements for future success of the VOs**
- **The state-of-the-art & Consolidated baselines**
- **Elaboration and characterization of plausible future scenarios**
- ...



Roadmapping is planning, not forecasting !



Multi-disciplinary contributions

Baseline

- Research on VO has created a critical mass and European-wide *intuitive* understanding of the area.
- Basic supporting infrastructures and relevant technologies are well represented, but the developments are often focused on particular needs and based on ad-hoc experiments, hardly re-utilizable.
- Generic functions or harmonization of achievements are addressed only in a few projects.
- Efforts on general plug-and-play architecture and interoperability are also to a large extent missing.
 - Consequently, no generally accepted *reference model* or *interoperability base* are available.
- Although several disciplines are concerned, the main focus has been on the ICT infrastructure. Research on social/organizational, including management, is mainly focused on best practice. Integration with technological development and impacts on structures are not covered. In addition little research is focused on the social and organizational issues created by VOs

Vomap

BRAID

<p>Life Setting: Independent living</p> <p>Vision facet: Established infrastructure and networks as the base for the support of independent living by technology</p>	<ul style="list-style-type: none"> • Increasing availability of Internet and speed of broadband access. • However, in some countries broadband access covers less than half of the rural population and, ageing people, this access is lagging behind. • Market trend towards mobile broadband access at a decreasing price. • Increasing availability and power of mobile computing. • Mobile phones with built-in GPS, facilitating context aware applications. • More applications running on Cloud Computing. • Progress on standardization and interoperability, facilitating the development of the web of services. • Progress on Internet of Things, new sensorial systems and wireless integration, creating the possibility of having more devices in the environment. • Large panoply of mechanisms and tools for safe communications, although still difficult to integrate and configure. • Technological convergence continues to merge multiple media types onto new hybrid devices. • Progress on systems integration around the concept of smart home. • Fast development of ICT represents a barrier for seniors, but broadband access also creates new opportunities for distance learning.
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<p>Life Setting: Independent living</p> <p>Vision facet: Assistive technology and support services that facilitate independent living</p>	<ul style="list-style-type: none"> • Advances in assistive/adaptive technologies for augmenting the capabilities of individuals, such as cognitive assistance, daily Living assistance, wellness monitoring, and health monitoring. • Progress in robotics, which may act as replacement for human care, including service and companion robots, and able to monitor and assist elderly people suffering both from cognitive disorders and physical disabilities. However, developments in this field encounter both scientific and economic challenges. • Progress in assistive communication technologies, which allows enhancing the communication abilities of the elderly to engage in desired person-to-person communications and person-to-machine communications. • Customizable user interfaces allow the usage optimization of screen space with adaptive interfaces, for different output channels (PCs, mobile phones, PDAs, etc.), and the inclusion of translation engines. • Experiments on preventing cognitive decline, focused on developments to compensate cognitive loss through assistive technologies. • Growing convergence between biology and ICT tools (e.g. ICT implants that enhance brain/cognitive function, genetic screening, DNA tests). But the use of biometric systems has not yet been fully explored, and ethical issues are likely. • Progress on assistive services for daily living assistance, driving assistance, cognitive assistance, etc.
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<p>Life Setting: Independent living</p> <p>Vision facet: Monitoring devices and technologies supporting ambient intelligence solutions</p>	<ul style="list-style-type: none"> • Progress in sensing technologies, creating the possibility of having more effective monitoring and context awareness reasoning functionalities. • Some developments applying reasoning and context awareness. Extraction of knowledge about the activities of the user and the current situation in this environment from low-level sensor data to plan the appropriate short-term and long-term reaction. • The elderly behavior can be observed and compared to typical behaviors, issuing alerts when necessary. • Assistive robots can act as replacement for human care, including service and companion robots. They can monitor and assist elderly people suffering from cognitive disorders and physical disabilities. Developments in this field encounter both scientific and economic challenges. • Early developments on perception / recognition of emotions. • Progress on smart homes development opens new opportunities for developing novel monitoring and intelligent assistance services.
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Vision statement

“ In 2015 most enterprises will be part of some **sustainable collaborative networks** that will act as **breeding environments** for the formation of **dynamic virtual organizations** in response to fast changing market opportunities and conditions.

Main mechanisms:

- Well founded models of collaboration
- Management systems for breeding environments replicable to a large variety of sectors
- Generic and invisible infrastructure and re-utilizable service toolbox, based on interoperability standardization
- Extensive use of pervasive computing
- VO management principles adapted to emerging behavior in complex networks
- Active innovation and new value systems management in networks
- Support of social responsibility, including “life maintenance”, based on a suitable ethical code
- Comprehensive (international) legal frameworks for VOs

As a result, a strong and cohesive social fabric is built in response to turbulence and uncertainty.

Vision instantiation for ICT infrastructures

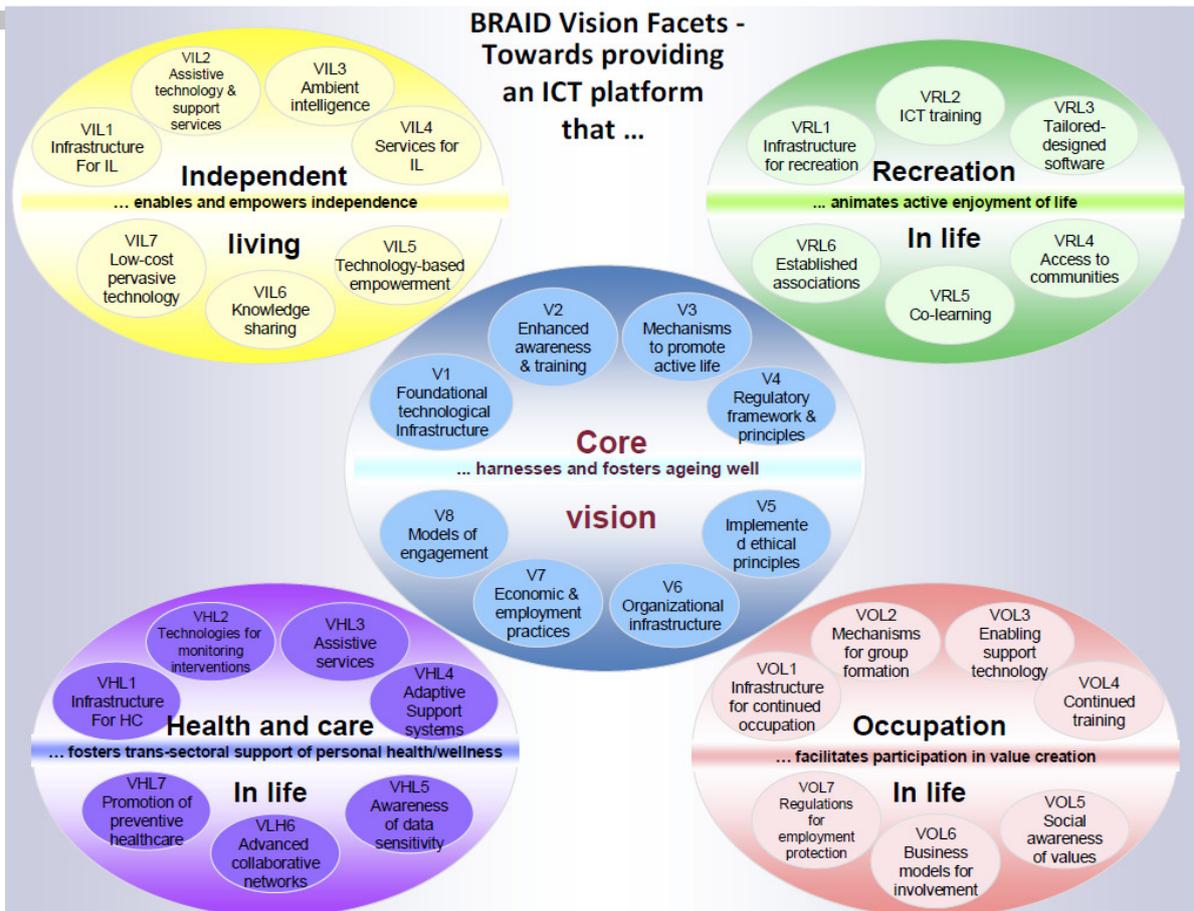
The ICT infrastructure will be developed as an invisible, affordable, and easy to use enabler of collaborative behaviors in networked organizations.

