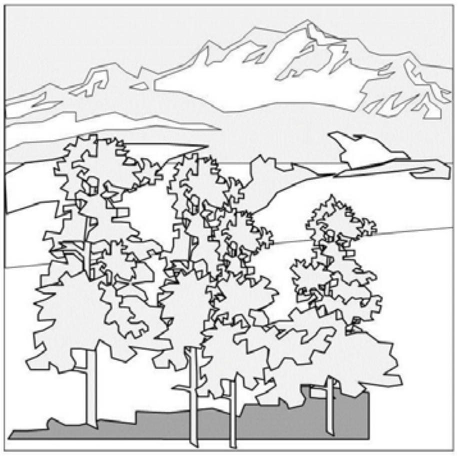

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Key Success Factors of Collaborative Planning Processes

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Key Success Factors of Collaborative Planning Processes[1]

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Abstract

Building design and planning is a typical instance of coordination and collaboration processes where experts work together in fulfilling their own distinct planning tasks that build the basis for the realization of the joint building project. Increasing requirements on building performance, like sustainability and energy efficiency, and project complexity call for a holistic view of the project rather than a fragmented one, as strengths in one domain cannot easily offset weaknesses in others. Traditional sequential planning processes fall short in fulfilling this requirement. This study compares sequential and integrated building planning in a large laboratory experiment with student participants. We identified that the success of building planning processes relies on the skills of the workgroup. Furthermore personality influences the results and the optimal planning procedure and conflict was handled better in integral planning.

Keywords: collaborative planning, integrated planning, building planning, experiment

1 Introduction

Design and planning processes are typical instances of coordination processes. Hereby numerous experts (architect, structural and HVAC engineers, project manager, building operator) – usually associated with different and legally independent firms – work together in fulfilling their own distinct planning tasks that together build the basis for the realization of the joint building project. Their tasks are highly specialized and at the same time highly interdependent. The success of a building design relies on optimized overall results so that weaknesses in one area cannot be offset by strengths in others. This is even more true for the augmented requirements on building performance and increased complexity of the planning process posed by sustainability and energy efficiency (Nofera and Korkmaz, 2010).
In the evolving field of design and planning in construction, the traditional planning process that follows a sequential workflow, where each expert performs her task on the basis of the previous expert's output, falls short of fulfilling sustainability goals in complex situations. The reciprocal interdependencies between tasks call for an integrated rather than sequential planning process (Thompson, 1967).. Despite this development the success factors of the different planning processes are yet not well understood.
We lack solid empirical foundations to judge whether and if, then under which conditions, integrated planning is superior to sequential planning.

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The research question of this paper therefore is: What are the key success factors of collaborative planning processes, especially comparing sequential and integrated planning procedures. In order to develop customized integrated planning strategies, where the main driver is achievement of sustainability aims instead of reduction of planning time and costs, the methods for optimal procedure choice should be developed through exploration of the importance of team-structure and personality traits.

In an attempt to take the first steps towards answering this research question, we conducted and analyzed the laboratory experiment with student participation reported in this paper, its remainder is structured as follows: After this brief motivation Section 2 reviews the literature on the development of integrated building design from its roots in concurrent engineering. Section 3 describes the experimental study and the data gathered. Results of regression analyses of the collected data are presented in Section 4. Section 5 summarizes the main results and draws conclusions for research and practice.

2 From concurrent engineering to integrated building design

There is currently a shift in attention from traditional sequential to integrated planning as it is argued be superior in addressing the current issues (energy efficiency, reduction of emissions) of the field. However, its roots in concurrent engineering date back to its first introduction in the automotive and aeronautical industry and lessons learned there can partly be transferred to building design.

In recent years especially integrated project delivery (Lahdenpera, 2011, Owen and Prins, 2010) collaborative planning in AEC industry (Dossick and Neff, 2011, Dewulf and Kaderfors, 2012) and project-organizations engaged in collaborative practice (Hartmann and Bresnen, 2011, Love et al, 2010) are upcoming topics in the context of concurrent engineering that have increasingly been discussed in literature.

The identified advantages of concurrent engineering, or concurrent design, originate in integration of concept-design-production phases and overlapping of activities, resulting with a reduction of changes, rework and consequently of the number of possible errors. Constraints and conflicts can be detected in the early design stages, where alterations can be carried out at low cost, the number of design alternatives is multiplied through early collaboration of all constituents, requirements of suppliers and users can be better grasped by early collaboration to improve the overall product quality (Wang et all, 2002). The importance of early phases (like conceptual design) plays a crucial role for future product performance: Design decisions account to 75% of product cost (Hsiu and Liu, 2000). The research community has generally advocated CE as successful method for improvement of lead-time, costs-reduction and product quality (Smith and Eppinger 1998, 1991, Pennel and Winner 1989).

