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SKETCHING A STRATEGY: EARLY DESIGN IN DIFFERENT INDUSTRIAL SECTORS

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Abstract

So far the early stages of product innovation have been under-represented in empirical design research. This paper presents the results of a two-year field study of innovation teams and allows for characterising the specific challenges of clarifying the design task. These challenges relate to analysing and integrating market demands, user needs, technological options and core competencies of the company. Based on these considerations, the teams developed an understanding of the future product that still allowed multiple interpretations but captures the essence: the sketch of a strategy. As an organisational process, product innovation mainly involved designers but also input from other disciplines. It requires goal setting for the design problem, co-ordination among team members and negotiating for resources. The paper analyses these activities in terms of collective action regulation and outlines some differences between industrial sectors.

Keywords: innovation, early phases of design, industrial case study

1 Early stages of product innovation

There is a considerable body of empirical research and conceptual works to understand designing, with a growing consensus within the interdisciplinary community on methods, terminology and models [1, 2, 3, 4]. This paper contributes to this discussion by focussing on two so far under-researched areas: the early stages of design innovation, and comparisons between different industrial sectors. We present the results of a field study and suggest a framework based on the literature on the innovation in engineering design, new product development, and organisational behaviour. Product design is understood as an organisational process to which the technical problem solving, the collaboration between individual designers and the management of resources contribute.

Product innovation involves marketing, engineering, economics, design, technology and production management [5, 6]. Early approaches to innovation built on linear models of the innovation process of ‘technology push’ or ‘market pull’. The empirical work at that stage attempted to identify critical factors by comparing successful and unsuccessful innovations [7]. Today, both theoretical and practical approaches are characterised by integration: Rothwell [8] presents a model of learning from various sources (lead users, competitors’ actions, reverse engineering, new personnel). Tushman & Nadler [9] integrate organisational and individual aspects of innovation such as linking mechanisms, core values like risk-taking and tolerance to failure, and problem-solving and team skills. To the designer, these models resemble sources of information he/she aims to consider during the design process. Psychological models of innovation describe how and why the individuals pursue innovation

[10] but in very generic terms of continuous improvement rather than a specific understanding of design. Clark & Wheelwright's [11] approach to innovation management is more specific to the task. They describe the innovation process as a funnel through which potential projects are processed.

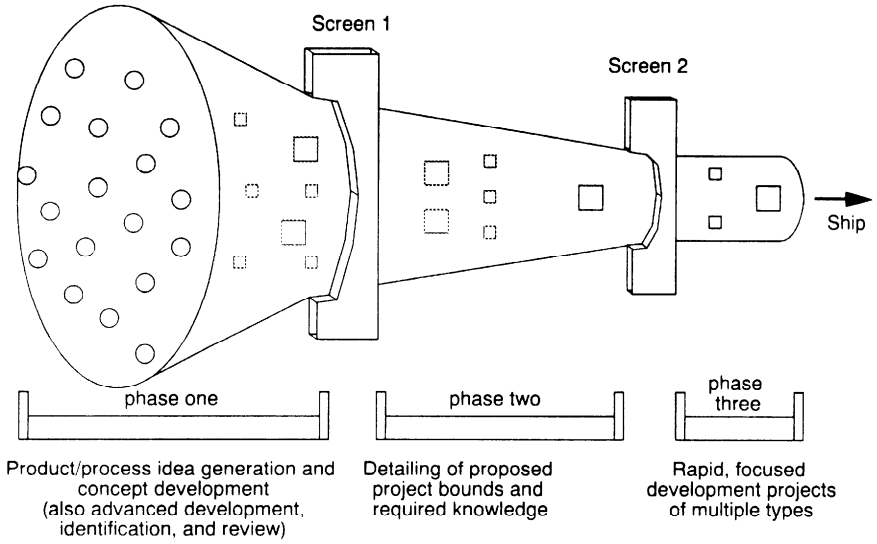

Figure 1. Innovation funnel, Clark & Wheelwright, 1993, p. 306

A well managed innovation process is characterised by a conscious screening of ideas at specific stages for resource allocation: There will never be enough time and money to pursue every possible innovation project, so a decision has to be made which concepts should be financed for further development. The goal is "to create a portfolio of projects that will meet the business objectives of the firm while enhancing the firm's strategic ability to carry out future projects" [11]. In the beginning, the challenge is to 'open the mouth' of the funnel to include a wide range of options and to avoid premature closure. In terms of focussing resources, the most promising options are selected. This is the second challenge of 'narrowing the neck' of the innovation funnel.