- Technology-independent reference architecture for the horizontal infrastructure
- Provide support for federated information and resources management
- Flexible control mechanisms supporting the implementation of a large variety of behaviors
- Plug-and-play concept extended to inter-organizational services
- Full e-transaction security is guaranteed
- “Configure yourself” philosophy (user “programmable” infrastructure)

Vision instantiation for socio-economic area

The socio-economic environment will be fully developed to support virtual organizations, stressing the importance of human-related issues at the individual and organizational level, in enabling institutions and in a transparent regulatory environment.

- People being prepared and supported to work as employees or professionals in enterprise networks or other virtual organisation settings
- New mechanisms and institutions to provide for human sense of belonging, long-lasting relationships and stability (social responsibility)
- New institutions and models to support “life maintenance”, e.g. social security and personal training and development
- Support for companies by enabling institutions and services to set-up, enter and develop virtual organisations regionally and internationally
- Transparent legal framework, specially in the case of institutional collaboration
- Regional assets and identity leveraged and preserved
- Well founded understanding of social and socio-economic processes and developments in the context of networked economies



VISION STATEMENT

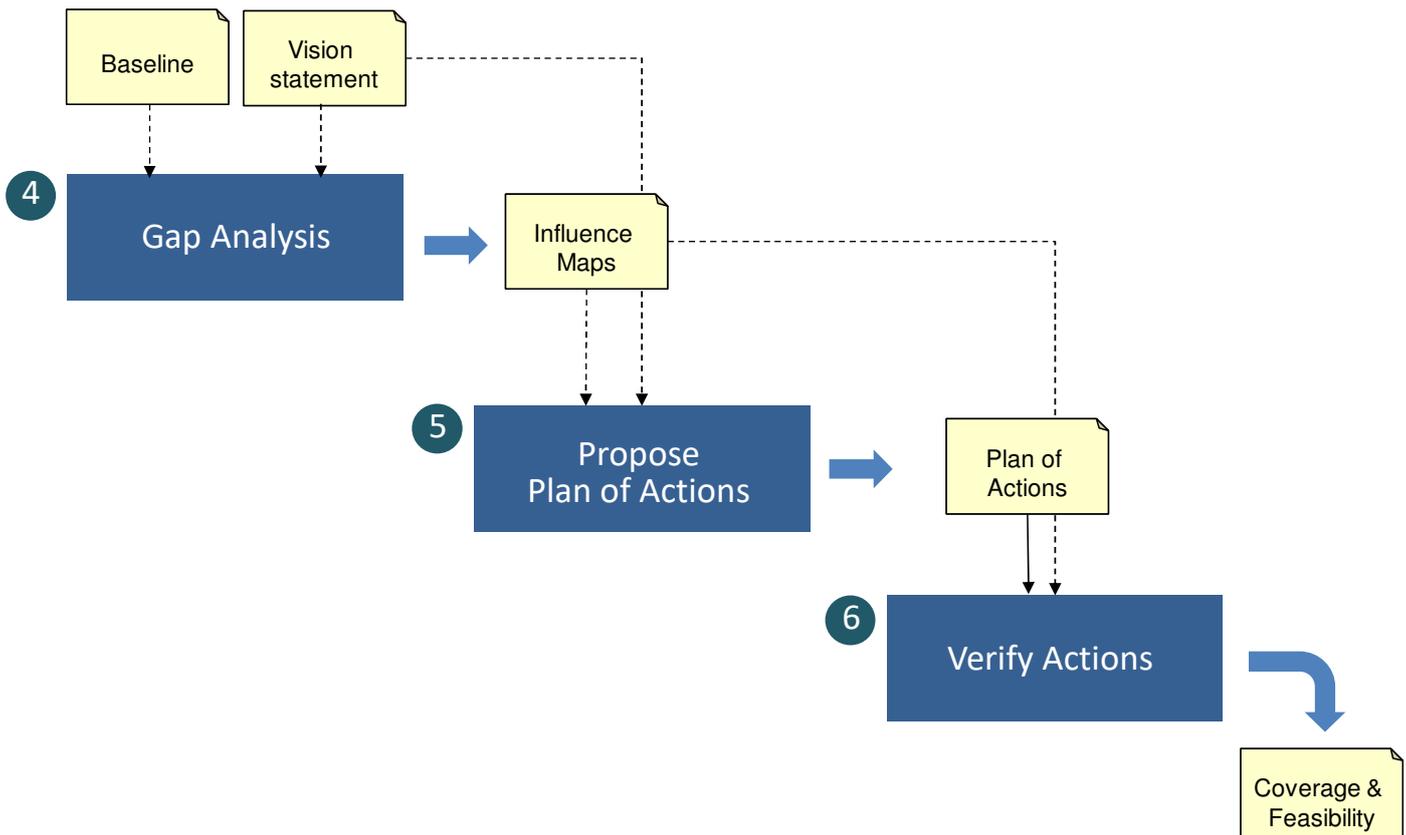
In 2020, lighting systems in buildings and other applications will:

- Enhance the performance and well-being of people
- Adapt easily to the changing needs of any user
- Use all sources of light efficiently and effectively
- Function as true systems, fully integrated with other systems (rather than as collections of independent components)
- Create minimal impacts on the environment during their manufacturing, installation, maintenance, operations, and disposal

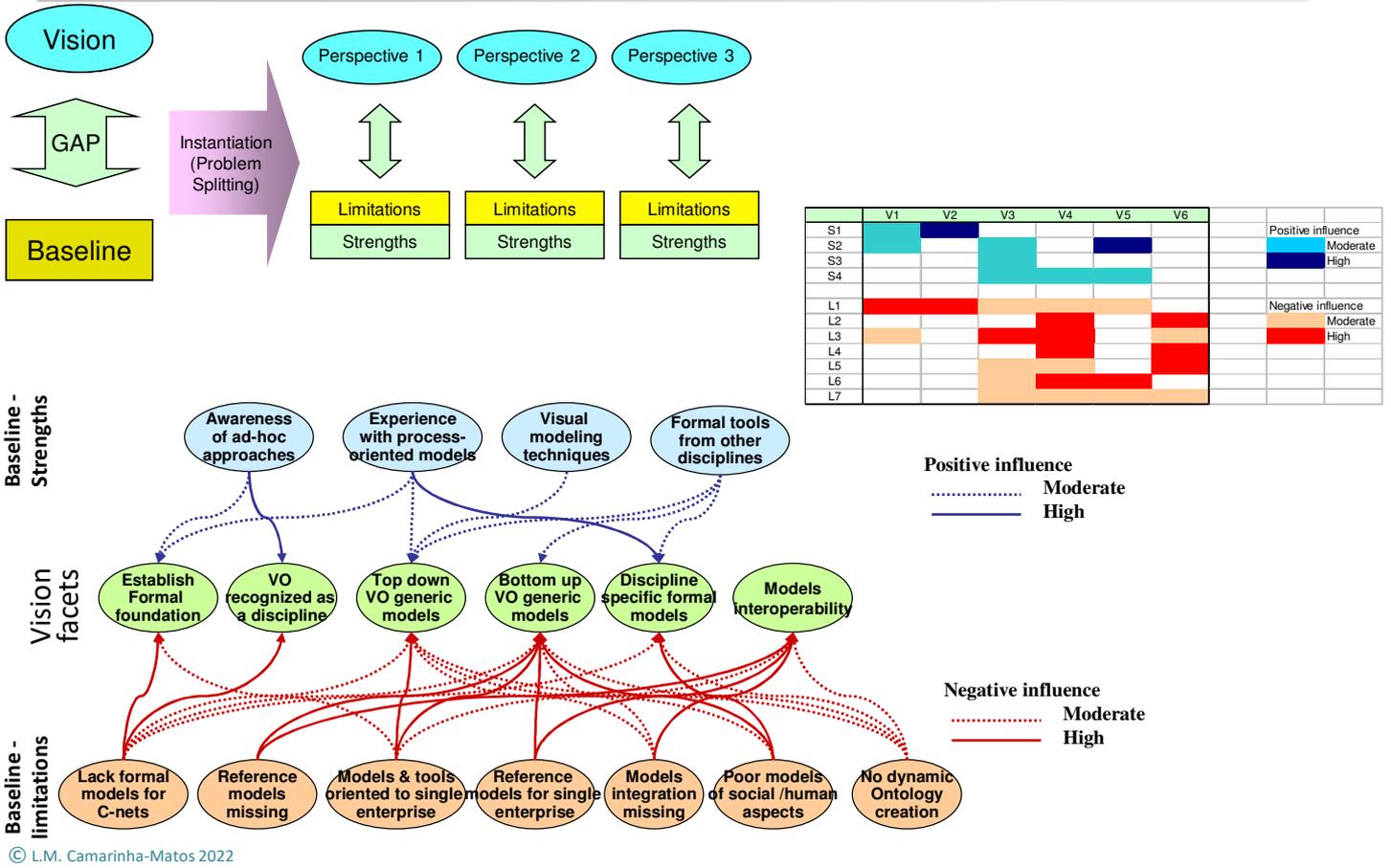
As a result, people will understand, value, and utilize the tangible, personal benefits provided by these lighting systems.