However, several studies **identify the deficits** of the concurrent engineering by analysing different CE models in terms of risks when applied to radical (breakthrough) or incremental product introduction. Yazdani and Holmes (1999) provide in their study a comparison of sequential and concurrent engineering methods and models as applied in automotive and aeronautical industry in terms of risks, main drivers, time, cost and quality. The study distinguishes four models: traditional sequential, design centred (two phase model: concurrent design and subsequent prototyping and test); concurrent engineering (review stages with stage gates), dynamic super-performance concurrent model (simultaneous start of all phases, with prolonged prototyping and testing). The study shows that CE and the dynamic model display high risks in case of radical innovation that feature high uncertainty, complexity and novelty. Design-centred model displays high level of design-quality as the dynamic model does.

Valle and Vazquez-Bustelo (2000) investigate the impact of CE on the introduction of radical or incremental innovation, demonstrating that CE proves beneficial for the incremental innovation in terms of time reduction and higher product quality, however for radical innovations involving uncertainty, novelty and complexity, this is not the case. They conclude that if the main driver is time-reduction and increase of product superiority it is not advisable to apply CE in radical innovative process; if the top priority is to reduce the costs, it is not advisable in the incremental innovative process.

It can be concluded, that for different drivers (reduction of cost, reduction of time, increase of quality) and different innovation-types customized instead of generalized models should be applied, based on a thorough analysis of companies' objectives and goals.

Concerning the **transferability of insights from CE for the AEC** industry, attention has to be paid to specific characteristics of this industry. CE is basically developed for the introduction of serial products, whereas building design and related design and construction remain to the domain of prototyping, because of unique characteristics such as building site, building-orientation, varying needs of users and investors, varying planning teams and seldom in-house planning.

CE in industry and integrated planning in architecture and construction differ through project-organization: In industrial design the whole team (designers, builders, tester) are known from the beginning and are mostly in the same company – this is not the case in Central European AEC industry. One team carries out the project development and feasibility study, the next (competition winning) team carries out the actual design, the contractor is known after the bidding process, where design is already done. The architecture and construction projects are multi-party projects, where there is no unity of ownership, command and culture, which is the case with in-house industrial design (van Aken, 2003).

These differences of the industries lead to specialities in integrated planning that make it distinct from standard CE and calls for additional research.
ACE practice reports the need for the change of the traditional design process, which is arranged in sequential manner, with little communication between constituents of different phases: 'There seems to be thinking out there that there's got to be a better way to do this that the way we've been doing it?' (AIA, 2009, 5). The practitioners report the lacking of early collaboration as especially deficient; as such the needs of users can hardly be considered, moreover, the lack of knowledge transfer from planning in operational phase is problematic (Kovacic and Müller, 2011).

Chachere, Kunz and Levitt (2004) work with the Integrated Concurrent Engineering Method (ICE) within a design-project class, which was developed upon NASA's concurrent design approach, with the main driver of radical development-time reduction. They claim that the limitation for speed of engineering processes is the response latency – or the waiting time in the communication between two experts (engineers) for a problem solution.

In our understanding, the integrated planning in ACE is perceived from two different perspectives: design-oriented or management-oriented. The main aims of management-oriented methods are cost, time and (process-) quality driven. The aims of the design-oriented models, on the other hand, are driven by increasing the quality of design throughout the life-cycle of a building. Even though both approaches are based on similar success factors such as flat hierarchy, collegial and respectful atmosphere, early involvement of stakeholders, workshop setting and close collaboration, they are used for achievement of different aims: e.g. ICE advises knowledge sharing for reduction of changes; where as Integrated Whole Building Design (IWHBD 2008) for recognition of design opportunities.
We argue, that CE as a method has advantages for planning of sustainable buildings, through close collaboration of planning stakeholders from the beginning, and thus bundling of knowledge and information in the early, for latter building performance so crucial, design phase. Main driver for industry design is in many occasions the reduction of lead-time of design and production, in order to meet the market-demands due to the short life-cycles of products (especially in the information technology or automotive industry). For the design of sustainable buildings this often is not the case. Relatively short design- phases (one year) influences the next 50 years of the buildings' life-cycle, it should therefore ensure optimal life-cycle performance of the building. The main driver for integrated planning is a superior building in terms of sustainability, instead of planning time or planning cost-reduction. With this in mind, a closer attention should be paid on how to optimize the integrated design process in order to increase the building-quality.

