Paper 6 : Dynamic monitoring of future developments

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Abstract
A crucial element of foresight studies is the gathering and analysis of future developments. Often this forms the fundament for the identification of strategies and their translation to actions. However, the systematic gathering is time and budget consuming. Existing information sources are not suited to the specific alternative questions and they are static of nature. New intensive analysis of the existing material is needed, or even new fieldwork.

The Dutch Ministry of Economic Affairs, in co-operation with TNO developed a new foresight approach, called Dynamo. In this approach issues and innovations, representing demand and supply of our society, are collected systematically and stored in a relational database: The Dynamo database. The collected data forms the basis for interactive discussions with stakeholders, initiating brokerage and inspiration for new business opportunities and policy.

The collection of concrete information elements builds up the core of the system, but the objective of the expert system is to draw conclusions at a meso-level. Using a “fingerprinting” method, the information is made dynamic and can be used as a core source for many projects. This fingerprinting uses international accepted classifications for industry and research, and a tailor-made classification for the consumer & social side. In this way, industrial sectors, research areas and consumer/social demands are linked to specific innovations and issues. This enables four types of results:
1. Straight outputs, based on research and business
2. Generation of themes, or clusters of innovations
3. Overview of innovations relevant for individual users.
4. Cross-correlation between research and business on possible areas for co-operation.

The database uses different sources as input. A first category is the systematic analysis of foresight studies (secondary validated sources). Also national and regional research programs are used as a source. Another, more expert oriented source is formed by individual S&T watch activities, like NOST. At this moment, the database is a core element of five projects. More than 1200 topics are gathered. One of the most important projects is the Dynamo 2004 exercise, where three Dutch public funding agencies (Senter, NWO and STW) are using their project portfolio to give input. Within the framework of this project in April 2004, a public Dynamo Theme Day is held to discuss with business, research and government the opportunities of the Dynamo approach and the database.

The paper will present more of the backgrounds of the Dynamo-approach and the Dynamo-database, including the elaboration on the concept of the system. Also some results of the Dynamo 2004 exercise will be described, including the results from the Dynamo Theme Day.
1. Why Dynamo?

1.1 Future studies and policy

“Future studies constitutes a systematic attempt to observe the long term future of science, technology, society, the economy and their mutual interactions in order to generate knowledge with which to effect social, economic and environmental improvements based on well founded projections.”

With this statement Mr. Ramon Marimon, Spanish secretary of the state for Science and technology opened his preface to the Conference Proceedings of the Foresight conference held in Spain 2002 [Marimon, 2002]. It is clear that future studies can support the coherent development of research and innovation policies on a national and EU-level. They deliver economic analysis, technological indicators, future arrangements and demands in the field of science and technology. But beside the information aspect, it can also inspire and facilitate the alignment of thoughts, investments and efforts of the stakeholders involved. In this way, a more effective and efficient policy can be developed to address the social issues we are facing today and tomorrow.

From the initial experiments and exercises for national science and technology policies in a few countries, the range of future studies has enormously increased, especially for countries in the periphery of S&T; for specific industrial and policy sectors, for regions, for organizations and for specific technologies. The number of possible tools to do future studies has increased as well. Since the early years of future studies, the focus has shifted to other methods, like scenario studies, road mapping and participative methods; methodologies to improve the processes of foresight and the creation of commitment to process and results. Another reason is that foresight increasingly gets linked to other tools for strategic policy making, such as evaluation and technology assessment, thus adopting their approaches [Kuhlman, 2001; Rip, 2003]. Traditional methods of forecasting are adopted more and more, even though the aims differ and results and their interpretation often serve other purposes [Cuhls, 2003].

As a result, policy makers more and more are confronted with the question how to design the appropriate foresight process to maximize their effect in terms of initiated action. Experience shows that the actual effect of future studies is not optimal. A recent study of the UK Foresight program shows that the Foresight projects in the UK focuses on the foresight processes and only some degree of systematic attention is given to the implementation of the results [Miles, 2002]. The Technology RADAR assigned by the Dutch ministry of Economic Affairs showed limited effect on implementation and innovation. Also the process orientation initiated by “foresight” is loosing some momentum and in favor of more and better need for content, although stakeholder involvement is still considered crucial.

These notions stimulated the Dutch Ministry of Economic Affairs to develop Dynamo. This new future oriented approach, puts systematically and economically gathering of content information in the centre and gives priority to the use of results, both from the industrial and governmental perspective. This paper describes the Dynamo approach and presents its first results.
1.2 Systematizing future studies in the Netherlands

Dutch science and technology policy has experiences with future studies for a long time. From the seventies onwards one can find successful and unsuccessful foresight exercises and programs within Dutch science and technology policy. Most of the studies were done by ad hoc panels focusing on developments within a specific area, discipline or technology. In the mid-seventies the first attempts to foresight were initiated as part of the objective to link scientific research to social issues.