The paper reports case studies in six companies and provides a task analysis for early stages of the design process. The next sections describe the method and sample of the study, followed by the results on characteristics of early stages. We interpret these results by outlining a framework of collective action regulation in design and discussing differences between industrial sectors.

2 Field study of early stages

The aim of the study was to investigate forms of co-operation in the early stages of product innovation. It was devised as a field study with practitioners and was carried out in collaboration between engineers, industrial designers and work psychologists at ETH Zurich.

Sample

The sample consisted of 79 professionals from six different companies in mechanical engineering, appliance engineering and consumer goods. All companies were based in Switzerland and had a high standard of vocational and professional training and comparatively low outsourcing. Switzerland is competing in a global market with extremely high

labour costs: compared to Zurich salaries, the average in London is 51.6%, in New York 77.8%, and in Singapore 30.4% (UBS economic research, 1998). Therefore most Swiss companies have specialised in complex, high quality products, and complemented them with a comprehensive service for consulting, on-site training, software solutions and spare parts. In an interview study we found different forms of innovation management in different types of companies [12]: Large companies with specialised R&D departments have well-established systematic procedures and dedicated staff to explore new technologies, markets and user needs. SMEs invest less in structure and develop new products from flexible adaptations of previous products. Engineering service providers mirror the normative design methodology sensu VDI 2221 [13] most closely in a staged, risk-assessed approach to be able to check the brief and the costed plan against the client's expectations.

All companies were traditionally Swiss in terms of their culture and structure. Being a small country with relatively little international mobility, professionals often worked within a tight social network, and personal contacts played an important role in business. The form of government but also the way business relations are managed is characterised by a search for mutual agreement rather than open conflict or majority rule. Compared to working in and with German and British companies, I would describe the psychological contract as an expectation of high commitment and shared responsibility for business success, in return for an offer of stimulating tasks and excellent working conditions. Employees were encouraged but usually not financially rewarded to contribute their ideas.

We observed twenty-two team meetings and triangulated this with interviews with the project managers on the progress about a year after the observations. Participants were observed as part of their normal working practice. The teams received feedback on meeting organisation and the team process at the end but the researchers did not influence the design process. The meetings ranged from regular review meetings of two to five hours to large-scale workshops of three to five days. The shorter meetings were project reviews with an emphasis on co-ordination and idea generation meetings for subtasks of a project. These meetings involved on average 7 participants. The longer meetings were strategic retreats of whole R&D teams to define the scope of a new project, with an average of 19.6 participants. All teams were of mixed discipline (mechanical engineering, marketing, software and industrial design), often from more than one company. The participants were highly educated specialists, predominately male with women being present in only 6.2% of the meetings.

Observation

For the observation, the team meetings were recorded on video with a total recording time of 96 hours. The team interaction was analysed sentence-by-sentence using a category system [14]. The system is based on protocol analysis [15] and coding schemes for meetings from social psychology. The categories differentiate between three basic processes:

1. Cognitive task of problem solving, i.e. defining the scope of product innovation
2. Social and emotional processes in the group e.g. mutual support and solving conflicts
3. Monitoring of group discussion such as procedural suggestions and summaries.

Critical situations of importance for the progress of the project as defined by Badke-Schaub and Frankenberger [16] were transcribed and categorised in terms of content and interaction process. Additionally we used artefacts and documents created by designers and field notes by the researcher.

Interviews and mental representations

For the interviews, the project leaders were asked to describe how the innovation had progressed and how this process was managed methodologically and as a team. The semi-structured guideline focussed on methods, team and organisational aspects of innovation. The interview partners were also prompted about specific events in the project. Interviews were carried out in Swiss German dialects, transcribed in standard German, and paraphrased and interpreted in English by the author. The transcripts were coded using a Filemaker application for qualitative data analysis, AQUA (©klapt.net, 2000).

3 Characteristics of early stages

We carried out a task analysis of design activities during the early stages based on the observations and the interviews to account for the characteristics of early innovation we observed in this sample. For most of the designers involved, a breakthrough innovation or strategic re-think of this scope occurred only every two years and therefore clearly does not represent daily routine. The relevance for research comes from the impact and importance of the early stages, not from being representative for everyday practice.

