FORMAT WHITE PAPER

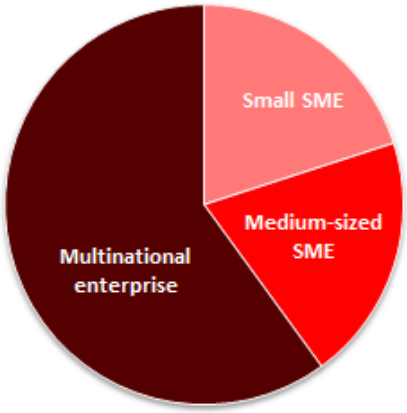
Requirements of the FORMAT methodology in terms of user friendliness and output

In January 2013, a questionnaire was sent out to the networks of the researchers involved in FORMAT, in order to assess the way companies handle innovation and problem-solving (see report on Deliverable 2.1). The questionnaire inquired about the usefulness of forecasting as an innovation tool and about the preferences in terms of needed input (resources, costs) and desired output (benefits). The idea at the time was to incorporate the results as recommendations for the FORMAT methodology, e.g. how much effort can go into it, which expertise is generally available, what output is expected… The questionnaire can be found at: http://www.format-project.eu/on-line-questionnaire-1

The results of the questionnaire are summarized in this white paper. Some conclusions can be drawn from it and these are translated into some recommendations for the optimization and the exploitation of the FORMAT methodology, in order for it to be useful and attractive for decision makers.

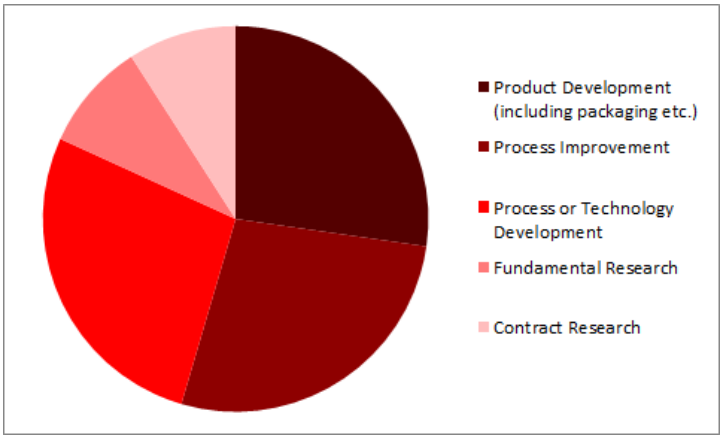
OVERVIEW OF RESPONDERS

The questionnaire was answered by 10 companies in total, their activities ranging from chemistry and medicine to mining and automotive. Of these 10 companies, **6 were MNEs and 4 were SMEs** (2 small and 2 medium sized). All of them employed dedicated research personnel at at least one location of the company, their number ranging from 2 (in the small SMEs) to tens (medium SMEs) to several hundreds or even thousands (MNEs).



From a statistical viewpoint, a sample size of 10 companies is, of course, a rather small sample size. Ideally, we would have liked at least 50 companies to have responded to our survey to be statistically significant. The questionnaire will therefore remain online for the duration of the project.

Based on the input gathered so far, a shorter version with only 5-10 questions will be distributed to specific networks of the FORMAT project partners. The questions will be selected based on the relevance of the info that they can still provide at this stage of the FORMAT project (these responses can be used in order to enhance the methodology and the presentation of potential results). A proposal is given at the end of this white paper.