Verkenningscommissies were installed to advise about research on education, science for policy and spatial planning. Although the reports invoked some discussion on the development and organisation of these fields of research, the effects were limited.

From these initial attempts three strands developed which are important for the development of foresight in the Netherlands and which still continue.

1. In the first strand, foresight became one of the tasks of sectoral advisory councils for research. A National Council for Agricultural Research already existed and new ones were modelled after. The main reason of success for these institutions is that they provide for interaction, mutual positioning and agenda building. In the Dutch political and scientific culture, this has given them a viable role, despite some criticism that reports are too general and not implementable. The COS is now coordinating these activities.

2. The second strand of foresight studies developed within the context of technology policy. Initially, in the early eighties, technology foresight was implicit within the selection and preparation of innovation oriented programmes (IOPs). These national programmes aim to stimulate strategic research in promising technological areas.

3. A third strand of foresight developed mainly within the context of a science policy for the sciences, but appeared to be sensitive for the changes in the policy relation between the government and the universities. At the end of the seventies science policy became more oriented to disciplines and 'verkenningscommissies' on chemistry, physics, biochemistry, biology and later on biofysics and mathematics were installed. These committees consisted mainly of academics and focussed in their reports on university research. Although the Ministry pressured each committee to be selective in its claims and outward looking, the committees hardly set any priorities and concentrated on university research. These activities now take place under the supervision of the KNAW.

In the late eighties technology foresight became a separate activity, aiming at improvement of the technology policy of the government and awareness of new technological developments among the...
industry. Within technology policy foresight is linked to issues like ‘globalization’, the international technological competition and to the support of technological innovation of SME’s. In the early nineties the integration of these future studies has become an issue because of the objective to set national priorities and posteriorities for public S&T efforts. In 1992 a Foresight Steering Committee has been installed by the then Minister of Education and Sciences to coordinate future studies and integrate results. Nevertheless, heterogeneity in foresight studies continues as the information needs of the actors within the field foresighted are still more important than the need for integration of results.

Although more specific foresight studies are carried out regularly at various organisations, institutes and department in the Netherlands, it has been since 1998 that the Technology Radar has covered all the whole technology spectrum. The themes resulting from the Radar have been studied and have resulted in policy measures. Today, future studies are carries out in a fragmented approach. On a smaller level the Foresight Steering Committee still carries out field focused future studies and other ministries carry out their own specialized future studies (e.g. Weterings, 1997) and the activities of the Sector councils still are future study oriented. Although many themes mentioned in Radar are still actual and relevant today the underlying information is not and so, in 2002, a need for a new and systematic foresight system at the Dutch Ministry of Economic Affairs was expressed.

2. The Dynamo approach

2.1 Historical background of Dynamo

After the experience of the Technology RADAR and other international foresight programs, the Dutch Ministry of Economic Affairs came to the conclusion that the effects of a large Foresight Program were limited, and much information was already (internationally available). On the other hand, there was a need to anticipate on future developments, both from an industrial and governmental perspective. To address this problem, early 2003 the Dynamo approach was developed as part of a foresight process in order to gain a better view of the relevant national and international innovative developments at a meso or theme level.

Parallel to this, in 1999 TNO developed an innovation database based on an assignment of the Ministry of Economic Affairs, within the framework of the National Environmental Programme 4. The overall objective of this project was to identify the potential of technology to solve the persistent environmental problems, including the policy needed [Butter, 2000]. To manage the information overload experienced, the database was developed linking technological systems to the persistent environmental problems. This was integrated with the information from a previous environmental foresight, done by TNO in 1996 [Weterings, 1997].

The database proved to be a core element in the economically and dynamic monitoring and analysis of future developments. However, to ensure continuity, consistency and access on the long term, more than a “1 year assignment” was needed. In 2003, TNO and the Ministry saw the opportunity for mutual benefit and created a joint venture to further develop the information management system into an expert system, also able to make analysis. TNO concluded that further development was both scientifically and commercially interesting. Priority was given by TNO to further develop the

The Netherlands and innovation policy

The Dutch innovation policy agenda aims, amongst others, actively support collaboration initiatives of the universities, technological institutes and business to introduce innovations to the marketplace. These initiatives, usually a mixture of different scientific disciplines and industrial sectors, focus on technological ‘themes’.

27 Dynamic Monitoring
28 Meso meaning at a branche or ‘dynamic cluster’ level
Dynamo database to a strategic foresight tool. The Ministry of Economic Affairs decided that the joint venture could provide a multi user platform, where economies of scale could ensure multi stakeholder involvement and commitment of industry and research to the Dynamo approach.