The concept of IPD is seen to bear high potential for innovation in the building practice, but it is also found that the collaboration can be challenging, if individuals do not fully embrace the IPD approach (Nofera et al, 2011). Jassawalla et al (1998) claim that participants personality traits influence the level of cooperation: openness to change, willingness to cooperate and trust are fundaments of high-level-integration, which can be endangered by personal attitude such as disinterest towards the collaborative process. This suggests that the integrated planning process depends on team performance and personality characteristics of the teams.

2 Method

To investigate the key success factors of collaborative planning procedures we conducted a role-playing experiment with student participants from the curricula civil engineering and architecture at the Vienna University of Technology in fall 2011. The experimental study was part of the research project 'Costs and benefits of integrated planning'.

Previous research on work groups suggests that the type of the task, the size of the work group, the project length and available resources as well as the environment influence the group performance (Cummings, 2004). To gain reliable insights into the effect of the planning procedure – i.e. integrated versus sequential planning – and the effects of personality traits, it is necessary to control for these aspects which is possible in laboratory experiments.

All planning groups consisted of four members (client, architect, engineer, business consultant) with distinct tasks and deliverables. The group task was identical for all groups: the design of a temporary, self-sustained smoothie bar in the surrounding of the Vienna University of Technology main building, target customer group being students, to assure the work groups have sufficient and equal knowledge of the location and the target group. Deliverables for each role included an architectural design drawings and cost calculation for the architect, structural design drawings and calculation as well as the energy-system design drawings and calculation of solar gains for the engineer, cost and benefit calculations for the business expert, and marketing strategy description for the client. The resources where identical (standardized sheets for the drawings, calculation tables and forms, catalogues with equipment and interior) and also the project time was fixed with eight hours (the experiment was scheduled one whole day).

The only difference between the work groups was the planning procedure they had to use, which at the same time constitutes the two treatments of the laboratory experiment. In the integrated planning treatment all four group members sit and work together during the whole experiment. One the other hand, in the sequential planning treatment the different experts were situated in different rooms and only allowed to meet in a one on one fashion. Communication was restricted to face-to-face meetings and discussions, so that the experimenters who supervised the participants in the different rooms could assure that the experimental conditions were not violated. The experimental condition was induced by separate briefings of the two sets of work groups, so they did not about the distinct planning procedures until a debriefing event, where also first results were presented to interested participants.

These two predetermined procedures are argued to best represent the essentials of sequential and integrated planning, respectively. One-on-one meetings require redo-loops in case of additional information, feedback or problems from other professions concerning an accomplished task, as it is the case in sequential planning. If the work group members interact during the whole process this information can be provided or requested timely and avoids redo-loops or sub-optimal results.

This standardization of the all available resources, like the available planning time, materials and human resources shifts the attention towards the outcomes of the building design process, which was a jury evaluation of the results of the work groups in this study. This is in contrast to the main part of the literature as mentioned in the introduction, which especially in the domain of concurrent engineering, focuses on process efficiency like reductions in planning costs through reduction of number of changes or in planning time.

We argue that in building design the process effectiveness is of much higher relevance compared to process efficiency, as planning time and planning cost are negligible compared to the resulting building’s life cycle time and cost. However, process efficiency was not ignored, first analyses on the data gathered in the laboratory experiment fount a higher time efficiency of integrated planning teams and a higher satisfaction of the work groups with the integrated planning process (Kovacic and Sreckovic 2012).

To assure equal capabilities in both treatments, information about the participants' professional experience, the progress in their study, drawing-skills etc., were collected – together with other information as described in the subsequent section – by a pre-experiment online questionnaire. Based on this information pairs of participants with as equal as possible experience where identified and randomly assigned to one of the two experimental treatments (sequential planning or integral planning). Afterwards, within the two treatments groups of students were generated assigning an architecture student to the architect role of one group at random and three civil engineering students to the remaining three roles (client, engineer, business consultant) at random.

On the experiment day the participants were split up according to the treatment they were assigned to, and accordingly briefed by the experimenters. Afterwards, the groups (in the integrated planning procedure) or the participants with equal roles (in the sequential planning procedure) found together in their rooms and started to work on their tasks to perform their deliverables.