Type of research conducted

The majority of the companies (6 out of 10) indicated *Product development*, *Process improvement* and *Process/Technology development* as the main research being conducted in their company. Two companies indicated *fundamental research* and/or *contract research.*

FORMAT Forecast and Roadmapping for Manufacturing Technologies
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APPROACH TO PROBLEM SOLVING AND R&D

Organization flow for problem solving

In problem solving situations, a general pattern could be identified for the involvement of different responsibility levels. Management identifies important problems and is then mostly involved at the decision points. R&D identifies and plans a solution (in some cases in cooperation with external partners), that is executed by technology managers, engineers and operators. If marketing is involved, it is mostly in the identification of the problem to be solved. Some systematic methodologies are used (mostly by the MNE's), but these are mostly limited to the overall well-known *Root Cause Analysis, Six Sigma* and *Plan-Do-Check-Act*. Only 1 company actively uses *QFD* and *DFMEA/PFMEA* while none of the companies indicated *TRIZ*, even though this is considered a popular problem solving technique.

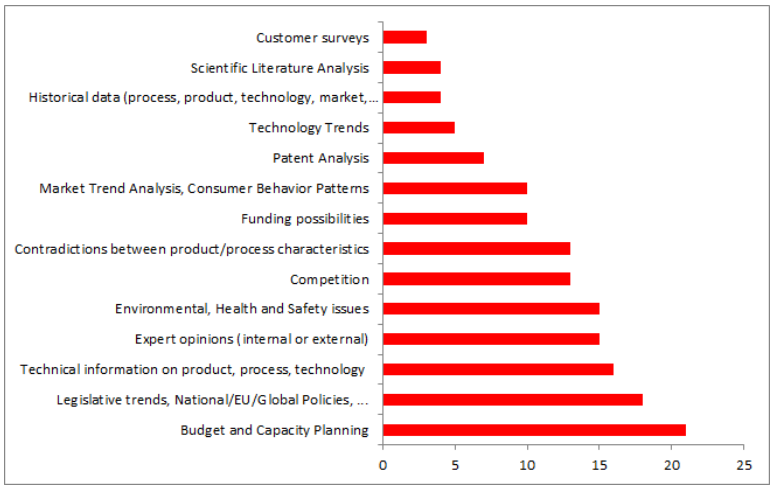
Organization flow for R&D

The table on the right shows the top 2 answers (3 in case of a tie) for the involvement of different responsibility levels in R&D activities. The main decision makers for R&D projects belong to the (high) management levels. However, in case of new product development, marketing will also have some decision power. The execution of R&D projects is done by the R&D team and engineers, with some involvement of the product or process managers. Eight of the ten companies indicated an involvement of external partners in their research activities, primarily for the delivery of ideas, but in some cases also to execute part of the research.

Who?	What?
High Management (CEO, business manager...)	Decision making (Go/No-Go) Delivering input
Management (Process Manager,Product Manager…)	Decision making (Go/No-Go) Delivering input Executing
R&D	Executing
Engineering	Executing
Marketing	Exploitation Decision making (Go/No-Go)
Operators	Not involved Exploitation
Customers	Not involved Exploitation

Critical information for Go/NoGo decisions

For a list of information types, the responders were asked to indicate whether these are deciding factors (+3), important factors (+1), interesting but not necessary factors (0) or of no importance (-1) in order to take Go/No-Go decisions in an R&D project. None of the listed factors had more than 2 companies voting on 'not taken into account'. None of the companies indicated any extra decisive factors that might have been missing from our list.



By counting the votes, five information types scored at least 50% (15 out of a possible 30). **'Technical information on the product, process or technology'** that is the subject of the R&D project **is only at a third place, after** the two primary factors '**budget and capacity planning'** and '**legislative trends'**. This is not surprising in a business context, where a stage-gate process for project management will usually require a business plan in the first gate and capacity planning and budget monitoring at each of the following gates. Legislation is also an expected important factor. Even though this is almost entirely outside of the control of the company, legal trends deliver obvious limits to technology development (e.g. environmental laws). It is clear that in a technology forecast, these two primary motives will always need to be taken into account (e.g. as barriers or limits). The top 5 is completed by *'Expert opinions'* and *'Environmental, health and safety issues'*.