2.2 The Dynamo concept

The overall aim of Dynamo is:
To facilitate economic development, by offering concrete information about possible present and future innovations and issues.

Dynamo puts content in the heart of the process. This overall objective is divided into the following objectives:

- To encourage and inspire industrial and research stakeholders into new economic activities, by showing present and possible future themes of research and development with an interactive approach.
- To identify possible new areas of co-operation in business/business, business/research and research/research, as well as broker between “supply and demand” in the field of innovation.
- To facilitate these objectives by offering a platform for dissemination and networking using existing information.
- Feeding the policy process with future oriented knowledge, innovation strategy based on analysis on the gathered information (like research areas, issue analysis, stakeholder analysis, etc.).

The Dynamo approach was developed with the following criteria in mind:

1. Multi-stakeholder and multi need: Whereas most systems target single users the output of Dynamo has to accommodate different users with different needs.
2. Dynamic and flexible: Rather than a paper report, losing value over time, Dynamo should develop the content and information continuously. Targeting different stakeholders and, just as importantly, developments in policy, the ‘system’ therefore has to be able to render the information flexibly in various formats.
3. Economical and added value: The process has to be economical, using information from other sources were it can, but providing added value.
4. Autonomous and appreciated: Other stakeholders, users of the system, should in turn for use participate in keeping the information up-to-date. This will obviously also add to the economical aspect of the system. Naturally, when it wants to be mostly autonomous Dynamo has been gain respect and appreciation.

2.3 The Dynamo process

The Dynamo approach combines the interactive meso networking with activities on a micro level. The basis of the approach is formed by a continuous gathering of information about important future developments that could be of interest to the Dutch economy. It collects data on the micro level and draws conclusions to the meso level. The information collected is used as a starting point for theme oriented brokerage meetings and to initiate policy discussions.

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29 Within TNO, the Dynamo database is/was used in 7 projects and a specialized team is formed to ensure continuity and quality.
The Dynamo approach can be divided into three elements
1. Data collection and input
2. Inspiration and brokerage
3. Policy analysis

In the Collection phase data are gathered from various available sources. A criterion is that the collected data is verifiable, so sources like newspapers and individual ideas are not included. The main types of sources are:
- Delphi surveys and other futures studies.
- Expert workshops
- Portfolio analysis of funding agencies, trade organisations, or RTOs (e.g. universities, TNO).

The Internet is used to fine-tune the existing data and is not used as a source.

As one of the core functionalities and objectives of the Dynamo approach is the “dynamization” of information, all data collected is centralized and made available in a flexible way. The concept is to modular gather and use data for specific demands, and to add existing data. Also the input made for the specific demands is made available for future demands. This makes the usage for other projects possible, as well as the enrichment of the core data. Of all data collected the sources are linked, enabling systematic “activation” to specific demands.

In the next phase, Clustering and Brokerage, the data collected is presented to a large group of stakeholders during a clustering & brokerage workshop. Previous to this workshop the database generates so-called themes or innovative clusters. These themes consist of ‘clusters’ of innovations from the collection phase which have a similar characterisation (this will be discussed later in

Various data sources
The data gathered in Dynamo database can originate from several sources, depending on the user. For example, the first data included was based on the analysis of 5 Delphi surveys and included more than 400 innovations, and was based on the so-called Dynamo 2003 exercise. The second input was done within the Science Forward Look project and included some 250 issues, gathered through expert interviews and desk research. The Dynamo 2004 exercise used information from government funding projects at NWO and Senter, and inputted a total of roughly 500 innovations into the system.
chapter 3 ‘database’). The participants are invited to judge and possibly comment on the data, but, more importantly they will discuss innovations, themes and trends amongst each other. This discussion is a goal in itself, it acts as a brokerage whereby stakeholders can be inspired and design innovative initiatives.

Individuals have access to a subset of the data in an interactive way. They can get inspired by the presented data, but also are able to find the organisations and individual persons linked to specific data. This facilitates the individual identification of new business opportunities and offers a brokerage to initiate networking.

In the last phase the policy implications from the previous activities and the data collected are analysed for internal (Ministry) and external use. The collected data can be used as a starting point for in depth analysis of innovation areas, like possible new surfacing areas, possible new networks and other policy relevant information. Also the functionality to transparently present governmental funded projects is an asset to the approach.

3. The Dynamo database

3.1 The data model

The core element of the Dynamo approach is the systematic collection and storage of data. To address the criteria of dynamization, flexibility and multi user, a relational database is used, called the Dynamo database. The general concept of storing this data into the database is to look at innovation ‘classically’ as a linear process. An innovation can be seen as a product or process successfully introduced in the marketplace resulting from a new combination of developments in scientific areas. Using this scheme it would result in the figure on the left. It shows a combination of scientific areas resulting in an innovation that is introduced into the marketplace through, possibly, different business sectors in order to fulfil, various (consumer) demands / needs.

