# Method of selection of test cases for FORMAT

*"A journey of a thousand li (miles) begins with a single step."*
Lao-Tzu, an ancient Chinese philosopher, 6th century BC

This white paper presents a part of the work done for task 2.6, Definition of test cases of the FORMAT project. At Whirlpool Corporation, as in many industrial enterprises, various technologies exist. The aim of this work was to select test cases for the application of forecasting methodologies on manufacturing technologies.

## INTRODUCTION

*What is the need for forecasting?* One of the common myths is that prediction is an independent process. However, forecasting can be viewed as a component of a system of processes and tasks. In this paper, the creation of a forecast for decision-making in investment plans has been considered.
*How can a forecasting project be initiated?* We consider the process of creating a forecast to be similar to the process of manufacturing a product. Thus, in this analogy, the forecast is equivalent to the manufactured product. Various existing forecasting techniques [1], [2] provide methods to initiate a forecasting project. The present article may provide another such method.
*How can a forecast be applied?* Let us consider an example. If a manager has a reliable forecast, he can plan and implement the work of an enterprise with confidence. Forecasting is useful for the processes of modification of investment plans and estimation of human resources requirements for implementing new technologies. A forecast can help managers to reach the goals listed above. However, if the forecast is not recognised as valuable by managers, it will be ignored. Thus, a forecast can be influential in changing the opinion of the decision makers.
*How can the forecast be made understandable to the decision maker?* One way to achieve this is to ensure the direct involvement of the decision makers in the forecasting project.

The process of selection of case studies consisted of several phases as shown in Fig. 1. Specialists from the company participated in each phase.

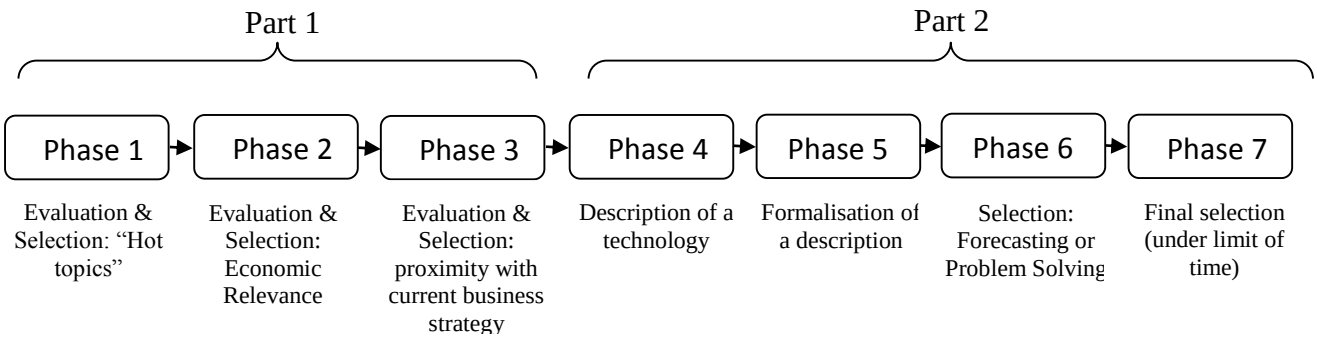


**Fig. 1. Phases in the selection of case studies**


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# Part 1. Selection of technologies by experts

## 1.1. Phase-1. Evaluation & Selection: “Hot topics”

Two groups of specialists from two organizations within the company worked on Phase 1. The organizations involved were:

1) Advanced Manufacturing Organization,
2) Whirlpool Operation Center of Excellence Organization – (WOCE),

Advanced Manufacturing Organization, a global organization, has a yearly plan for selecting new technologies for scoping and research. This yearly plan is usually the result of a process of gathering needs and priorities from all Whirlpool regions around the world.

The second organization, WOCE, a European level organization, provides a list of “hot topics” based on field experience of the managers.

The above-mentioned organizations provided the initial list of topics to be considered as test cases for the FORMAT methodology. Experts provided opinions about the importance of the forecast for each test case. Each test case corresponds to a particular technology. As a result of this process, 21 technologies were enumerated for the purpose of forecasting.

## 1.2. Phase-2. Evaluation & Selection: Economic Relevance

21 technologies (from Phase 1) were examined in Phase 2. The technologies were evaluated and selected based on the following criteria:

1. Economic relevance: the impact of the technology on cost and planned investment. High economic relevance means that the decisions related to the technology can have a greater impact on the total cost of ownership of a technology, or can significantly influence the savings or cost avoidance of a product.
2. Quality relevance: the relationship of the technology with product quality (perceived quality, durability, performance, etc.)
3. Sharing across product categories: the relevance of the technology across different product categories, and, hence, its impact on different products and businesses.
4. Synergy with other projects: the extent to which the technology is being used in company projects that are currently running or ready to execute, so as to maximise the availability of resources for technology forecasting (TF).