Vision 2020
The lighting technology roadmap
www.nrel.gov/docs/fy00osti/27996.pdf

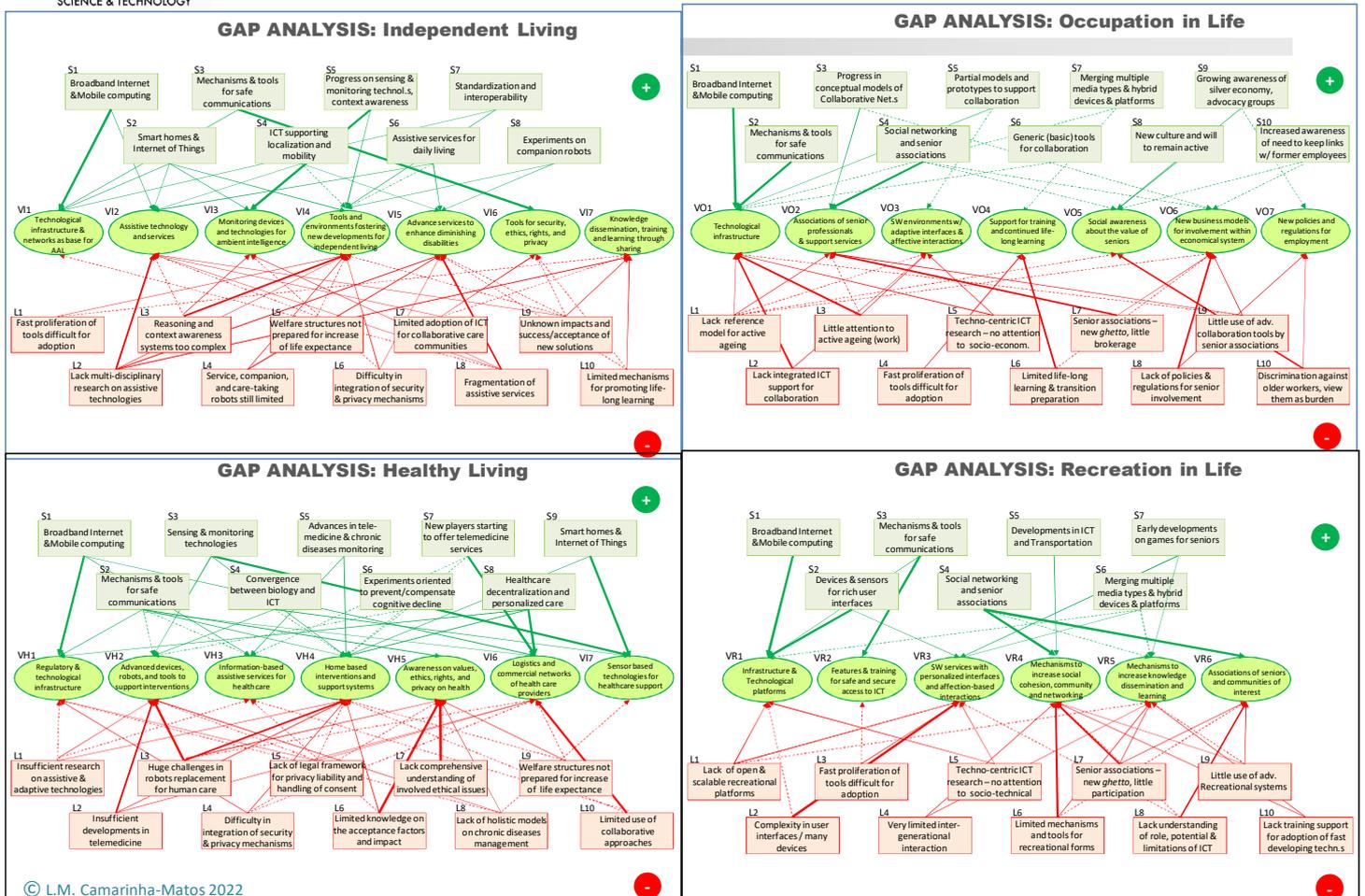
Next steps ...