The concept of the Dynamo database is that future studies focus on possible technological, organisational, institutional and cultural changes in our society and includes the context in which these changes take place. So, future studies are not limited to the changes, but also about the factors and actors that are related. This is made operational in the database by focusing on changes and characterizing these changes using contextual dimensions.

The core element of the database is formed by a set of innovations and issues (called topics), which stands for the demand and supply side of our society. As the aim of Dynamo is the brokerage and the analysis on a meso level, the character of the topics is multi-actor at micro level. The topics can be seen as the linking pin between business, research and other societal organisations and are the focal points towards action (both problems to be solved and the solutions). These issues and innovations are “fingerprinted”, using predefined classifications. The philosophy is that these classifications create a profile of the issues and innovations.
A dimension can be defined as: *a structure to classify the context of a topic from the perspective of technical, organizational, institutional or cultural improvements in a systematic way.* Based on the three basic strands of the triple helix concept (universities-industry-state), the “fingerprinting” uses three core dimensions [Leydesdorff, 2001]:

- **Industry**
  This dimension represents the industrial side of our economy. To classify Business, the NACE code is used, which is the EU accepted industrial classification of industry [see RAMON]. This classification is included in a three “digit” approach.

- **Research**
  The research dimension represents the public research related infrastructure, including universities and semi public RTOs. To classify the research infrastructure, the Australian Standard Research Classification (ASRC) is used, which is based on the Frascati manual [OECD, 1998; ABS, 1998]. This classification is included in a three “digit” approach.

- **Society**
  The third side of societal changes is formed by the social needs of citizens. They represent the changing markets and consumer needs. To classify this dimension, a combination of the Maslow’s Hierarchy of Human needs [Maslow, 1943], a translation to economic needs [Weterings, 1998] and governmental domains is used.30

Three interacting dynamics (knowledge production, markets-i.e., diffusion and control) can be expected to generate innovation. By identifying the relevant parts of these institutional entities, the relevance of the topic for industrial activities, universities, consumer needs and governmental action can be identified.

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**An integrated optoelectronic chip probe for direct blood flowmetry (example of innovation)**

Laser Doppler blood flowmetry is a non-invasive optical technique to measure the blood flow in skin and other human tissue. The spectrum of certain fluctuations yields information about the concentration and velocity of moving red blood cells. The innovation will allow the discrimination between flow in shallow and deeper tissue layers or between flow in small and larger blood vessels. From a medical point of view such discriminations are very highly desirable. This innovation is an integrated laser Doppler probe which means that one silicon wafer will contain one or two lasers, a detector, electronics. This probe will be much smaller than the present ones and have a higher spatial resolution. The absence of fibres will largely eliminate the disturbing effects of patient motion.

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**Diversification of farming: new species: llamas, ostriches, deer (example of issue)**

Johne's Disease in camelids; need recognized for establishment of protocols for the study of certain diseases in camelids; Valid diagnostics are required by world trade agreements to ensure rapid and safe movement of livestock. In regards to llamas and alpacas, bovine brucellosis, vesicular stomatitis (VS), bluetongue (BT) and epizootic hemorrhagic diseases (EHD) are priority concerns: importance of conditions under which ostriches are raised for health and welfare: danger of extrapolating from other species.

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30 This dimension is still “under construction”.

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The innovations are defined as: *New application of knowledge and/or technology in a potential commercial way* [OECD, 1996]. These innovations are systemic of nature (no bolts or nuts) and need, or needed substantial investments (financial, or HMR) of several organisations. They must be usable in a broad market. Next to a title and short description, specific characteristics are included in the database, like:

- Time horizon for market breakthrough.
- Level of innovation (e.g. incremental, radical, system change).
- Type of innovation (market, technical, organisational, cultural)
- Phase of development (fundamental research, development, fabrication, communication, adoption).

These innovations can also include organisational changes, new markets and other innovative changes.

The issues are defined as: *Societal problems that must be addressed on a programme level*. The issues are also systemic of nature (not project related knowledge questions, or
3.2 Input and gate keeping

The most important element of the database is continuity, consistency and sustainability of the data. TNO is responsible for the structure and content of the database, but it is impossible for a single organisation to include the topics, including “fingerprinting”. The modus operandus is that other organisations (third parties) offer suggestions for new topics and TNO gate keeps the data. The data collection is divided into the following stages:

1. Input by third party
2. Gate keeping by TNO
3. Acceptance or rejection.
4. Approved by the Dynamo Steering Committee

The data included is evaluated periodically. In this way, the quality of all information is ensured. Also “evolution of future innovations” is monitored, enabling historical analysis.