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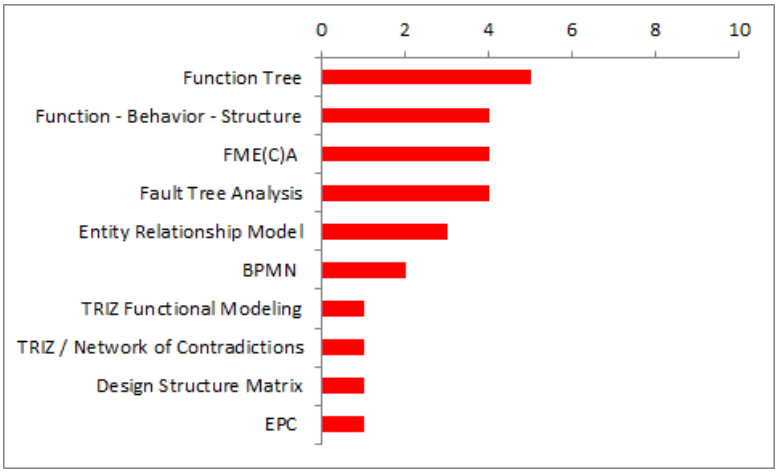
'Contradictions between product/process characteristics' was listed as decisive by 4 companies and is at a 6th place next to '*competition'*. In contrast with this last factor, and maybe surprisingly, *'patent analysis'* scores quite low in this assessment. It was only listed as a decisive factor by 2 of the companies. Also, 'Technology trends' and 'historical data' are at a low place.

FAMILIARITY WITH FORECASTING AND MODELING

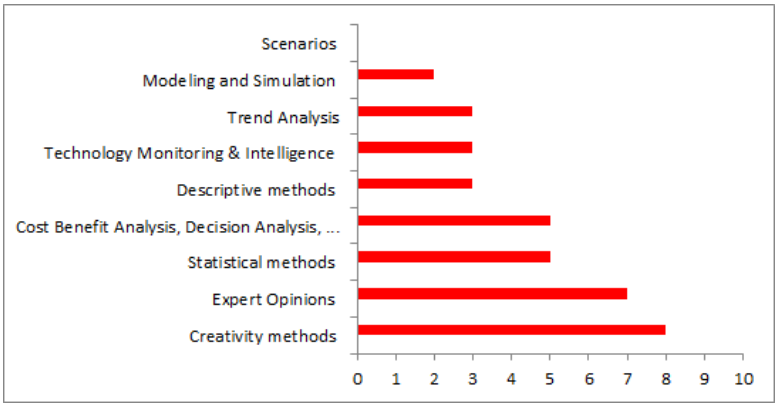
Known methodologies for Product and Process Modeling

None of the process or product modeling techniques were known by more than half of the companies. Mostly MNEs seem to have a broader knowledge of process modeling methods such as *Function Tree, Function-Behavior-Structure, FME(C)A, Fault Tree Analysis* and *the Entity Relationship Model*. The other listed methodologies received only 2 or 1 (see table) or even no votes (not shown).