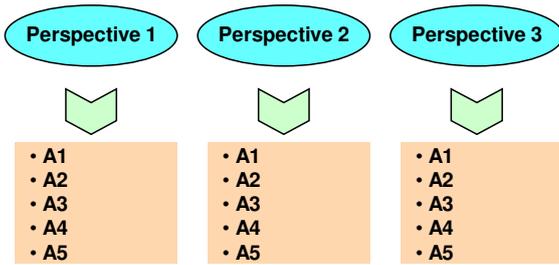
Example - Gap analysis



Example - Gap analysis



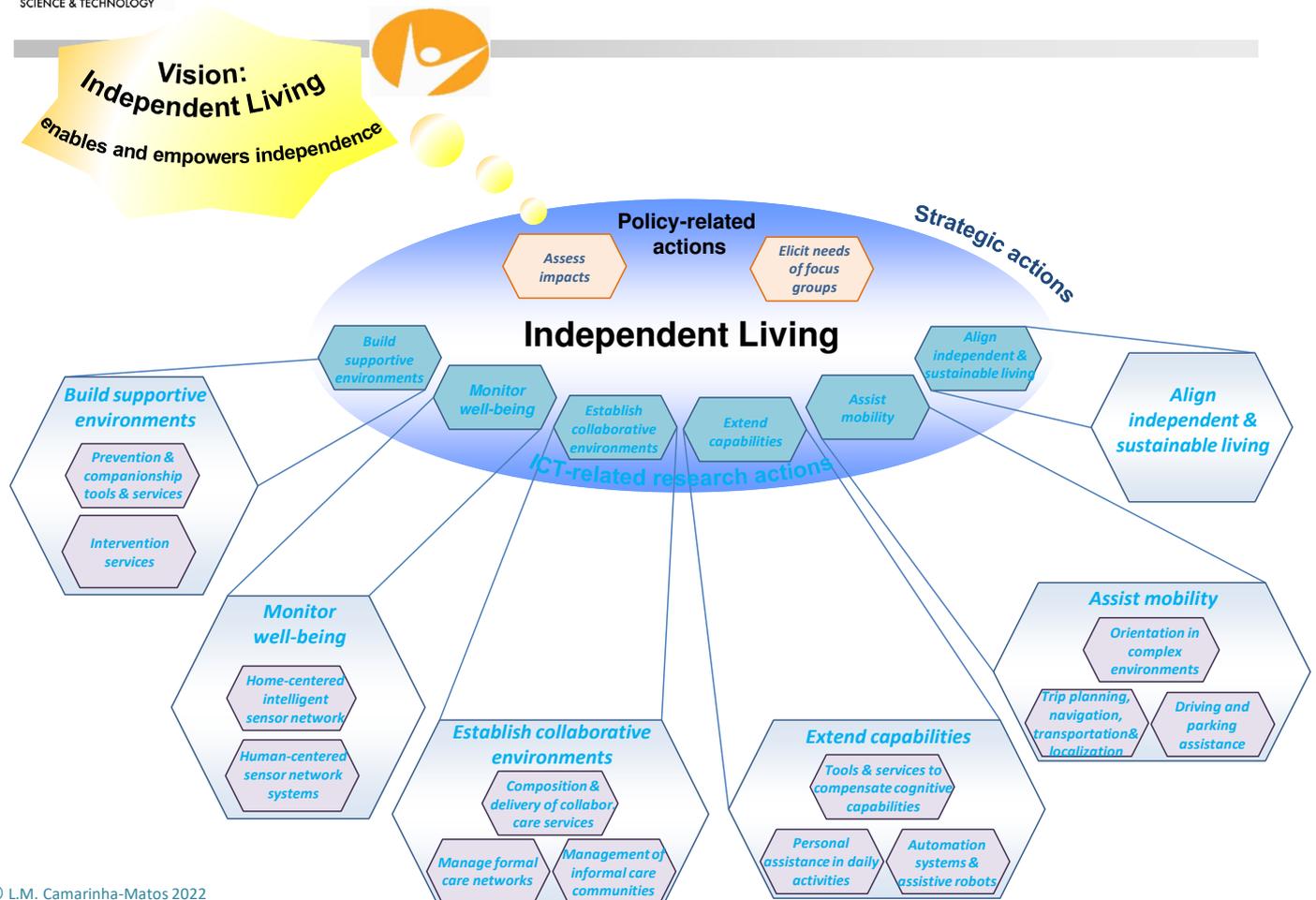
Example – Plan of actions



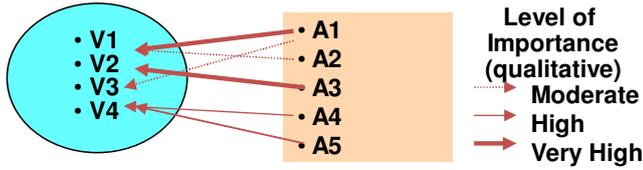
Actions
Perspective X

- A1** ■ Establish a **formal theoretical foundation** for modeling dynamic collaborative networks
- A2** ■ Elaborate approaches for **models interoperability**, supporting multiple modeling perspectives (e.g. structure, behavior) at generic and focused area levels
- A3** ■ Define basic **formal reference models** (including ontologies) for collaborative networks at general and focused-area levels
- A4** ■ Elaborate **soft modeling approaches** and soft models to both handle incomplete / imprecise knowledge and capture the social/human aspects in collaborative networks
- A5** ■ Devise mechanisms for **evolution** and maintenance of reference models for collaborative networks

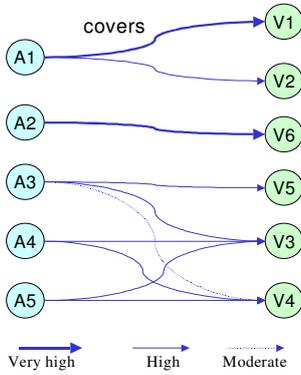
Example – Plan of actions



Example – Verification



Covering the vision



Covering the vision ?

Covers	V1	V2	V3	V4	V5	V6
A1	Very high	High				
A2						Very high
A3			High	High	High	
A4			High	High	High	
A5			High	High	High	

Very high
High
Moderate

or



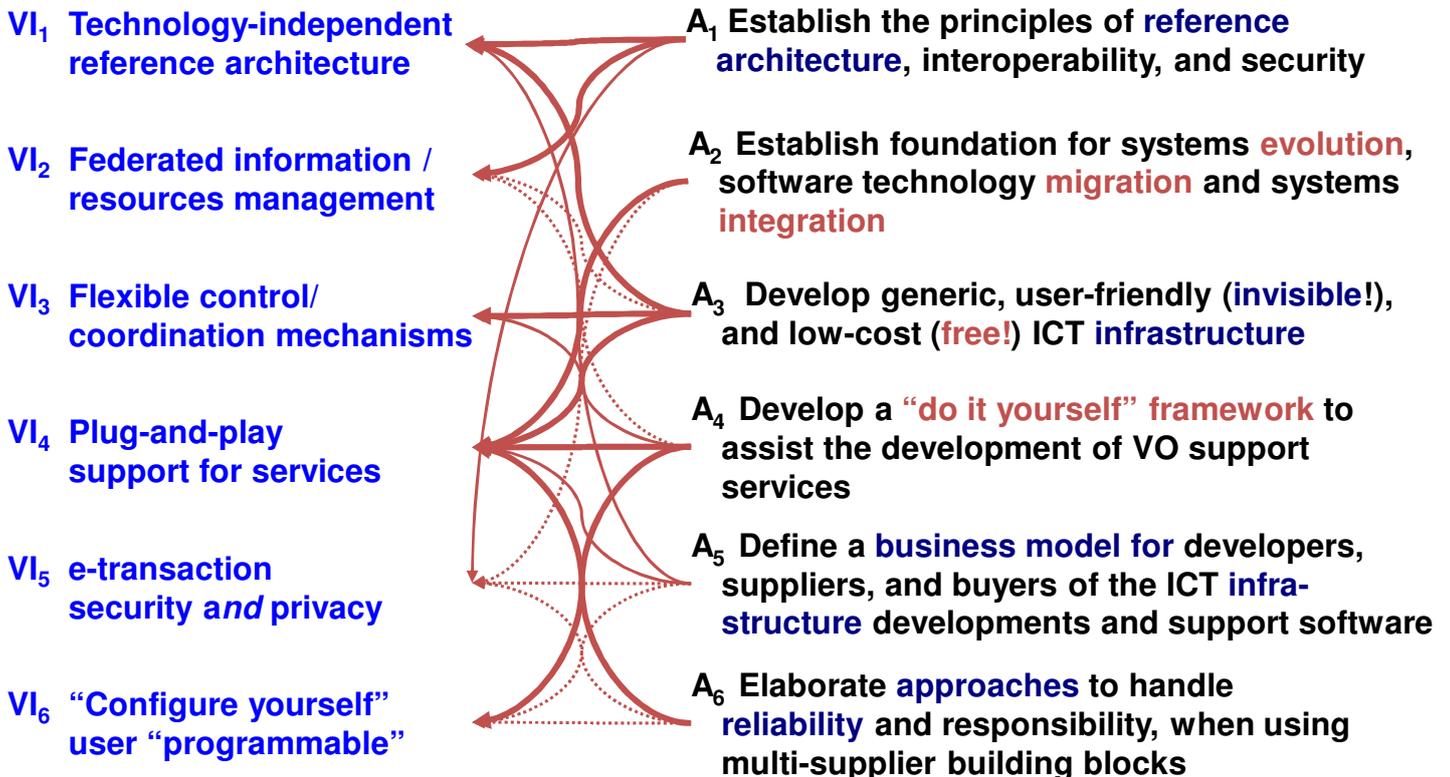
Feasibility check

	S1	S2	S3	S4	L1	L2	L3	L4	L5	L6	L7	Difficulty
A1				Strong help from	Strongly limited by							Moderate
A2				Moderate help from	Strongly limited by							Moderate
A3			Strong help from	Moderate help from	Strongly limited by							Mod/hard
A4			Limited help from	Moderate help from	Strongly limited by							Hard
A5			Limited help from	Moderate help from	Strongly limited by							Hard