The task analysis showed that the early stages are not only vague and creative as often conceived. They also involve very systematic subtasks. In our sample, the goals were only broadly defined, such as ‘a new product generation in two years time’ or ‘complementing the existing portfolio to gain more market share in the low cost spectrum’. Apart from the engineering service providers, teams were not given a complete brief. They had to search and develop a list of requirements as part of their task. This involved analysing market demands and user needs, researching new technology, and identifying gaps in the product portfolio. One engineer coined the metaphor of a fjord for this process: when setting out, the ‘coastline’ is visible and known, but then the journey takes to the ‘ocean’ of a far less predictable future. We found that this process was not always formalised [12]: Some companies followed a standardised process with milestones such as ‘innovation justification’ in which the innovation team had to justify the strategic implications to senior management for a go/no go decision. In companies where the strategic dimension was less explicit, the definition of goals was best understood as an ongoing process from a ‘wish list’ to requirements and an agreed set of specification, against which the product has to be tested and evaluated.

From this analysis, we propose that the step in the design process to clarify the task of can be decomposed into four essential subtasks:

1. Formulation or adaptation of an overall innovation strategy (Why? What? Where?)
2. Identifying the technical potential and technology strategy for the key competencies of the company
3. Analysing market demands and opportunities to develop a product/market strategy
4. Understanding usage and user needs to translate them into usability criteria and appeal.

Based on the outcome of these four subtasks, the innovation teams developed what we termed a strategy sketch. This sketch has similar features to the individual sketching in its ability to assist the mental analysis and synthesis, and to depict the *gestalt* without fixing the exact boundaries. However, unlike drawings, the strategy sketch is more abstract and has to be developed collaboratively. In the teams we observed industrial designers were instrumental to aide the abstract discussions by providing visual images. However, the visual images were also discounted if seen as over-simplifying.

As the list of subtasks indicates we strongly argue that early stages require interdisciplinary co-operation, as integrated product development has claimed for more than a decade [17]. In our sample, teams typically consisted of 5 to 20 professionals from different engineering disciplines, software development, marketing, and industrial design. Members often work for more than one project, and some were only part of the team as and when required. Our results indicate that it is crucial to allow for sufficiently overlapping activities among R&D, marketing and management. For projects that achieved this collaboration, product managers in marketing developed a better understanding of the technical background, and engineers gained more essential insights into the use of their future products.

The task analysis clearly showed how the early phases differ from later stages. Their scope pre-empts that of classical engineering methodology, and only some of the problems can be handled using those techniques. Their complexity is of a different nature. Product innovation has a huge impact on business strategy and vice versa. The identification of an appropriate product-market strategy was the key factor for successful innovation in this stage. However, designers were not actually entitled to decide on strategic issues but rather found themselves influencing the future portfolio of the company without nominal power. As a result of this, project managers had to employ lateral leadership skills beyond the technical dimension of the task to persuade their peers and superiors.

We also learnt that the early stages are not only determined by creative thinking as some theories propose [e.g. 10]. All four tasks require a "commitment to the systematic practice of innovation" [18]. At this stage, the activities were concerned with search, negotiation and clarification. Methods for this stage are much closer to marketing techniques for judgements based on qualitative information, than to design methods. Note that the framework suggested here does not imply a linear process in the listing of the four tasks. Market demand is essential and often seen as a natural starting point in innovation management. However, in the cases we analysed, the initiative usually came form R&D who highlighted technical possibilities and key competencies. The drawback of this strategy was that it required more effort to get buy-in from management and marketing. We conclude that neither the technical options, nor the strategy, nor the demand, or the user need can be determined in isolation.

Also both the observations and the interviews clearly highlighted the importance of internal politics and negotiation during these early stages. Which aspects are regarded as relevant and which set of arguments eventually succeeds, is not only determined by rational choice but is also subject to power relations and contradictory goals. The rational problem solving models of designing have usually not dealt with this process of negotiation. The empirical research, in describing it as social rather than organisational, has restricted it to an issue among individuals. We therefore suggest a theoretical framework, which conceptualises the design problem solving and the influence on strategy as collective action regulation.

