

## EXPERIENCE WITH DISTRIBUTED DEVELOPMENT OF HOUSEHOLD APPLIANCES

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### Abstract

The development process of complex household appliances like frontloading washing machines which are distributed in high quantities in Europe, Asia and North America involves a variety of processes and is an example of distributed development of consumer products. In this paper we consider the experience of design engineers in a company with its main development centre in Germany and local development departments, local factories and local suppliers in Germany, Spain, Turkey, Poland, China, USA, and elsewhere. Their experience and their conclusions will help product developers and project managers who are working on international product development projects. Some recommendations are also made for methods and skills for design engineers in distributed development projects.

*Keywords: Distributed product development, international projects, experience, consumer products*

### 1. Introduction

Household appliances are consumer goods which are produced in large quantities and often distributed in various countries and continents. Because of different customer expectations in these markets, the appliances will be realized as localised product variants. The discussion of the international development process of household appliances shows a range of influences which are also important for distributed product development in general.

#### 1.1 Influences on distributed product development in general

Many influences on distributed product development in general have been already discussed in the literature, [1], [2]. Challenges faced by geographically distributed teams include time zone differences, cultural differences, communications problems, constraints on mobility, and general heterogeneity [1]. Opportunities of geographically distributed teams are time zone differences, cultural variety, market closeness, mobility, and heterogeneity [1]. Important prerequisites include good data management, especially for distributed design coordination as described in a case study of blades for a steam turbine [2]. For product variants it is also important to use shared product platforms [4], [5].

#### 1.2 Advantages and problems with distributed development

Distributed product development offers several advantages, e.g. additional resources of locations, expertise of personnel and training opportunities for subsequent development of variants after the initial product launch.

But there are also some problems associated with distributed development [10], [14] and distributed development projects, including communication difficulties, frictional losses

because of cultural differences, shortage of management capacity, conflicting targets, resistance of employees, dependence on cooperation partners, loss of expertise to partners.

### 1.3 Influences of designing in context

The product development process can be seen in a context of user, product, process, and designer [6]. The following points are discussed in chapter 2.1 for the case of large household appliances such as cookers, ovens, refrigerators, washing machines, dryers and dishwashers, focussing mostly on washing machines:

- Influences of users in the different markets
- The product and its complexity
- Development process, depth of development
- Design teams in interaction with other groups in development process

## 2. Objectives and Methods

In this paper, our objectives are to identify key influences and define recommendations for international projects.

Based on a survey of the literature, relevant facts for the distributed development of household appliances and consumer products in general are analysed and compared. The first author analyses an international project based on notes and personal experience. Experienced developers and project leaders of international development projects are interviewed about relevant influences for the distributed development. The results of the interviews are analysed and discussed and compared with literature. Finally, recommendations are made.

### 2.1 Influences of designing in context – example household appliances

- Influences of users in the different markets:  
For the designers of products it is very important to know the requirements of the users in the different markets [8] e.g. for the development of washing machines and dryers it is necessary to know details about the laundry, and how often customers need to do which kind of laundry. Other relevant points are the importance of energy and water conservation, the space available in the dwelling, and the likelihood of fluctuations of water pressure and the electric power supply.
- The product and its complexity:  
Complex systems typically have numerous components and interconnections, interactions, and interdependencies [7]. The complexity of products like household appliances depends on the number of functions, the number of parts, the necessary rotational or transversal movement of components, forces and deformations. In the case of washing machines, for example, the general functions of washing and spinning place considerable demands on the functionality: these are input, handling and output of water, input of detergent and mixing with water, mechanical movement of laundry, high speed spinning to remove water from laundry resulting in high dynamic forces (about 7000 N). Additionally, water temperatures up to 60°C or 90°C are needed for the washing process. Finally, it is important to synchronise all the operations.
- Development process, depth of development:  
It is relevant to know the extent to which processes of product development are

distributed. There is a big difference between managing and realizing processes in one large project team in one location, and a large number of smaller project teams which are working in different locations. With a growing number of project teams the number of interactions between the teams increases disproportionately. There are dependencies between product, process, teams, and locations. A product with systems and components needs processes, processes need project teams and project teams need locations with resources. Finally product development depends on locations.