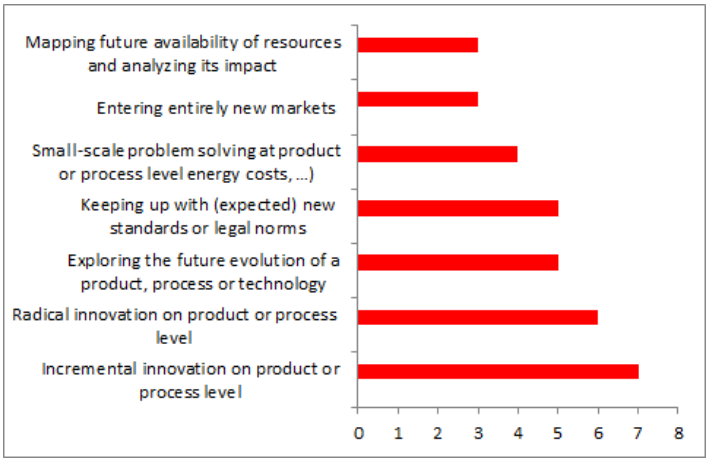
Known Forecasting methodologies

As opposed to modeling techniques, at least some of the different approaches to forecasting are known by more than half of the companies. The *Creativity Methods* such as brainstorming were marked by 8 of the 10 companies. Methods involving *Expert Opinions*, such as Delphi were marked by 7 companies. And quantitative methods such as statistics, risk analysis, cost-benifit analysis... were marked by 5 companies. The other methods were listed by fewer than half of the companies that answered the questionnaire.



REQUIREMENTS FOR FORECASTING AS AN R&D DECISION TOOL

Four companies indicated that a forecasting methodology could be useful as a decision tool in certain R&D related situations. Five other companies indicated insufficient knowledge about forecasting, while only one company clearly stated that such a tool would be obsolete. The following results were collected from the answers of 9 companies.



Forecasting purposes

The companies were presented with a number of R&D or Problem Solving related situations. The results of the questionnaire show that for each of the listed situations, a forecast could be useful at least for certain companies, since no situation received fewer than 3 votes.

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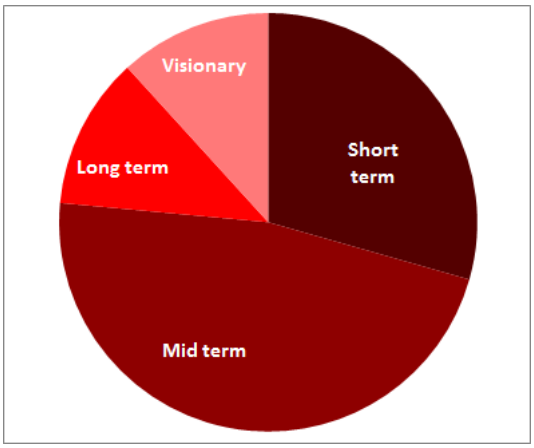
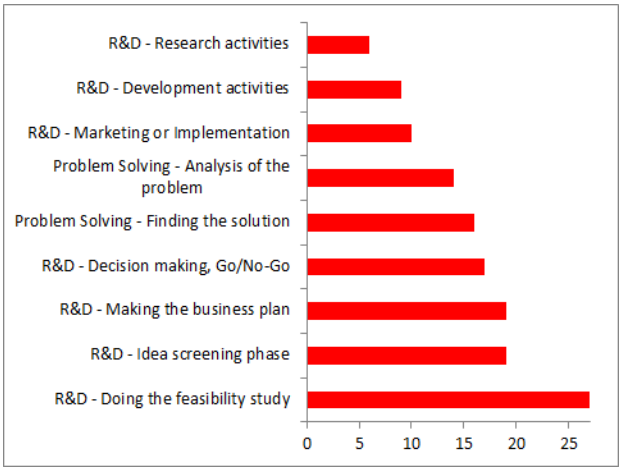
Incremental innovation and *radical innovation* projects received the top scores (7 and 6 votes out of 10 respectively). These were closely followed by *exploring product, process or technology evolution* or *keeping up with legal trends* (5 votes each).



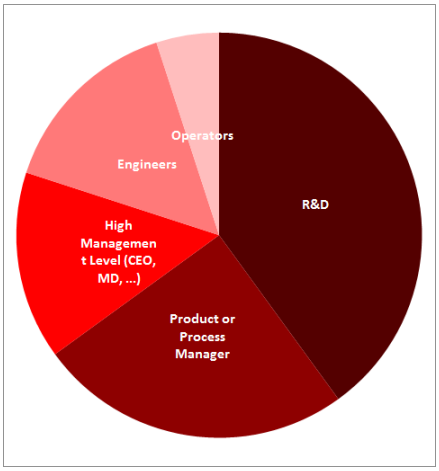
Moreover, there was a clear preference in using a forecasting tool for mid-term (2-5 years) and short term (0-2 years) R&D or problem solving projects rather than for the long-term (5-10 years) or visionary projects (>10 years). This has some **implications for the maximum amount of time that could be spent on a forecast**. Overall, for *Problem Solving* projects, the forecast should be finished within several days to weeks. For *incremental innovation* projects, it should be finished within several weeks to in some cases months while for *radical innovation* projects and projects leading to *new market entries*, even spending more than 6 months could be considered reasonable.