TNO has set up a Dynamo Gatekeeper Team that evaluates all entered information. At this moment, the team has about 5 members, so medium term consistency is ensured. Also internal procedures and manuals for gate keeping and data entry are developed to enforce consistency.

3.3 Four types of results

As the information is gathered in a dynamic way, the output generated can be diverse. The simplest output is transposing the database; instead of looking at the data from the perspective of the included topics and presenting the related classes, a specific class can be selected and the corresponding topics can be presented. This enables answers to questions like:

• What kinds of future innovations are relevant for the food industry in general, or Production, processing and preserving of meat and meat products in detail?
• What kind of issues are in need of innovation looking at the Industrial Biotechnology and Food Sciences?
• What social needs are innovation related and what kind of innovations can help solving environmental problems?

All output can be fine-tuned using the detailed characteristics of the topics (timeframe, type, etc.). This enables short, medium, long term views, as well as other interesting detailed analysis.

Because of the number of topics, statistically important relations between classes can be identified:

• Relating classes internal to a specific dimension, e.g. business to business.
• Relating classes in different dimensions, e.g. business to research.
But besides the possible relations between classes, also an initial agenda can be set up. The topics that are common to both classes are actually possible areas of co-operation.

Within topics, a distinction between innovations and issues is made. This enables a cross correlation between the demand and supply side of our society. The system provides for example an answer to the question: What kinds of innovations are related to the issue of obesities. Also, a overview can be given which kind of business and research organisations are relevant. This is a very powerful functionality, because specific clients can make use of the core data to search for action to solve their specific issues, including an overview of possible important stakeholders.

The ability to make a cross reference between classes within a dimension enables a valuable additional output. A project specific dimension can be added, for example an organisational structure of a firm (units). If then all topics relevant are “fingerprinted” by this dimension, a cross correlation can be generated that shows the linkages between the organisational units. By doing this, two interesting outputs can be generated:
1. Initiation of innovation, or issues oriented reorganisation based on content.
2. Identification of possible areas of co-operation between the organisational units.

At this moment, more than 1500 topics are included in the database. The objective is to increase this number 5-10 fold. With this large number of topics, strategic analysis can not be made due to the information overload. A clustering of topics is needed. Because of the “fingerprinting”, it is possible to correlate topics. The database can be “asked” to find innovations that are related to a specific innovation with specific related business, research classes and social needs (Themes). This clustering method is based on statistical analysis, using similarity index as means of correlation. For each dimension, the similarity index of a primary innovation (or topic in general) to a secondary innovation (or topic in general) is calculated, using the following method (Sorensen-Dice):

\[ SI = \frac{2 \times a}{(a+b) + (a+c)} \]

Where:
- \( SI \): Similarity index
- \( a \): the number of classes both in the primary and secondary topic (overlap)
- \( b \): the number of classes unique to the primary topic
- \( c \): the number of classes unique to the secondary topic

To calculate the overall similarity index according to all dimensions, the geometric mean between all specific indexes of each dimension is calculated:

\[ SI_{total} = \sqrt[3]{SI_{research} \times SI_{business} \times SI_{society}} \]

\( SI_{total} \): The general similarity index
In this way, clusters of topics are identified that have (more or less) similar business, research and societal characteristics. This means that clusters are identified where research, business can cooperate to develop new markets.

The clustering mechanism can also be used for individual stakeholder searches. A user profile can be set up, fingerprinting their characteristics using the dimensions (business, research, societal needs). This profile can be used to find “similar topics”. Next to possible important topics, important types of organisations can be identified. This functionality enables a brokerage type of use. Organisations, or individual users can search in the database for new markets, possible innovations that may inspire them to new business opportunities. But next to this inspiring element, direct linkages with involved organisations are possible; networks, or even partnerships can be initiated.

3.4 Dynamo in practice: Internet and MS-Access

Dynamo uses the Internet as a communication network for data entry, gate keeping and public output. A dedicated Internet server is present to provide the technological platform. The Internet interface primary functions are enabling third party input and provision of public output. With project dedicated login username, data can be included in the database (input account). The user will be able to enter and adjust data. Next to this public website, a Gatekeeper website is developed. This provides online access to the data and project management. Also specific functionalities to evaluate the data entered by third parties, like sending changes to the third parties based on history logs, cross correlation of data entered, facilitation of Internet evaluation, user management. The access of this website is limited to the Gatekeeper team.

An MS-Access application is developed to make specialized data analysis. The MS-Access application is available using a password token. This enables an electronic snapshot of the database, including selected data. The application can be used to in dept analysis, making project dedicated queries. This enables functionalities, like:

- Including the topics characteristics in the analysis.