4 Framework for product innovation as collaborative action

Our framework for product innovation is based on the concept of collective action regulation [19]. It refers to team members jointly carry out a reciprocally interdependent task. Team members interact, plan and co-ordinate their actions about the approach to the problem, about resource allocation and the relations to external agents. In this process, team members generate artefacts and concepts that are seen as manifestations of the common knowledge base [20]. The model does not assume that designers constantly interact and work together. Within division of labour, co-ordination of parallel activities is the normality, and co-operation is only required for new tasks or troubleshooting. In terms of Weber’s typology, innovation teams constitute teams with “distributed core task elements”: their task has

subcomponents such as software or mechanical development but they all relate to one project. This requires team members to communicate within their sub-team but also to interrelate with other parts in anticipation of the impact their decisions may have on other people's work.

Product innovation can be analysed into the primary task of developing new products and the secondary process of project co-ordination during the meeting and for the distributed subtasks after the meeting. For the primary design task, Stempfle & Badke-Schaub [1] propose four basic cognitive operations to deal with any kind of problem space: generation, exploration, comparison and selection. The secondary task involves the emotional and social interaction as well as the collective action regulation in the team. We assumed that explicit co-ordination of who was to carry out which actions would be more effective than implicit agreements over assumed duties. For role clarification and leadership, other research on intense work groups [21] suggests that these are fundamental paradoxes that cannot be resolved in principle, and hence effective teams deal with them implicitly.

All teams showed some form of collective action regulation though it was often left to the last minutes with little explicit goal setting for the meeting itself at the beginning. Teams balanced democratic decision making and leadership: Most teams contained one or people with more decision making power who took part in the discussion but also issued the closing comment, often implicitly containing a decision on how to proceed. The category for explicit decision-making was hardly ever used, even in the review meetings that aimed at this purpose. Views were aired informally before and during the meeting but none of the teams we observed ever voted to make a decision. Sometimes the atmosphere became awkward if team members awaited a signal from their boss in vain. We interpret these observations as part of the culture of seeking agreement without explicit fighting over potential conflicts.

The following ranking of outcomes (Fig. 2) is based on three scales used by the researches. All scales are ordinal (5 is always better than 4) but not necessarily uni-dimensional and equidistant.

- **Innovation** (1= no new ideas developed or discussed, 2= applications of existing solution but new for company or team, 3= some new contribution, discussion of new ideas previously developed by team, 4= new to the company, 5= new to market, high potential for successful innovation)

- **Collective action regulation** (1= only information, one-way, no shared planning, 2= decisions delayed, made outside of meeting, 3= scheduling of tasks, goals determined elsewhere, 4= some collective planning, scenarios, 5= explicit and well-structured planning of goals and actions)

- **Long term impact** (1= project shelved, no further action, 2= slow uptake, little impact, 3= potential for impact but problems during implementation, 4= technically good product but impact on market less than expected, 5= successful product on market).