Stages and responsibility levels

A forecasting tool was considered to be most useful during the earlier R&D stages: the feasibility study, the idea screening phase, making the business plan, making gate decisions.



This concurs with the answers given for at which responsibility level the tool would be most useful, and for who would be most likely to use the forecasting tool and execute the forecast, namely the people involved in executing R&D projects (including R&D, the Product/Process managers, the engineers and the technology experts).



Human resources and training

Most companies indicated that a maximum amount of 1-3 people at higher responsibility levels could be involved in preparing, executing and interpreting the forecast, together with potentially 4-10 people assigned at lower responsibility levels. In general, external experts in science and technology could become involved as well, but experts with socio-economic or cultural backgrounds are a lot less likely to be consulted.

Overall, the users of the forecasting tool should be able to familiarize themselves and learn how to use the tool *within two weeks up to maximum 1 month*. To prepare and execute the forecast, several months up to >6 could be spent depending on the type of project (see above).

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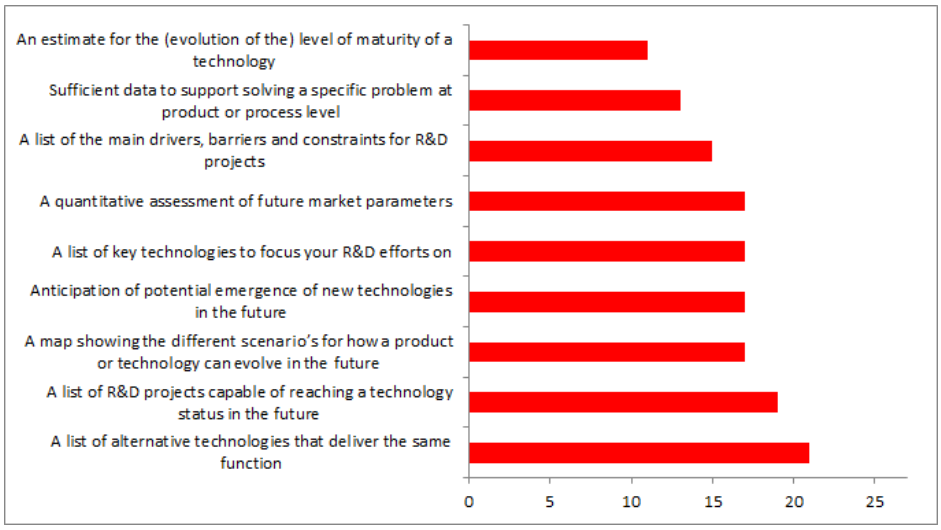
Readily available input (information) for a forecast

A lot of information that can be useful in a forecasting exercise is readily available in most of the companies that answered the questionnaire, namely both actual and historical *market trend analyses, technical information, consumer behavior patterns, cost and resource analyses, environmental and safety issues...*

Scoring the lowest on this list is a TRIZ-like *analysis of the contradictions of product or process*. However, since the contradictions were indicated as the 7th decisive factor, we can assume that while such analyses are not 'readily' available for any product or process, the expertise to make such an analysis would be available. In accordance with *patent analysis* scoring low as a factor for decision making, it again scores lower than other information types in this list, indicating that making patent analyses is not a standard practice in all companies.