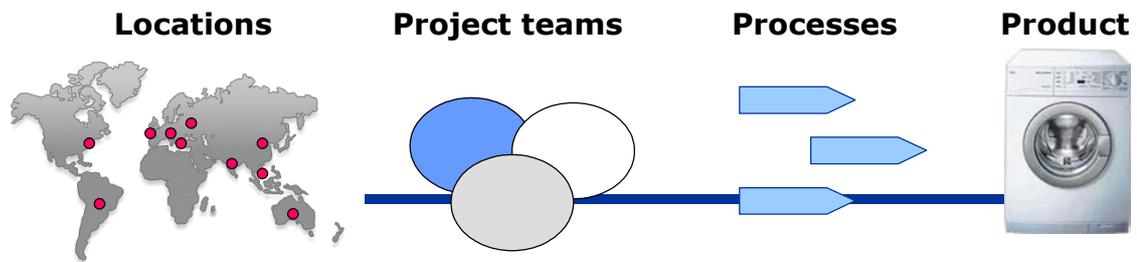


Figure 1: interactions between product, processes, teams and locations

- Design teams in interaction with other groups in development process: Furthermore the development process must take into account the locations involved in the aspects of the development process itself like product planning, conceptual design, embodiment design, testing, purchasing, quality management. Also important are the locations where the components are to be produced, the locations of suppliers of tools and moulds, raw materials and semifinished parts, and the locations where the appliances will be assembled.

Experience of the first author shows that the targets of distributed development projects are not always the same at each location of project teams.

## 2.2 Analysis of an international project

A larger international development project of a washing machine is analysed to find out relevant influences on distributed development projects. This analysis is based on the first author's own experience and on notes and reports of an international project.

A new washing machine with a new platform concept was developed by distributed development teams in four locations. The production was planned for factories in four European countries (Germany, Spain, Turkey and Poland) with the option of extension later. Therefore new systems and components had to be developed and other systems which were also used for other appliances had to be adapted.

After defining the main requirements, development time from conceptual design to series start was about 24 months. The project was organized in 11 project teams with a total of more than 50 development engineers and additional team members e.g. from quality management, production, purchasing and marketing. For most of these team members this was the first international development project.

At the start of the project, some factors were defined for the project teams. For example, communication and official papers should be in English, the same information tools had to be introduced in each location, and the project members had to be trained in these information tools.

According to the experience of the first author, team members who are working the first time in such a project must learn to work together in international teams. For cooperation with project partners from different cultures, intensive personal contact between project partners at the beginning of a project is fundamental. Also in critical project situations direct face-to-face interaction is very important. For example, in one case test results were interpreted differently. Even two discussions by video conference could not resolve this. In contrast, a short trip to the project partner and a discussion with the project partner about the appliance tested was successful, and led to agreement.

### 2.3 Preparation of interviews of project members

Compared with a project in one location, challenges of distributed development projects can be:

- A project start not fast enough
- B daily project work not efficient
- C critical project phases cannot be managed by team members
- D optimization in general necessary

After studying the literature together with the experience of the first author and the study of notes and project reports, the following influences for international projects were determined:

- Management strategy, for example a platform strategy [4], [5], a network of competence centres, local development departments, suppliers and development partners [3].
- Definition and agreement of common targets of project partners
- Opportunity to learn to work together in international projects  
time and travel costs, early project meetings
- Timely realisation of the necessary prerequisites for the project  
such as infrastructure, organizational structure and budget.
- An understanding of the cultural backgrounds of the project partners [1].
- Intensive communication and data transfer [12]
- An understanding of the preferred approaches and methods  
of the product developers involved in the project. Also detailed information about the skills and tools used by product developers.
- The availability of a common IT infrastructure,  
e.g. the same office tools, the same CAD-systems and product data management systems [2], [12].
- Harmonised development process  
with agreed criteria for validation which are defined at the beginning of the project, to support decision making regarding design stages, tests, components and the product, [12]
- Use and understanding of a common working language (mostly English).
- A very systematic and detailed project organisation.  
The tasks and the responsibilities of the project members have to be clarified at the beginning of the project.