After the evaluation and selection process, the number of technologies was reduced from 21 to 17 candidates. This process was carried out by specialists in the company. Two specialists from the FORMAT project participated in the work.

## 1.3. Phase-3. Evaluation & Selection: proximity with current business strategy

After the selection of 17 technologies in Phase-2, four other criteria for further evaluation and selection of technologies were applied, as highlighted below:

1. Relevancy: (the results of the forecasts in the test cases are used in arriving at business decisions) Relevancy is a metric that helps selecting the technology in its alignment to current business strategy.
2. Adaptability (availability of relevant data and competent people in the industry). This metric is used to help identify the topics that are familiar to the industry. The more adaptable a technology, easier and more reliable will be the process of recruiting resources in a short time. High adaptability topics guarantee that the test case will not stall because of a lack of knowledge and data. Competences required to gather will already be available in a project.
3. Scalability (the boundary and details of the cases should be fitted to the resource and time available in the project). This metric helps to evaluate how much the proposed test case is actually feasible in the scope of the project (time and resource limitations). The evaluation will take into account how “big” the topic is (i.e. degree of complexity, number of players in the market, the physics governing the main principle etc.)



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4. Extendibility (the approach tested in the case should be extended to other industrial sectors). This metric evaluates how much the chosen topic is related to a specific industrial field. For example, topics very specific to domestic refrigeration will be given lesser weightage compared to topics shared among different product categories across industries (e.g. automotive, electronic, constructions, etc.).

**Table 1. The Evaluation of Technologies**

| group of experts | Technology | Relevancy | Adaptability | Scalability | Extendability | Total score |
|---|---|---|---|---|---|---|
| 1 | Technology 1 | 14 | 15 | 10 | 15 | 54 |
| 1 | Technology 2 | 11 | 13 | 15 | 15 | 54 |
| 2 and 1 | Technology 3 | 15 | 13 | 10 | 15 | 53 |
| 1 | Technology 4 | 12 | 14 | 15 | 10 | 51 |
| 2 | Technology 5 | 13 | 15 | 10 | 10 | 48 |
| 2 | Technology 6 | 12 | 13 | 15 | 8 | 48 |
| 1 | Technology 7 | 13 | 14 | 10 | 10 | 47 |
| 1 | Technology 8 | 13 | 12 | 5 | 15 | 45 |
| 1 | Technology 9 | 13 | 10 | 10 | 10 | 43 |
| 2 | Technology 10 | 10 | 10 | 10 | 10 | 40 |
| 1 | Technology 11 | 10 | 5 | 10 | 15 | 40 |
| 1 | Technology 12 | 9 | 5 | 10 | 15 | 39 |
| 2 | Technology 13 | 11 | 5 | 5 | 15 | 36 |
| 1 | Technology 14 | 11 | 5 | 5 | 15 | 36 |
| 2 | Technology 15 | 10 | 10 | 10 | 5 | 35 |
| 1 | Technology 16 | 9 | 5 | 15 | 5 | 34 |
| 1 | Technology 17 | 5 | 4 | 5 | 15 | 29 |

An evaluation and a selection of technologies presented in Table 1.
It was decided to select a group of seven highly ranked topics to be analysed further..
*) The actual names of technologies have been omitted from this paper owing to the sensitive nature of the information for Whirlpool Corporation.

# *Part 2. Selection of technologies through analysis of case studies*

## 2.1. Phase-4. Description of a technology

In Phase-4, a draft text descriptions for selected 7 technologies were prepared. The purpose of the technology was described.

## 2.2. Phase-5. Formalization of a description

In Phase-5 a formalization of the descriptions was carried out.
At this stage of the work, the description of each case was reformulated according to the following template:

1. The name of the case study (of the Technology);
2. A short description of the technology:
    - A short text describing the main peculiarities of the technology: how it works; advantages and disadvantages;
    - Several pictures to illustrate chosen cases;
3. What is the objective of the forecast for this case study?

When implementing this Phase it was necessary to answer the questions below:

- What are the main objectives and expected outputs? (Answering questions: What? When? Where? )
- How will the forecast be applied to the decision making process? (Why is the forecast relevant from a super-system viewpoint?)