Useful outputs

The top two most useful data that companies would like to receive from a forecast are: *A list of alternative technologies that deliver the same function* and *a list of R&D projects capable of reaching a certain technology status in the future.*

These are closely followed by *a map of evolutionary scenarios for products or technologies, anticipation of emergence of new technologies, a list of key technologies for R&D focus* and *a quantitative assessment of future market parameters*.

Overall, the difference in score between types of output that could be delivered by a forecast analysis is not very broad, indicating that the companies are at least interested in most of the output types that were listed in the questionnaire. Only one possible output of a forecast received a negative score (not useful). This was: *A historic and evolutionary map of the emergence of solutions for problems (contradictions) in a technology* (not included in the graph).

RECOMMENDATIONS FOR THE FORMAT METHODOLOGY

The answers to the questionnaire give some insight into how the FORMAT methodology would be used in company situations. Some recommendations for the FORMAT project are the following:

1. Make sure that, next to purely technological information, the **information** that is considered critical for decision making is considered in the forecast analysis, namely the budget and capacity analysis and legislative trends. This information can be either incorporated into the methodology, or it can be taken from other data sources that can be used complementary to the FORMAT output.

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2. A lot of the information that can be used as inputs in a forecast is readily available in the company. The FORMAT methodology should embed a way for collecting this information. If some steps or methods can be skipped because the info already exists in some form, the FORMAT tools should be sufficiently **flexible** to handle this. The FORMAT methodology should also allow to use the FORMAT outputs complementary to the existing information, if this can enhance the results.

3. Overall, the familiarity of companies with 'basic' forecasting techniques is quite high (e.g. Delphi, brainstorming, risk analysis, cost/benefit analysis...), but experience with more structured forecasting techniques and with process/product modeling techniques is quite low. If a lot of complicated forecasting and/or modeling techniques are incorporated into the methodology, the FORMAT manual should include sufficient **training** materials for the forecast executers. Consider also that the training needed in order to be able to work with the FORMAT tools should be in total limited to max.1 month!

4. Consider that, while external experts could be consulted, the **number of people** internal to the company that can be involved in the preparation and execution of the forecast analysis is limited.

5. A lot of **output types** are considered to be useful for decision-making. It would be nice to ask upfront, during the preparation of the forecast, which types of outputs are most desirable as this could also have an **impact on which information is needed** as input in order to deliver these outputs and it could **determine which methods** are most useful in the steps of the methodology where such a choice is allowed.

6. When the forecast is completed, these **outputs** should be **presented** in a format that is useful for the decision makers. Remember that these **decision makers** are mainly in the management level, but could in certain situations also include the marketing department.

CONTINUOUS USE OF THE QUESTIONNAIRE

Short 7Q version

Now that the methodology has taken shape, it is clear that it will be a tool most useful in the overall innovation management process, to help decide upon the overall objectives that projects should fit into in order to start-up or continue them. Some questions in the questionnaire can be reworked into being more related to decision making in the overall innovation management (who makes decisions based on what), valuable output (which output can be valuable for managing the innovation process and in which situations) and previous experience or expertise (familiarity with process modeling and forecasting).

After a critical selection and some adaptations, we prepared a 7Q questionnaire that can still deliver valuable information for FORMAT. Since it is a lot shorter, it can be more easily distributed directly in an email, so that people will be more inclined to answer it. This 7Q questionnaire can be found on the following link:
https://docs.google.com/spreadsheet/viewform?formkey=dEpSQlczems2Snh2ODJNRlV1NnJWcXc6MA#gid=0

Use part of the questionnaire as template for TF preparation

Moreover, after reviewing the questionnaire it became clear that *many of the questions itself can be reshaped into templates* that can be incorporated in the FORMAT methodology for gathering the input in the first stages (what are the objectives, what is the expected output, what are the available resources...). Examples can be found on the following link:
https://docs.google.com/spreadsheet/viewform?formkey=dEZKZ3FVaE5lYzlULUN1OV85b0ZueFE6MA#gid=0

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