3 Results

A total of 160 students participated in the laboratory experiment, quarters of which were architecture students. 80 participants were assigned to 20 groups that followed a sequential planning procedure (work group members communicated exclusively in one on one meetings – as described in the previous section), the remainder 80 participants were assigned to 20 groups that followed an integrated planning procedure (work group members where placed together in one room – as described above).

For the analyses of key success factors we gathered significant amounts of information on the participants, the planning process of the work groups and their outcomes. The pre-questionnaire elicited demographic data about the participants (age, gender) we used as control variables in the analyses, as well as information about their experience: full time equivalent of relevant professional experience, how many semester they study and a self-evaluation of their drawing-skills on a four point scale (from one very bad to four very good). Furthermore the pre-experiment questionnaire surveyed personality traits of the participants. As argued above the personality and preferences of the individuals, as well as the resulting work group composition might influence how effectively planning procedures are used and their potentials are realized.

The pre-questionnaire covered four of the 'big five' (Costa & McCrae, 1992) general personality traits: extraversion (PEI), agreeableness (PAG), conscientiousness (PCO) and openness to experience (POE). Neuroticism as the fifth of the 'big five' personality traits was not included because of two reasons. On the one hand it was not clear how neuroticism should affect planning while there are straight forward relations for the other four aspects, on the other hand pre-tests of the pre-experiment questionnaire indicated that participants were reluctant to answer the questions that measure the neuroticism scale which could harm truthful information revelation or participation in the experiment. Extraversion, agreeableness, conscientiousness and openness to experience were surveyed by standard 10-item scales. Furthermore specific personality traits that might be relevant to group work where elicited from the participants attitude towards teamwork (STW, 9-item scale), attitude toward cooperation (SCO, 10 item scale) and attitudes toward communication (SCO, 6 item scale). The participants had to answer these questions on a 5-point Likert scale ranging from 1 (by no means at all) to 5 (totally true). Based on the answers of the participants the scales where checked for consistency and reached satisfactory Cronbachs alphas.

During the experiment the participants continuously self-documented the tasks they were performing, as well as the perceived level of workload and conflict within the group (each on a 10 point scale, at least all 30 minutes). The experimenters took care this information was indicated and reminded the participants if necessary. After the experiment the participants had to fill in a brief post-experiment questionnaire indicating their satisfaction with (i) the procedure, (ii) their result, (iii) the functionality of the team and (iv) the collaboration in the team. Furthermore they had the possibility to communicate suggestions or affliction. All deliverables where handed over to a jury of five experts from industry and academy. The jury members individually evaluated all 40 groups (without knowledge of group participants or planning treatment) concerning four specific criteria (architectural design, structural design, energy-efficiency, life-cycle costs and benefits) and also provided and holistic evaluation (each evaluation was done on a scale from 1 and 10, the higher the better).

The average holistic information serves as the dependent variable in our analyses as an approximation of the quality of planning groups' outputs. The independent variables gathered on an individual basis where aggregated to group level variables by the common approach of calculating the averages (Cummings, 2004). Table 1 provides descriptive statistics of the independent and dependent variables at the level of analysis (i.e. the group level). Note, however that the averages at the individual level are equal to the averages at the group level as all group sizes are equal.

	mean (sd)	min	1. Q	median	3. Q	max
age (years)	22,870 (2.102)	20,500	21,690	22,500	23,000	29,750
female	0,294 (0.203)	0,000	0,250	0,250	0,500	0,750
study (semesters)	5,650 (2.558)	3,250	4,188	5,000	6,000	16,500
drawing skills	3,131 (0.420)	2,250	3,000	3,000	3,312	4,000
experience (months FTE)	7,888 (7,746)	0,000	3,438	4,500	10,542	27,500
extraversion PEI	3,331 (0,262)	2,725	3,194	3,362	3,506	3,775
agreeableness PAG	3,826 (0,240)	3,200	3,700	3,900	3,956	4,275
conscientiousness PCO	3,746 (0,235)	3,200	3,544	3,800	3,931	4,175
openness POE	3,650 (0,207)	3,275	3,450	3,663	3,775	4,100
teamwork STW	3,789 (0,243)	3,333	3,604	3,806	3,917	4,472
communication SCM	3,982 (0,222)	3,625	3,833	3,958	4,135	4,417
cooperation SCP	3,328 (0,204)	2,625	3,219	3,312	3,500	3,675
workload	4,031 (0,532)	2,061	3,652	4,143	4,382	4,849
conflict	4,034 (0,533)	2,030	3,674	4,157	4,392	4,854
jury	6,255 (1,161)	3,800	5,550	6,500	7,200	8,200

Table 1: Descriptive statistics for dependent and independent variables at the group level

From Table 1 one can observe that the participants on average where about 23 years old in their 5th to 6th semester and already possessing around eight months of professional experience. About 30% of the participants were female.