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- Including the topics characteristics in the analysis.
• Relating issues and innovations.
• Using a project subset of the dimensions.
• Making overall cross correlation tables
• Introducing client specific monitoring functionalities for business opportunities.
• Facilitate generation of themes, including selection of dimensions as basis for correlation.

However, using this application needs in depth knowledge of the database.

4. Results of Dynamo 2004

4.1 Introduction to Dynamo 2004

Although the Dynamo approach is general, it is applied in a periodic cycle. In 2004 the Dynamo approach is tested in an experimental, but representative environment with limited stakeholders. This first public trial and presentation of the Dynamo concept is called the Dynamo 2004 project and the ambition was to strive for a good representation of the innovation at every research field and sector. Only innovations were gathered in this exercise. The objective of this trial project was to explore if the approach would be valuable and viable.

The information gathered by the Dynamo 2004 exercise was limited. Two government funding agencies, NWO and Senter used their public funded project portfolio as a source. Additional innovations based on projects and future studies by the Economic Affairs Office for Science & Technology and TNO was added. This represented a balance between innovation projects respectively from science and industry.

The analysis of the information gathered was limited. Based on expert judgement and an internal project meeting, themes were identified and elaborated upon. No in-depth analysis were made because of the limited representation of the sources.

On April 21st, 2004, representatives of science, research, institutes, business, branch organisations, intermediaries and government were invited to examine the first public results of the Dynamo process and the database. Parallel sessions were organised discussing various themes and improvements of the process and database.

4.2 Collection of information

During the period of November 2003 and March 2004, within the framework of the Dynamo 2004 project some 600 innovations were fed to the database and gate kept. The input was based on the following sources:
• The Senter portfolio of funded projects, based on the programs EET, TS and EDI.
• The NWO portfolio of accepted projects in several research programs, based on the research councils (limited to 2002): Earth and Life Sciences; Chemical Sciences; Medical and Health Research; Physical Sciences; Physics; Technology.
• The TNO portfolio on co-financed industrial projects (limited to 50 innovations)
• The Technologies clés 2005 future study provided by the Economic Affairs Office for Science & Technology [CM International, 2000].

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31 Dynamo 2004 ran from August 2003 to April 2004
32 NWO : Netherlands organisation for Scientific Research, is the main subsidiser for scientific research. Senter, part of the Ministry of Economic Affairs, is the agency which is responsible for the execution of grant schemes on behalf of a range of Dutch ministries and is the main subsidiser for industrial innovation projects.
33 Executed by the Technology Foundation STW.
Table #: Overview of innovations collected within the Dynamo 2004 project.

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<thead>
<tr>
<th>Source</th>
<th>Number</th>
<th>Nature Research</th>
<th>Nature industry</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Natural sciences</td>
<td>Medical science</td>
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<tr>
<td>Senter</td>
<td>248</td>
<td>Chemical</td>
<td>Manufacturing</td>
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<td></td>
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<td>Physical</td>
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<td>Biological</td>
<td>Industrial</td>
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<td>TNO</td>
<td>50</td>
<td>Information</td>
<td>Manufacturing</td>
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<td></td>
<td></td>
<td>Physical</td>
<td>Chemical</td>
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<td></td>
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<td>Biological</td>
<td>Industrial</td>
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<tr>
<td>NWO</td>
<td>165</td>
<td>Chemical</td>
<td>Medicine</td>
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<td></td>
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<td>Information</td>
<td>Clinical</td>
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<td>biochemistry</td>
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<td>TWA</td>
<td>70</td>
<td>Chemical</td>
<td>Manufacturing</td>
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<td>Biological</td>
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The emphasis from the perspective of research is on Natural Sciences and Engineering and Technology. A specific source (NWO) gives much attention to Medical sciences. From the industrial perspective, Manufacturing is central. Some sources give attention to Transport and Telecom. There is little attention to Agriculture, Construction and other non technology industrial sectors. However, definitive conclusions can not be drawn, because this is the result of the biased collection of information (specific programs and limited literature).