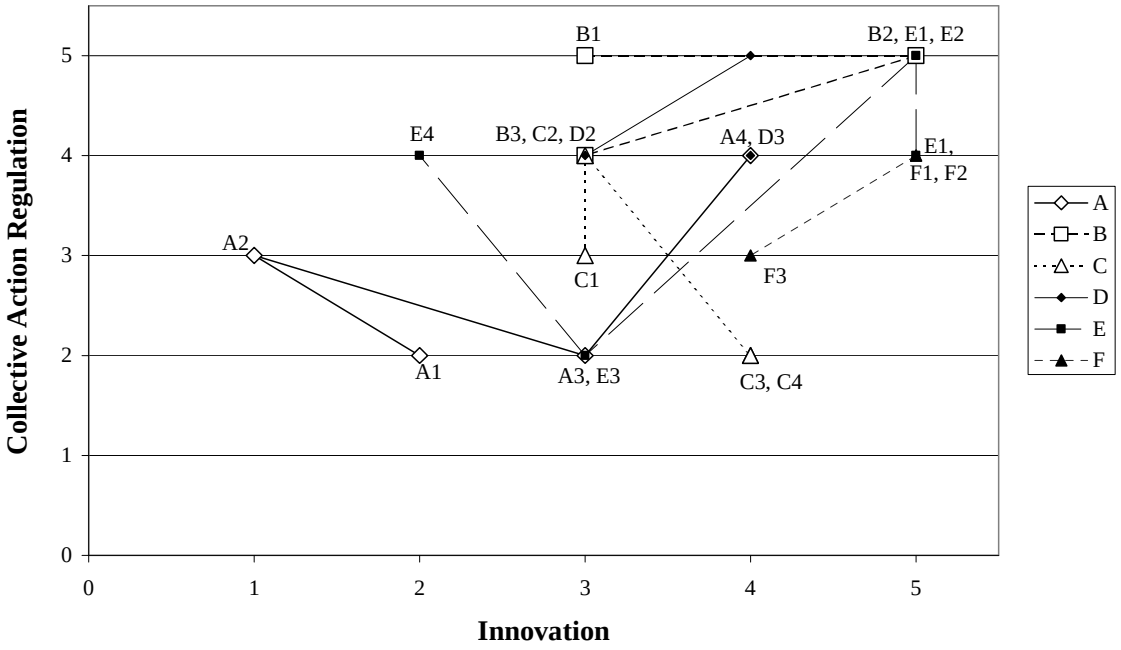

Figure 1. Project ratings for efficiency of collective action regulation and degree of innovation

Ratings for projects within one company are aligned. Project B turned out to be successful on the market whereas E and F were well-structured meetings but short-term initiatives not implemented as products. Projects in A and C underwent difficult periods with delays and high development cost but technically successful products. Projects in D dealt with innovative products but also internal reorganisation.

Based on the team observation and retrospective interviews, we have visualised the perception of project success over time (see figure 3 below) as two types of project.

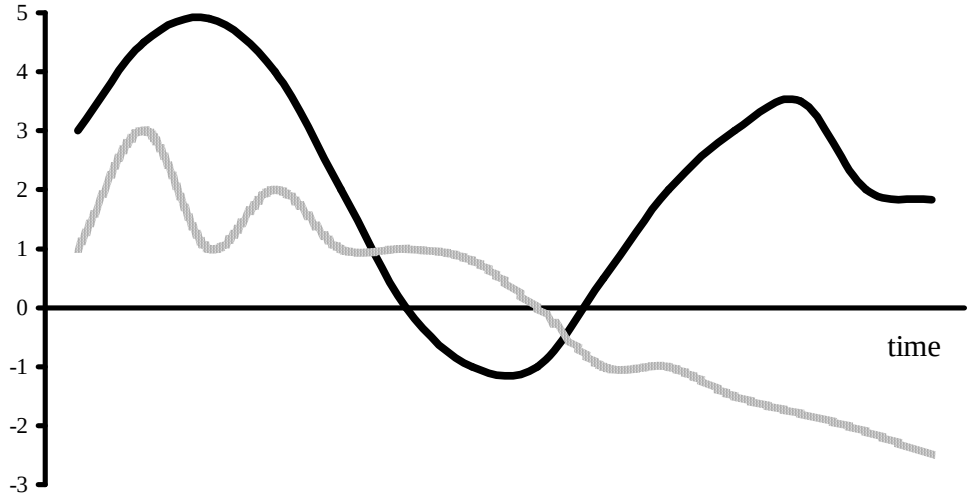

Figure 2. Perceptions of Project Success over time: 2 Types

The bold line indicates the more common form of eventually successful projects with an innovative, enthusiastic start and delays and hurdles due to lack of resources after the concept stage. The grey line symbolises projects with a rocky, ambiguous start during which a potentially innovative product is buried under daily business. Management support or the lack thereof played had a crucial effect on these delays, whereas collective action regulation

mainly determined the efficiency of meetings and project work. After the concept stage, these projects turned out to be too innovative for the company contemplating its implementation, and were also hit by the lack of resources. The long-term result was a disappointing market performance or an end to the project.

5 Comparison between different industries

Since our sample included a range of industrial sectors, we can also speculate about comparing the innovation process across consumer goods, appliances and investment goods. Any answer to this question will remain tentative because the total number of companies is very small and the companies differ in many respects. The course of action was not only influenced by the sector but also by individual personalities and idiosyncrasies of the company history. However the project partners themselves discussed differences as we visited each company and saw them as related to characteristics of the industries.

For the companies dealing with design oriented consumer products, the main challenge could be phrased as how to position oneself to the customer. Answers to this question were driven by marketing and branding issues, which lead to design solutions. These were then translated into a technical realisation. As a result of this situation, the early stages are characterised by a high degree of interdisciplinary and an involvement of the ultimate decision maker in aesthetic questions. Of the four tasks mentioned above, formulating a strategy was the most important aspect: innovation depends less on user needs or technical opportunities, and the products shape the market as much as they answer demands.