Strong help from
Moderate help from
Limited help from

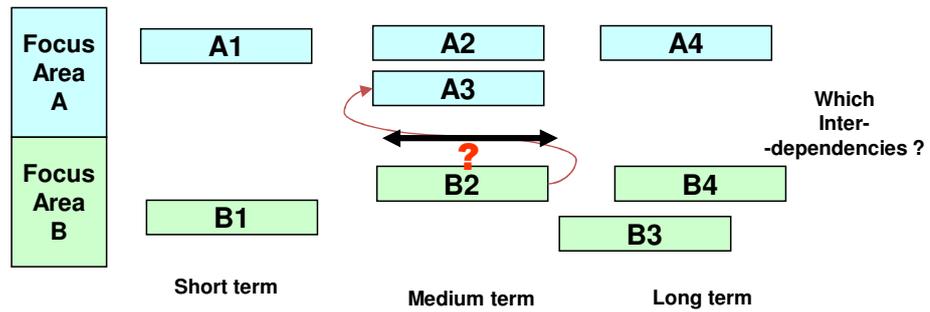
Strongly limited by
Moderately limited by
Partially limited by

Example – Verification



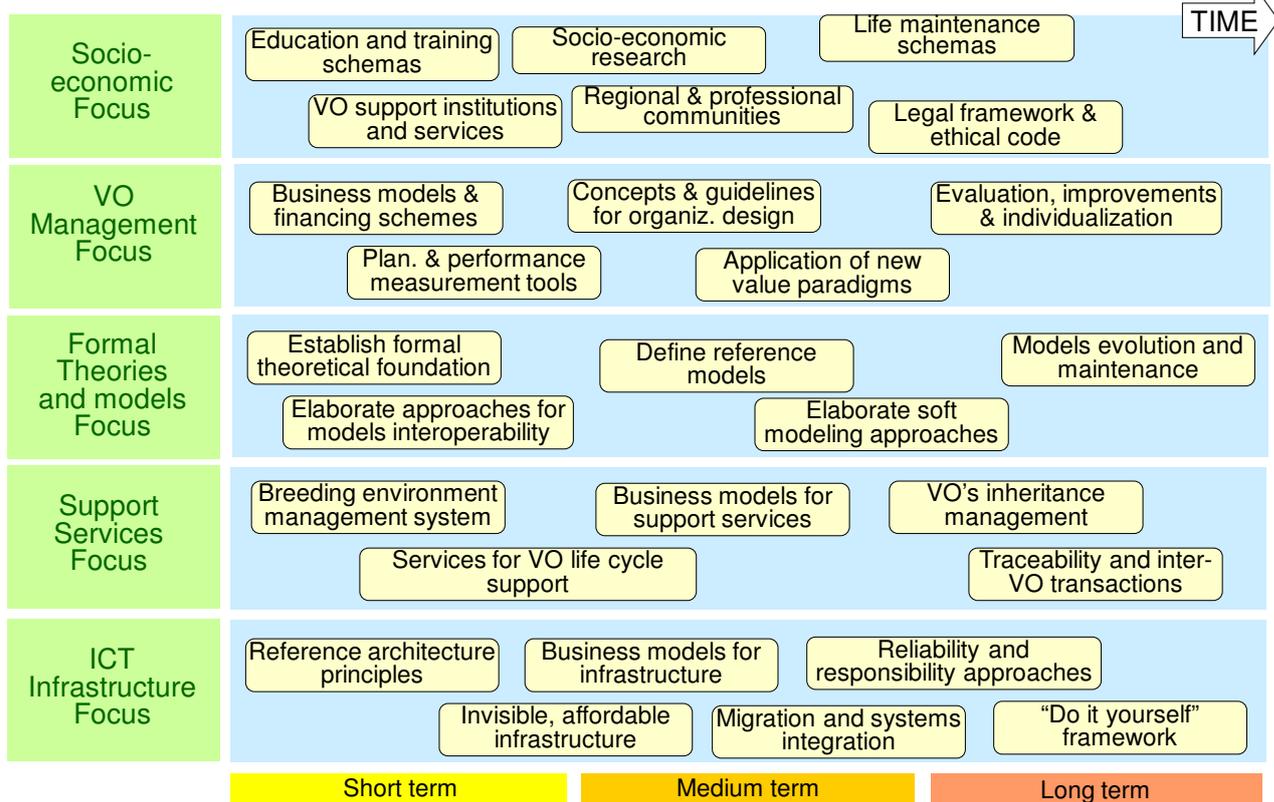
Example – plan details

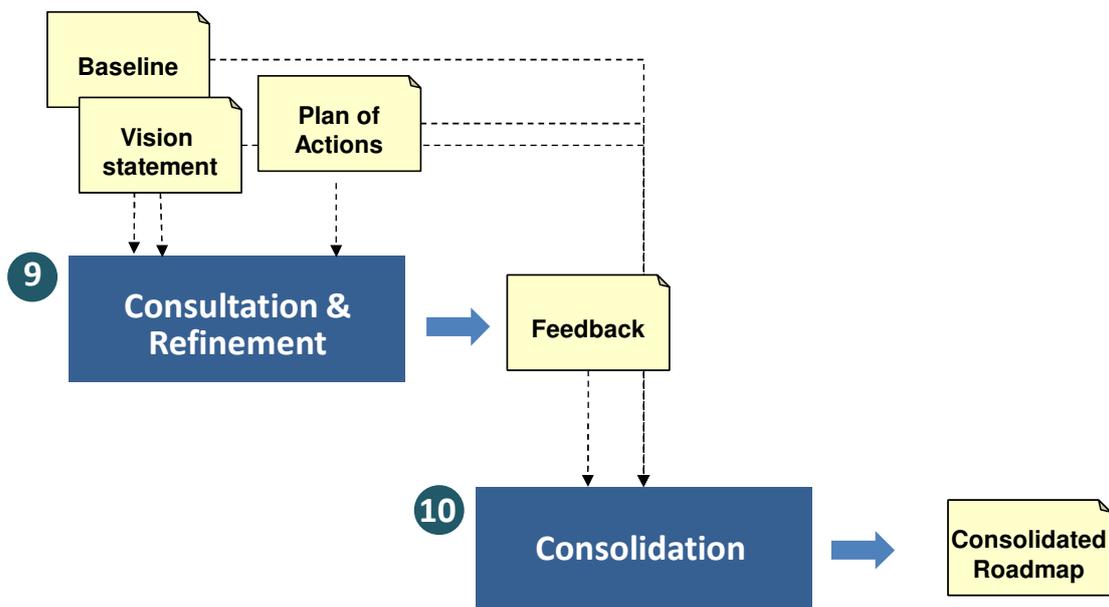
- A1
 - A2
 - A3
 - A4
 - A5
- +
- SCHEDULE**
- Short term
 - Medium term
 - Long term
- +
- OTHER ITEMS**
- Who
 - Resources
 - ...



How does a roadmap look like?