4.3 Clustering in themes

Based on the sources described above, an identification of themes was performed. This clustering process used the following steps:

1. Step 1: Automatic generation of clusters
   The correlation function was used as a starting point and generated 87 clusters (SI factor more than 0.2).
2. Step 2: Draft theme identification
   In the next step, expert judgement was used to sharpen the clusters into themes. The result was 40 draft themes and 8 residual clusters that did not have a clear focus.
3. Step 3: Sharpening of themes
   In a workshop, the draft themes were discussed, missing themes were identified, as well as overlap. Also the residual clusters were discussed. In the discussions the essential product/market combinations played a central role.
4. Step 4: Development of the final themes
   In the last step, the final 35 themes were described, based on the discussions in the workshop. 35 themes were identified. An overview has been given in table.
<table>
<thead>
<tr>
<th>Overview of identified themes</th>
<th>Devices for computing and communication</th>
<th>Plastics and Polymers</th>
<th>Environmental technologies and management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating and other surface technology</td>
<td>Medical diagnostics</td>
<td>Medical drugs and therapies</td>
<td></td>
</tr>
<tr>
<td>Enabling technologies for life sciences</td>
<td>Agricultural production and management</td>
<td>Logistics management</td>
<td></td>
</tr>
<tr>
<td>Infrastructural works</td>
<td>Packaging technology</td>
<td>Chemical conversion technology</td>
<td></td>
</tr>
<tr>
<td>Mining of natural resources</td>
<td>Metals and metal products</td>
<td>Industrial biological technology (white biotech)</td>
<td></td>
</tr>
<tr>
<td>Indoor climate systems</td>
<td>ICT networks and infrastructures</td>
<td>Transport safety and efficient automobiles</td>
<td></td>
</tr>
<tr>
<td>Materials and construction testing</td>
<td>Tools and methods for designing products and constructions</td>
<td>Sensor technology</td>
<td></td>
</tr>
<tr>
<td>Software for computing and communication</td>
<td>Public energy systems</td>
<td>Industrial energy systems</td>
<td></td>
</tr>
<tr>
<td>Ship building and water transport</td>
<td>Medical implants and transplantation technologies</td>
<td>Food production technology</td>
<td></td>
</tr>
<tr>
<td>Food preservation, quality and safety</td>
<td>Micro- and nanoscale applications</td>
<td>Building methods and concepts</td>
<td></td>
</tr>
<tr>
<td>Building materials</td>
<td>ICT services</td>
<td>Industrial safety</td>
<td></td>
</tr>
<tr>
<td>Industrial manufacture technology</td>
<td>Industrial separation technology</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It can be concluded that the data entered within the project Dynamo 2004 had focus on these themes. It can not be concluded that these are the main themes for the coming decades. However, the can be used to e.g. inspiring new brokerage meetings.

### 4.4 The Dynamo theme day

The objective of brokerage and identification of themes were tested during the Dynamo Theme day. Some 65 participants were present and represented industrial firms, RTOs, government, branche organisations and intermediary organisations. During the day, the Dynamo database was presented and some themes discussed. During the final sessions the added value of the Dynamo database and the underlying process was discussed.

The conclusions of the Dynamo Theme are as follows:

- The added value of the Dynamo database was confirmed. Especially the brokerage element was regarded highly useful to: 1) inspire new co-operation. 2) inspire new business opportunities; 3) make connections between organisations.
- The information present in the database was considered added value to the existing knowledge of experts. The broad overview was confirmed, although it was considered scattered and incomplete. More sources (e.g. patent data) should be incorporated.
- The themes ‘rang a bell’ and were useful, but the content of the themes (underlying innovations) were too fractional to give an overview of the major developments in the theme. However, it offered a useful starting point for discussions and was considered added value. The basis for policy implications was considered to be too small.
- Some suggestions were made for improvement of the Dynamo website. First the interface could be improved into a more intuitive approach, where different users could find the information the needed more quickly. A layman should be able to use the system, instead of the expert-interface now available. Also some remarks were given about the character of content, like the need for more firm oriented information.
- The approach of the system is still considered technology push. The information presented is about technological innovations and also market developments and organisational innovations are of importance. The demand pull side should also be developed.

Although the comments on Dynamo were critical, many of the participants of the Dynamo Theme day offered to assist the further development. The added value was considered high, although progress must still be made.
5. Conclusions

5.1 Collection

Parallel to the Dynamo 2004 exercise, the database is (has been) used as a knowledge management system for more than half a dozen projects (see Table # and Annex B). At this moment almost 2000 topics are included in the database.

<table>
<thead>
<tr>
<th>Project</th>
<th>Nature</th>
<th>Number of innovations (approx.)</th>
<th>Number of issues (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamo 2003</td>
<td>General</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Science Forward Look</td>
<td>Food, environment, rural areas</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Binco</td>
<td>Biotech, ICT, nanotech, cognitive</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Dynamo 2004</td>
<td>General, with focus on the Netherlands</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>RADAR 2004</td>
<td>Electric and building</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Suspronet</td>
<td>Product service systems</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Manvis</td>
<td>Manufacturing industry</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>Approx. 1450</strong></td>
<td><strong>Approx. 450</strong></td>
</tr>
</tbody>
</table>

The collection element of the Dynamo approach proved to be crucial. The Dynamo 2004 exercise shows that the information collected was considered inspirational, but the fragmented and fractional character of the set of innovations limited the use and added value. Although the Dynamo 2004 subset is increased by the other projects, still the total set is too fragmented and not consistent enough to be used for systematic analysis. Some 3000-5000 topics are needed to support useful conclusions at meso level.