For the appliance industry with their own strong market organisation, the main challenge could be described as offering further benefits for competitive prices. This implies understanding user needs and technological opportunities. The companies from our sample actively explored exploiting their core competencies to substitute other technologies. This involved engineers working beyond their core area of expertise to understand user needs and to justify the cost of an innovation.

The mechanical engineering companies in the sample designed and built machines as investment products for the manufacturing industry. Their products have clients rather than customers: only a limited number of machines are sold every year, and each involves an engineering project to adjust and equip the basic machine to the particular specifications of the client. The buyer is a different person from the operator as main end-user, and the selection process is longwinded and predominantly rational. As a result of this, the innovation process is treated as a function of the engineering department with some input from sales as “wish list”. The challenge is conceived as a technical problem, which was to be solved by applying new technology to generate a better, more powerful and intelligent product. In the companies we observed, the market potential was analysed but the problem or need mainly taken as given. For the early stages, this meant that the teams produced a variety of concepts around a not entirely defined design brief in the hope that a potential customer could be involved in the development of the prototype. Branding played virtually no part, and industrial designers were consulted after the main problems were solved.

6 Discussion

This field study contributes to the growing body of empirical design research by analysing early stages of product innovation in different industries. The scope of this study was broader than the typical protocol analysis study of design because we view product innovation as an organisational process to which designers contribute. In this concept, task clarification is not

only a technical question, and the methods appropriate to the early stages are closer to marketing than design methodology. Nonetheless an understanding of the early stages is invaluable to designers because they have a high impact on the project and the final product.

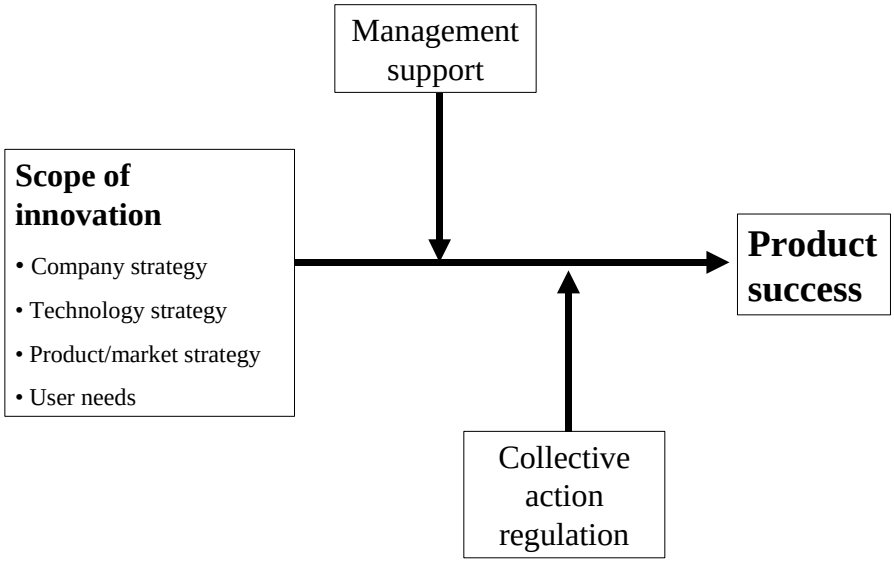

Figure 3. Framework of factors influencing the relation between innovation scope and success

Our results are relevant for both researches and practitioners: They indicate that a proper scope and goal clarification is essential for the success of product innovation. The early stages are still under-researched and even though our sample is bigger than many previous protocol analysis studies, it is still too small to determine which of the effects are due to a particular set of design problems, an industry or an organisational culture. It may well be possible that the extensive task clarification and proactive approach to early innovation is specific to these Swiss companies mostly among the market leaders in their area. More empirical studies are needed to investigate the effects of early stages.

However, the scope is not the only predictor: Our mainly qualitative study suggests that the relationship is moderated by management support as West's model proposes [10], which not only determines go/no go decisions but can also cause delays when resource allocation is not well co-ordinated. Collective action regulation did not seem to affect the outcome directed but influence the efficiency of meetings and development costs. This replicate research on team interaction in group interaction.

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