Furthermore in March 2005 ten project managers and engineers in international development projects for household appliances were interviewed. Five had been responsible for project teams in at least two international projects. Influences were ranked and other factors were noted.

### 3 Results of the interviews

The interviews show the importance of the influences. Every interviewee has experience of at least one international development project. Figure 2 shows the importance of the influences in general and the importance of the influences in relation to experience of project management in international projects. The interviews were divided in two groups. Group A are five developers with experience as team leaders with two or more international projects, and Group B are five developers with experience as team leaders with only one or no international project.

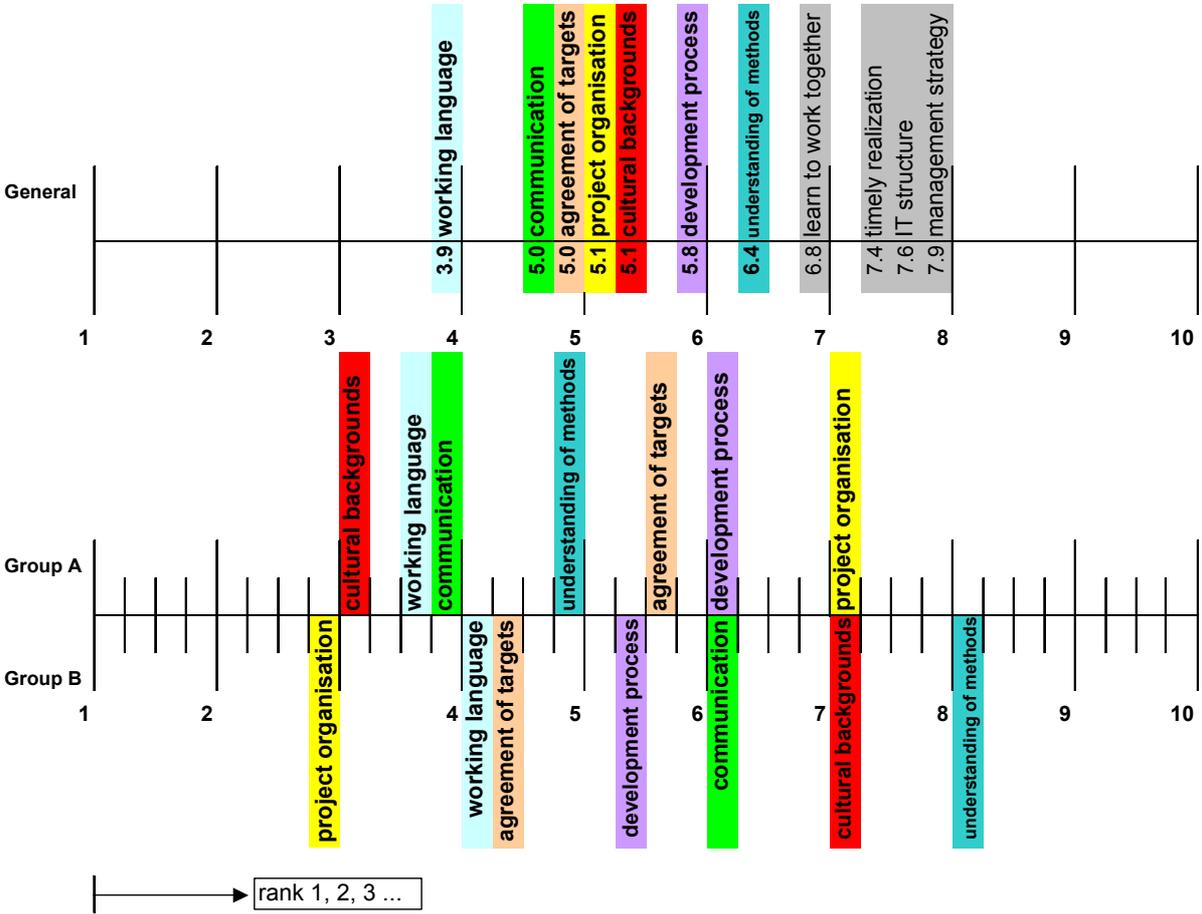


Figure 2: Ranking of influences based on ten interviews

In general the seven most important influences for international projects according the interviews are:

1. Use and understanding of a common working language
2. Intensive communication and data transfer

2. Definition and agreement of common targets of project partners
4. A very systematic and detailed project organization more intensive than project organisation in not distributed development.
4. An understanding of the cultural backgrounds of the project partners
6. Harmonised development process
7. An understanding of the preferred approaches and methods

### 3.1 Discussion of the results of the interviews

Rank 1: In general, the use and understanding of a common working language was seen as the most important influence. Most of developers wanted to be able to talk about complex things with their project partners in an easy way.

Rank 2: Intensive communication and data transfer is also a high priority. This can also be seen in literature [12]. For experienced project team leaders the communication is very important. They explained that good communication with the project partners can avoid critical situations.

Rank 2: Definition and agreement of common targets. The interviewees said that this is one important prerequisite which has to be fixed at the beginning of the project.

Rank 4: A very systematic and detailed project organization, though ranked third overall, was actually the most important point for the less experienced team leaders and developers working mostly as project members. The experience of the first author shows that misunderstandings about tasks and responsibilities can be avoided with detailed project organisation at an early stage.

Rank 4: An understanding of the cultural backgrounds of the project partners. Developers with experience as team leaders with two or more international projects (Group A) said that cultural backgrounds are most important. A study of the literature [15], [3] shows that project leaders rank cultural influences highly. However, a research colleague associate who made a study at our university [15] found nothing in the literature about the views of project members without project management responsibilities. The developers in Group B ranked cultural backgrounds in 6<sup>th</sup> position, see figure 2. The experience of the first author indicates that the views of project leaders, team leaders and project members about cultural aspects can be very important.

Rank 6: A harmonised development process with agreed criteria for validation which are defined at the beginning of the project was seen as a necessary prerequisite. Many discussions during the project can be avoided if important steps in the project are clear from the start.

Rank 7: An understanding of the preferred approaches and methods of the product developers involved in the project was seen as an important point at the start of the project.

The opportunity to learn to work together in international projects involving time and travel costs and project meetings in early project phases followed in 8<sup>th</sup> position.

The timely realization of the necessary prerequisites for the project such as infrastructure, organizational structure and budget which is necessary for forming the project teams were ranked 9.

The availability of a common IT structure was ranked tenth, surprisingly low given the importance often attached to this in the literature [2], [12]. This could be because the IT-infrastructure has got much better in recent years. Another reason could be that the documents

which are used for the development of household appliances are in general not very large in comparison with those used for example for the assembly of vehicles.

Management strategy with a platform concept [4], [5], a network of competence centres, local development departments, suppliers and development partners [3] got a ranked last of the eleven influences. It was seen mostly as a prerequisite before the start of an international project.

This study is based on literature, experience of the first author supported by notes and project reports and finally the interviews of project members. The experience is based on project of one company which develops and produces household appliances. The number of ten interviewed persons is in relationship to published interviews low but big enough to show clear trends. The deduction of further trends and further generalisation needs to take into account the background of the projects.

### 3.2 Recommended prerequisites for international projects

Based on the results of chapter 3.1, the following recommendations can be given for international projects:

- Use and understanding of a common working language is very important. Language courses and continuous training is a prerequisite.
- Communication between project partners in different locations should be very intensive.
- Cultural backgrounds of project partners should be recognized. Seminars and travel can help to understand the culture of project partners.
- A very systematic project organization with clarified tasks and the responsibilities of the project members at the beginning of the project is helpful. Also the responsibilities of the project leaders and team leaders who need the agreement of several location leaders should be defined at the start of the project.
- The common targets should be agreed on at the start of the project.

## 4. Final Conclusion

This study shows that a lot of important influences for distributed development projects are based on soft skills. Intensive communication in a common language and understanding of cultural backgrounds are specially important. A detailed project organization and the use of methods are helpful. Technical problems were not identified as main topics. Hence the influence of the product itself (washing machine, household appliance, or consumer product) is, in general, not a main priority.

The influence of cultural backgrounds on development processes is very important and should be researched in more companies and more international projects.

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