The overall procedure to have third parties make draft input and the gatekeeper team to make the evaluation and editing proved to be adequate. The input of third parties need assistance, but is crucial to achieve economies of scale and commitment to the approach. The translation of science oriented projects to innovations proved to be difficult. This needs business oriented thinking and a broad overview on possible markets, which takes special experience and capacities. The conclusion is that this “translation” of science projects should be done by the gatekeeper team to make it more efficient. The more industrial projects can use a more direct procedure and the innovations entered can be gate kept directly.

Although the quality of the gate keeping process proved to be sufficient, it can be improved by relating the input to existing input and make cross referential evaluation. These additional functionalities should be supported by the database.

5.2 Individual brokerage

The Dynamo Theme Day showed the enormous need for a system that can relate organisations through innovations. The fractional and fragmented character did not inhibit the use of the system, but proved even in this pioneers stage of Dynamo approach to be useful. The essential elements were:

- The output of innovations instead of projects.
- The possibility to use individual search profiles to identify relevant innovations.
- The possibility to identify other organisations (industrial and research) that are working in similar fields.
This functionality is mainly based on the Dynamo Internet website and can be accessed individually. However, the conclusion of the participants was that although in principle the functionality was there, the actual interface was not sufficient to stimulate broad use. It has to be developed into a more intuitive interface.

5.3 Dynamo as a policy tool

One of the objectives of the Dynamo 2004 project was to facilitate a selection mechanism to identify important policy areas to be addressed by further future studies and policy. The Dynamo Theme Day showed that this can not be facilitated by the Dynamo approach. Because of the fragmented and fractional character of the information a selection of areas can not be justified. The innovations were too specific to cover all research and business fields. Although every entry was relevant it was concluded, by e.g. branche organisations, this did not represent the whole.

To make the Dynamo approach more useful for policy, the data collected must be broadened. Furthermore, some functionalities proved to be potentially useful:

- Inspiring the innovation discussion with new areas. This functionality must be seen as a first point of departure to initiate new business and policy.
- An innovation platform to continuously identify possible new surfacing areas of innovation.
- Making project funding and momentum of innovation transparent to the public.
- An analysis platform for issue oriented innovation strategy development. Although this functionality is not developed yet, in the coming months it will be set up.

The database does not yet allow detailed policy analysis at this moment, because of the limited basis of data. However, there is definitely potential and it can already be used for inspirational purposes.

5.4 Final conclusions

The overall conclusion of the Dynamo 2004 project and other recent developments is that the Dynamo is a valuable approach, with much added value. Many stakeholders, governments, business and research, appreciated the approach, although the needs were not always the same. This proves that the first criterion of multi stakeholder and multi needs was met. The second criterion of Dynamic and flexible was also recognized. Data collected showed to have added value and could be translated to other projects. The economies of scale is possible, but needs involvement of other parties to enhance the quality of the date collected and outputs generated. At this moment, more than five projects are using the system and joining forces, therefore the conclusion of autonomous and appreciated can be considered true.

However, further development is needed. The broadness of the data collected must be expanded. Also other functionalities will enhance the economies of scale. An important element is the improvement of the public website interface. The conclusions are:

- Broadening the data collection nationally and internationally is necessary to improve the added value of the system.
- The inspiration and brokerage functionality proved to be very valuable and is already beyond the critical mass. However, the website interface must be further developed to enable layman use.
- The policy analysis functionality is still to be further developed. More data is needed to broaden its use.

The final conclusion is that the Dynamo approach has added value, but still needs significant improvement.
5.5 Dynamo in the future

The developments around the Dynamo approach are still ongoing. The ministry of Economic Affairs, together with TNO, Senter and NWO are discussing the further development. Also internationalization of the project is looked at. Also other projects use the Dynamo database, so the character of innovation platform is in place.

New functionalities are also considered, like:

- Further development of the brokerage tool. How can this functionality be organized in a self-sustaining way?
- Linking Driving forces and barriers to policy measures: Dynamo as a policy tool. The use of the system to identify policy measures based on the issues and innovations need a classification of driving forces and barriers.
- Impact assessment: Economic impact, environmental impact and employer risk are examples of indicators that are linked to innovations and can have added value to the system.

These new functionalities are further investigated.
References


Marimon (2002), Preface to the Conference Proceedings of “The role of foresight in the selection of research policy priorities, IPTS, Seville.


RAMON, the Eurostat classification server (http://europa.eu.int/comm/eurostat/ramon)