*VOMap
1st attempt*





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Example – Consultation workshops



**Group discussion
Argumentation
Amendment**



Voting

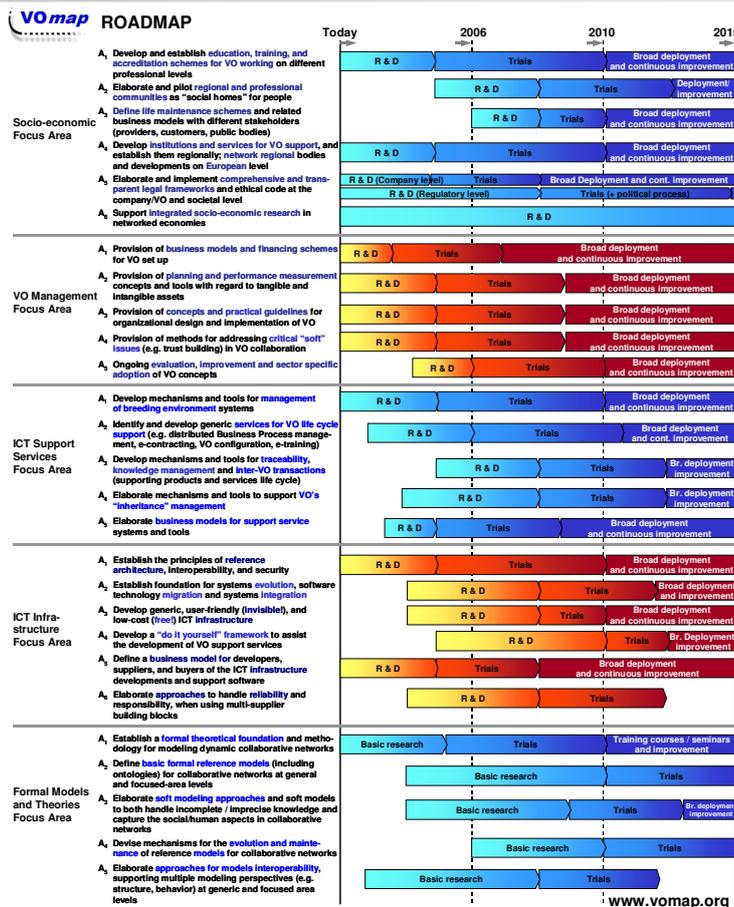
Summarizing conclusions



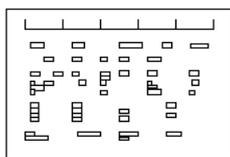
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Implementation
Mechanisms

R&D
Trials
Deployment &
Improvement



A roadmap can be represented at several levels of detail.

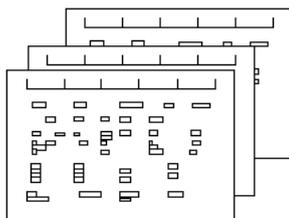


Toplevel
roadmap

Single page

Poster

part of many presentations

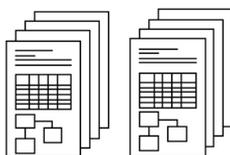


Supporting
roadmaps

Single page
per view
or per driver

Poster

part of many presentations

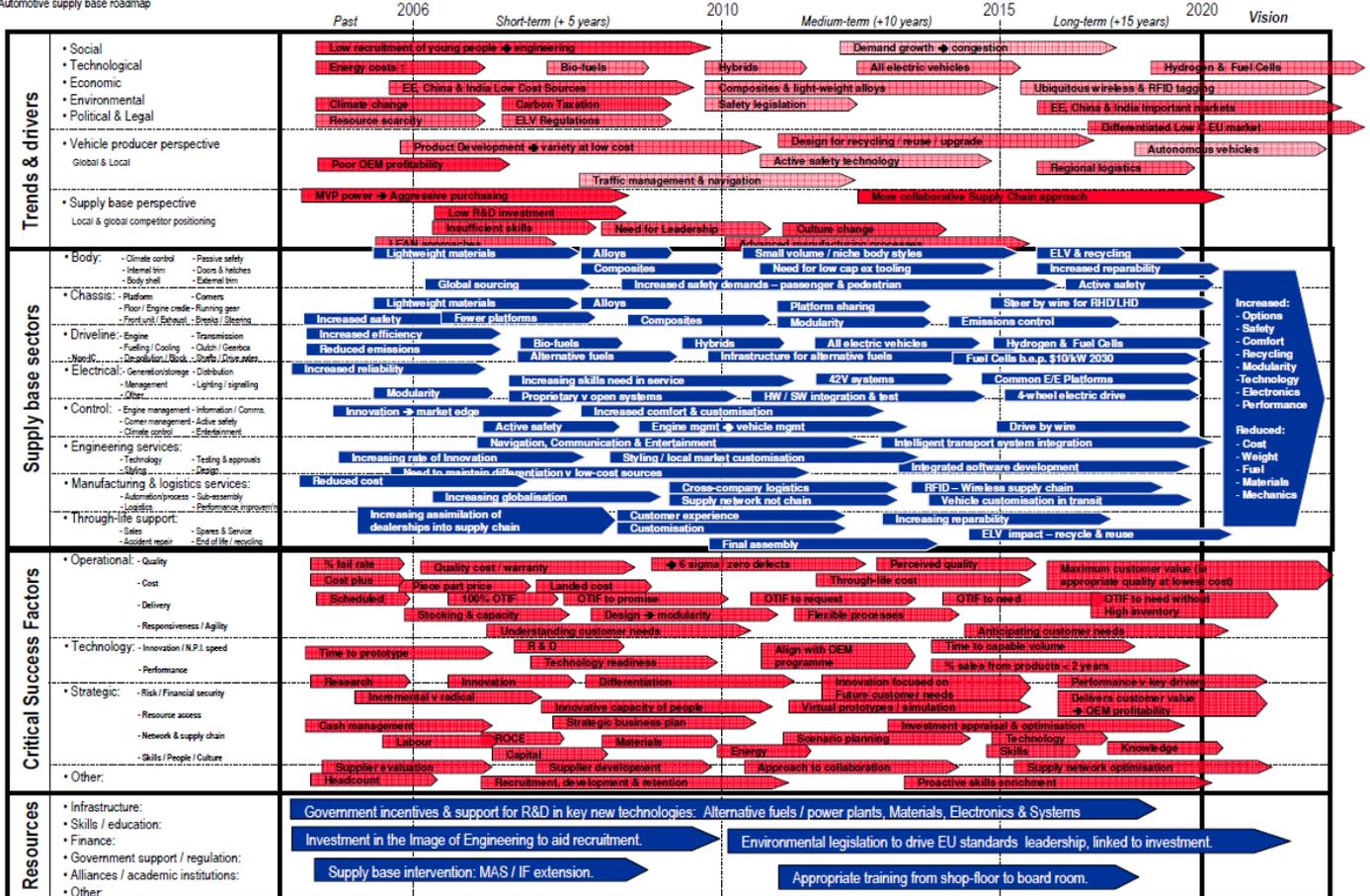


Supporting
reports

Document
per relevant
subject

How does a roadmap look like?