An Example:
**1. Name of the case:** A packaging material (EPS - Expanded polystyrene) and a packaging technology.
**2. Short text description.**
Expanded polystyrene (EPS) is used for packaging of finished products. Polystyrene, obtained by foaming low-boiling liquid, is a material consisting of thin-walled granules sintered together. Inside the EPS, pellets have micropores between the beads - the voids.


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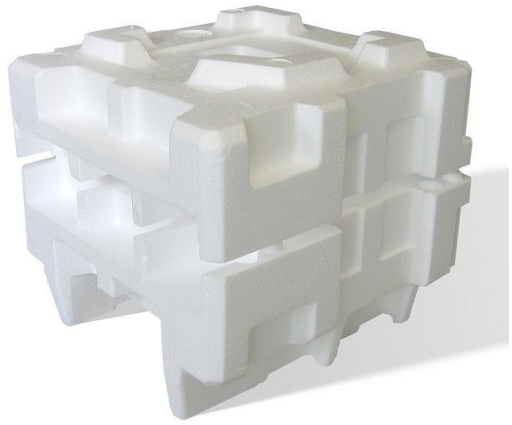

The material can be given any shape during its manufacture by sintering. Packaging of EPS may be such as boxes, fixing inserts and balls and elements of various sizes from 0.5 mm to several meters to fill the voids between the package and product. The packaging of EPS is typically standard for each product and is manufactured in advance.
The more critical the protection of a product by EPS, the more important is the performance of the fixing tabs. This increases the volume of the package. After delivery of the product, EPS which forms the packaging is usually removed and discarded. It is desirable to reduce the amount of packaging made of EPS and hence the cost associated with EPS. Polystyrene is one of the most widely used plastics, the scale of its production being several billion kilograms per year. [3] - Maul, et all 2007.

**Fig. 2. Packaging EPS box**

**a. What? Where? When?**
What?
A packaging material and a packaging technology
Where?
a) Geographically: names of the exact countries;
b) Segment (of the market; technology; …): from the factory to the location of the customer.
c) The product category: names of the exact products.
When?
Number of years or months;

**3. What is the objective?**
For the final formulation of the goals of the forecast the answers to the questions: "What? Where? When?" from the previous phase were used. Below is given a description of the goals in the form of questions for one of the 6 technologies.1. Will packaging technologies be needed in the future (number of years) to protect the products (name of the products) during their delivery from a Factory to a customer in these countries (names of the countries)?
2. Which is the most promising packaging technology in the future (number of years) for fulfilling the present and future products' needs (quality, flexibility, cost effectiveness) for all products (names of the products) during their delivery from a Factory to a customer in X, Y and Z these countries (names)?
3. When will a new technology be ready to substitute the Technology T and the technology for the products (names of the products) during their delivery from a Factory to a customer in these countries (names)?

## 2.3. Phase-6. Selection: Forecasting or Problem Solving

In Phase-6, seven technologies were analyzed.
During Phase-6 it is necessary to answer the following question:

- Can we satisfy the formulated needs without forecasting? (Yes/No) (Bypass solution to satisfy needs)

A decision was made that six technologies satisfy criteria necessitating a forecast, and one – necessitates problem solving. As a result, a list of six technologies was made with descriptions and goals for the forecast and with one technology for problem solving.

## 2.4. Phase-7. Final selection (under limit of time)

In Phase-7 six technologies were studied. Based on the criterion of available time necessary to perform a forecast, two technologies were selected. The descriptions and goals necessary for the forecasting activity were written up.


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## RESULTS

1. Test cases for forecasting were chosen for testing the FORMAT methodology, namely forming technologies for refrigerators cabinets and labelling/decoration technologies. These technologies constitute the test case for the two pilot projects of FORMAT and will be described in details after their completion in a next white paper to appear.
2. A methodology to define test cases was adapted and tested.
3. Conclusions on this methodology were drawn and recommendations for use were given.

## CONCLUSION

The questions: “What? Where? When? ” were helpful in the formulation of the objectives of the forecast. The preliminary analysis of a technology and the answer to the question “Can we satisfy the formulated needs without TF?” clarify another point. Namely, to determine what is the path forward in the given case: forecasting or problem solving?

Due to limitations in time, a final decision was made (in Phase 7) to choose two case studies for forecasting.

For an efficient definition of test cases the proposal by the author is to reduce the number of phases. This can be achieved in the following ways:

- by the use of a template for the specialists to fill in the first phases of selection;
- by the determination of the main limiting resource at the early phases (for example, the time to make a forecast).


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