Automotive supply base roadmap

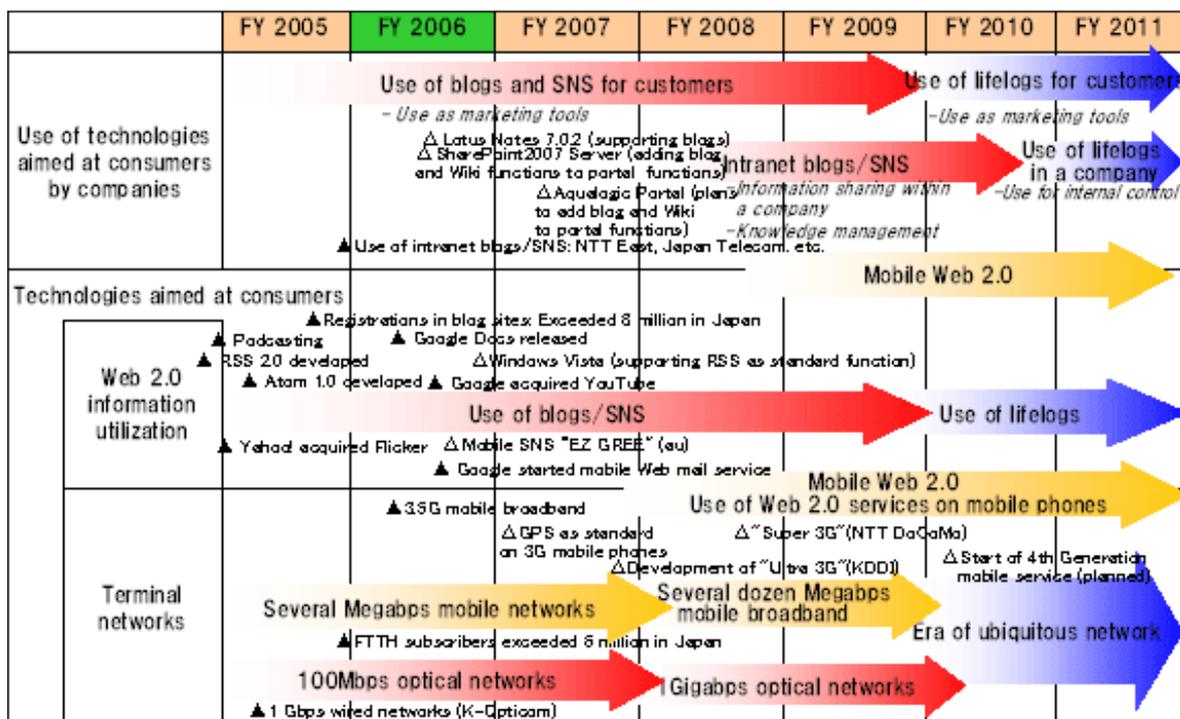


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http://www.ifm.eng.cam.ac.uk/ctm/trm/documents/automotive_supply_1.pdf

How does a roadmap look like?

“IT Road Map” of Web 2.0 Technology Up Until 2011

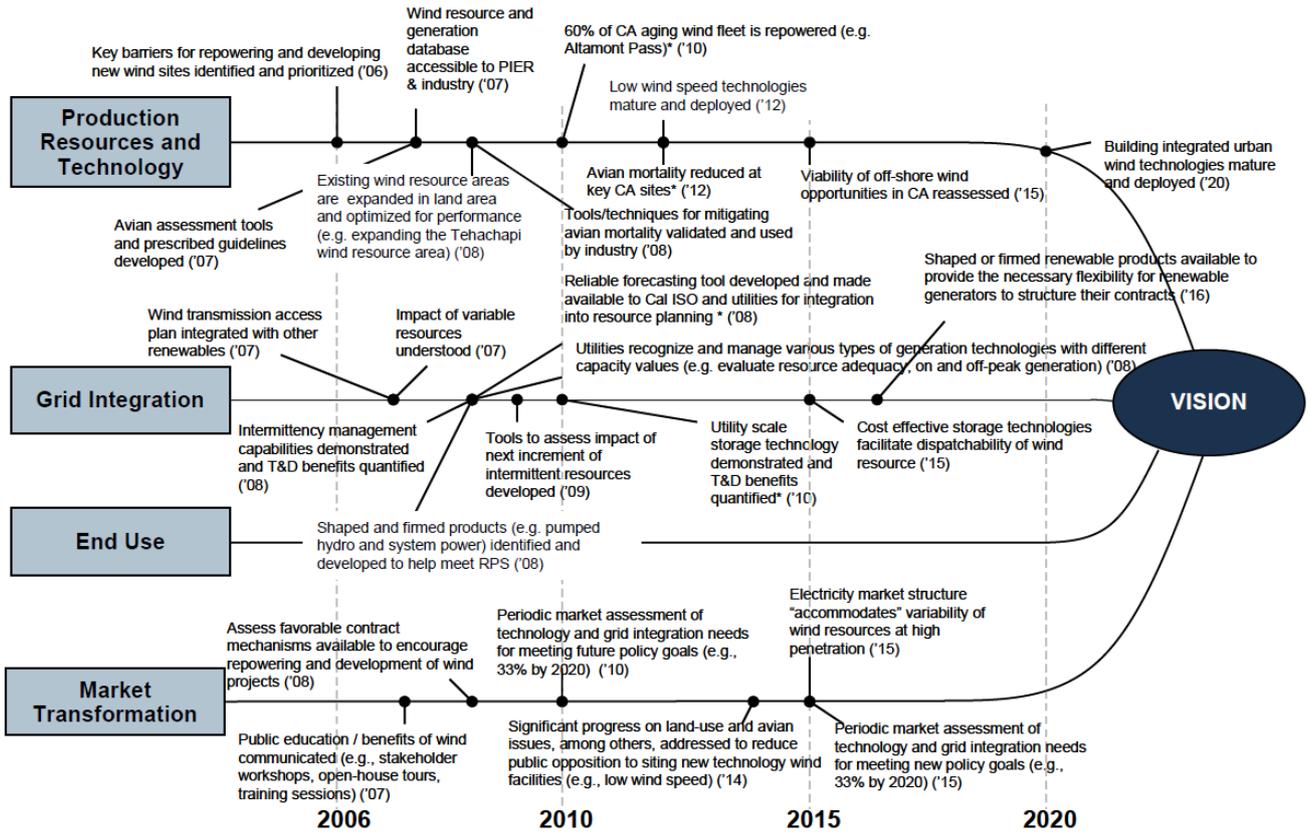


<http://www.nri.co.jp/english/news/2006/061110.html>

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How does a roadmap look like?

Utility Wind Detailed Roadmap (California)



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<http://www.energy.ca.gov/2007publications/CEC-500-2007-035/CEC-500-2007-035.PDF>

How does a roadmap look like?

TECHNOLOGIES ROADMAP TO 2050

CYBERNETICS / AGRO&INDUSTRY / INFORMATION ACQ&DELIV / EMISSIONS ABATEMENT / PARADIGMS&FUNDAMENTALS / BIOLOGY&GROWTH / MATERIALS&MANUFACTURING



	2010	2015	2020	2025	2030	2035	2040	2045	2050
CO₂/ENERGY	2nd gen biofuels 20k ha biofuel crops china >> US CO ₂ production# emissions trading nuclear reduction	20k ha biofuel crops photovoltaic concentrators wind power uptake# renew biofuels	coal price +/- \$ wide scale use of microgeneration commercial CCS	10% UK energy from biofuels production of bio-synthetic natural gas effective markets for C, N & S centralized solar PV nuclear growth	non-OECD 2/3 of world energy demand india >> US CO ₂ production# 20% coal/gas has CCS non OECD using 2/3 world energy#	50% new vehicles elec or hybrid climate adaptation measures	major shift to a bio-based economy stabilisation of global climate artificial photosynthesis systems	30% of transport by alt fuels 30% of liquid fuels biofuels	
VEHICLES	automatic parking voice control pedestrian sensors 360° vehicle sensing veh. occupancy monitoring solid state lithium batteries	H2/fuel cell hybrids electronic vehicle ID 3d sensors radar biotechs/gasification profitable adaptive systems for older drivers composite engine parts switchable adhesives	fuel cell recycling 3d sensors intelligent speed adaptation solvent free manuf. no paint shop manuf. intelligent engine condition/age monitoring	autonomous emerge intelligent speed adaptation 50% reduction in fatigue-related accidents modular vehicles switchable joining	total automated manuf. full LCA for veh. manufacture engine manuf. energy 50% of '02 emissions 5% of '02	climate adaptation measures	zero fault vehicles vehicle time-to-market minimized (1yr)		
TRANSPORT SYSTEMS	reduce traffic noise 3dB diesel 40% eff.	reduce traffic noise 3dB diesel 45% eff. minimum cost routing	reduce traffic noise 4dB diesel 50% eff. 50% hybrid bus fleets switchable H2 tanks/fuel stations home generated H2	reduce traffic noise 6dB diesel 55% eff. infrastructure/vehicle cooperation 50% vehicle fleet on H2 automated hwy systems full authority vehicle control	next gen fuel cells	average fuel economy 50% of 2009 levels global vehicle conversion rate 13.6% 30% alt transport by alt fuel/tech			
AGRI/FOOD	0.6 arabic acres/cap # bio-sensors low carbon recipes	earth simulator for ag 0.5 ha acre bio-tech #	LED greenhouse climate change simulator for ag marine farm freshness sensors	modelling of nutrient circulation electronic tags taste sensors	robotics for aquaculture/fisheries plant growth modeling root modeling	0.4 arabic acres/cap #			
SCIENCE	automated remote species identification LHC switch core distributed software js dominant reliable global climate/weather simulation molecular computer diagnosis available computational model of carcinogenesis	large-scale sensor networks research data machine readable 'data deluge' continues to increase individualized medicine molecular computer diagnosis available main disease pathways and gene networks identified	purpose-made 'informed matter' foundational theory of global ecosystems single cell simulation modelling based vaccines organ/organism simulation higgs boson found	general unified theory or equivalent disproof verifiable global ecosystem models comprehensive codification of biological knowledge molecular-computer 'smart drugs'					
COMPUT/IT	parallel processing evolving semantic web moore's law re-defined: move to parallel/multi-core cloud computing	heterogeneous parallel processing transactional memory concurrent sw infrastructure web 3.0	executable specification active xml for ubiquitous data system design automation personal agents						
NANO	nan-enabled fuel cells and solar photovoltaics artificial productive nanosystems	multifunctional biosensors artificial cancer agents 5-nanometer basic elements	artificial immune systems post-silicon extension of moore's law growth artificial organ systems			efficient, integrated, solar-based fuel production removal of greenhouse gases from atmosphere manufacturing based on productive nanosystems			

REFERENCES

- 1 Developing A Bioenergy Roadmap For The UK
Bioenergy research roadmap workshop, April 2007
Working Paper
REF: LNERG/NERG/ESM/2007/017
Professor Gail Taylor, UK Energy Research Centre
- 2 Intelligent Vehicle Technology Roadmap
Technology and Research Directions for Future Vehicles (v2.0)
2004
Forecast Vehicle SMMT
ISBN: 0-900685-51-4
- 3 Intelligent Infrastructure Futures
Technology Forward Look
Towards a Global Urban Ecology
Bill Sharpe
Tony Hodgson
Diagnosis Programme of the Office of Science and Technology
- 4 'Academic Roadmap' / Food Technology/
Japan Society of Applied Physics
Future Vision Reviewing Working Group, 2006
7
50 by 50 Global Fuel Economy Initiative
www.50by50campaign.org
FIA Foundation, IEA/AEI, International Transport Forum, UNEP
- 6 'Productive Nanosystems, A Technology Roadmap'
Wyatt Foundation, Battelle, Foresight Nanotech Institute, 2007.

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<http://www.slideshare.net/fred.zimny/technology-roadmaps-20102050>

How does a roadmap look like?

- S** Short—Less than 3 years
- M** Medium—3 to 10 years
- L** Long—More than 10 years

MARKET TRANSFORMATION

STRATEGY 1—Develop clear definitions and standards for lighting quality

Activity	Timeframe
✓ Develop a uniform set of performance specifications for lighting systems.	S M
✓ Create industry-standard formats for energy and economics data for use across the many available software packages.	M
• Increase enforcement of ASHRAE/IESNA Standard 90.1-1989 and adoption of ASHRAE/IESNA Standard 90.1-1999.	S
• Determine objective definitions and metrics of lighting quality.	S M
• Support and conduct third-party evaluation of integrated lighting system design and application.	S M
• Incorporate requirements for environmental sensitivity for lighting systems (such as daylight use) into the existing code structure.	M

Note: Checkmarks indicate the activities that ranked #1 in their respective category from the internet voting. For detailed voting results for all categories, visit the Lighting Roadmap Web site.

Vision 2020
The lighting technology roadmap
www.nrel.gov/docs/fy00osti/27996.pdf

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MARKET TRANSFORMATION

STRATEGY 2—Increase demand for high-quality lighting solutions by quantifying, demonstrating, and promoting life-cycle benefits to broad audiences

Activity	Timeframe
✓ Increase scientific knowledge of how lighting parameters impact human psychology, health, and productivity.	M
✓ Maintain nonpartisan lighting centers and laboratories around the country where innovative lighting technologies can be demonstrated.	M
✓ Conduct educational forums for end users about the effects of lighting on people and their activities.	S
• Identify real customer needs through needs assessments and focus groups.	S
• Determine unique lighting characteristics and needs for specific environments (e.g., hospital, retail, office, restaurant).	M
• Use work performance research to help make the marketing of quality lighting more effective, as with ergonomic furniture.	M
• Conduct regional light fairs/expositions to showcase innovative lighting technologies.	S
• Develop a marketing campaign promoting quality lighting to the general public.	S
• Increase use of government buildings to demonstrate innovative technologies.	S M
• Increase publicity on the results of collaborative design and construction projects.	S M

MARKET TRANSFORMATION

STRATEGY 3—Strengthen industry education and credential lighting professionals

Activity	Timeframe
✓ Create educational programs on the design, installation, and use of lighting controls.	S
✓ Improved education on daylighting, including simple rules of thumb for architects.	S
• Provide training to product sales and distribution professionals about life-cycle cost analysis and the effects of lighting on people.	S
• Increase incorporation of NCQLP and CLMC certification requirements into Request for Proposal and Request for Quote language for building construction projects and energy-saving performance contracts.	S
• Establish design assistance teams to teach others how to better integrate lighting into overall building design and how to maximize daylighting.	S M
• Increase use of the Internet to provide information on research, demonstration, and regulatory activities.	S

Further reading

COLLABORATIVE NETWORKED ORGANIZATIONS

A research agenda for emerging business models

Edited by
Luis M. Camarinha-Matos
Hamideh Afsarmanesh



Kluwer Academic Publishers

Camarinha-Matos, L.M.; Afsarmanesh, H. (2004), [A roadmapping methodology for strategic research on VO](http://www.researchgate.net/publication/226937637), in *Collaborative Networked Organizations – A research agenda for emerging business models*, cap. 7.1, Kluwer Academic Publishers, ISBN 1-4020-7823-4.

www.researchgate.net/publication/226937637 [A Roadmapping Methodology for Strategic Research on VO](http://www.researchgate.net/publication/226937637)

Camarinha-Matos, L.M.; Afsarmanesh, H. ; Loeh, H.; Sturm, F.; Ollus, M. (2004), [A strategic roadmap for advanced virtual organizations](http://www.researchgate.net/publication/226527248), in *Collaborative Networked Organizations – A research agenda for emerging business models*, cap. 7.2, Kluwer Academic Publishers, ISBN 1-4020-7823-4, 2004.

www.researchgate.net/publication/226527248 [A Strategic Roadmap for Advanced Virtual Organizations](http://www.researchgate.net/publication/226527248)

Camarinha-Matos, L.M.; Afsarmanesh, H. (2009), [The Need for a Strategic R&D Roadmap for Active Ageing](http://www.researchgate.net/publication/226527248), *Proceedings of PRO-VE'09, 7-9 Oct 09, Thessaloniki, Greece, Leveraging knowledge for innovation in Collaborative Networks*, Springer, pp. 669-680.

http://en.wikipedia.org/wiki/Futures_techniques

<http://horizon.unc.edu/projects/seminars/futuresresearch/>

Muller, G. (2008). Roadmapping - <http://www.gaudisite.nl/RoadmappingPaper.pdf>

California Energy Commission - PIER RENEWABLE ENERGY TECHNOLOGIES PROGRAM RESEARCH DEVELOPMENT AND DEMONSTRATION ROADMAP
<http://www.energy.ca.gov/2007publications/CEC-500-2007-035/CEC-500-2007-035.PDF>

James Parnitzke (2011), [How to build a Roadmap](http://pragmaticarchitect.wordpress.com/2011/03/05/how-to-build-a-roadmap/)
<http://pragmaticarchitect.wordpress.com/2011/03/05/how-to-build-a-roadmap/>

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