Table 2 presents the correlations of the independent variables. Not surprisingly age, the semester of studying and the months of professional experience are positively correlated. Moreover the strong correlation of the personality threats agreeableness and the attitudes toward teamwork is comprehensible. Interesting is the striking positive correlation between group averages of self documented level of perceived workload and the level of perceived conflict, indicating that workload, work distribution and conflict go hand in hand during the planning processes.

	2	3	4	5	6	7	8	9	10	11	12	13	14
1. age	-0,07	*** 0,78	0,21	*** 0,58	0,18	-0,20	-0,07	0,09	-0,20	-0,03	-0,12	0,04	0,04
2. female		-0,05	-0,13	0,04	-0,06	0,19	-0,23	-0,03	0,12	* -0,33	-0,12	0,01	0,02
3. study			-0,05	*** 0,59	0,18	-0,07	-0,07	0,14	-0,19	-0,14	-0,06	-0,07	-0,07
4. drawskill				* 0,36	0,07	-0,13	0,15	0,12	0,14	0,19	0,15	0,24	0,24
5. experience					0,34	-0,23	-0,12	-0,02	-0,07	-0,15	-0,12	-0,01	0,00
6. PEI						* 0,36	0,27	* 0,34	* 0,37	0,15	-0,20	-0,20	-0,22
7. PAG							** 0,46	0,30	*** 0,63	* 0,38	-0,15	0,05	0,04
8. PCO								** 0,46	* 0,35	** 0,50	0,22	-0,13	-0,13
9. POE									0,17	*0,39	-0,24	-0,01	-0,01
10. STW										* 0,40	-0,15	-0,09	-0,09
11. SCM											0,01	0,08	0,09
12. SCP												-0,07	-0,06
13. workload													*** 0,99
14. conflict													

Significance levels: *** <0,001, ** <0,01, *<0,05

Table 2: Correlation of independent variables

Regression analyses were started with a base model (model 0 in Table 3) that considers the effects of the planning procedure as a dummy variable (0 for sequential 1 for integrated planning) and the control variables. Consistently with initial and previous uni-variate analyses we found no direct effect of the planning procedure on the outcome quality of the design process (Kovacic et al, 2012). Also control variables, i.e. the average age and the portion of female group members, have no impact on the outcome.

	model 0	model 1	model 2	model 3
intercept	3,520	2,704	-7,645	-9;102
	(-1,672)	(1,644)	(-1,204)	* (-2,057)
procedure	0,198		10,618	6.750
	(-0,54)		(1,208)	(0,995)
age	0,128			
	(1,449)			
female	-1,034			
	(-1,138)			
drawskill		0.931	0,947	0,917
		. (1,907)	* (2,078)	* (2,362)
study		0.181	0.113	0,092
		. (1,955)	(1,588)	(1,483)
experience		-0.049		
		(-1,510)		
POE			1,551	2,083
			(1,150)	* (2,394)
PCO			1,949	0,971
			(1,492)	(1,010)
PEI			0,556	
			(0,505)	
PAG			-1,144	
			(-0,971)	
procedure*POE			2,438	
			(1,259)	
procedure*PCO			-5,580	-4,018
			** (-3,233)	** (-3,002)
procedure*PEI			-2,362	
			(-1,404)	
procedure*PAG			2,313	
			(0,228)	
conflict				0,238
				(0,693)
procedure*conflict				1,838
				* (2,073)
mult. R^2 (adj.)	0,09 (0,02)	0,14 (0,06)	0,48 (0,27)	0,51 (0,38)
F-statistic	1,243	1,864	2,329	3,997
DF	36	36	28	31
p-value	0,308	0,153	0,035	0,002
AIC	130,494	128,661	124,449	116,086

Table 3: Overview of the regression analyses

Model 1 considers the effect of skills and experience and finds weakly ($p<.1$) significant contribution of the average drawing-skills and the average study progress. These first two models did not fit, however, model 2 keeping drawing skills and study progress as explanatory variables and adding the four general personality traits – as well as their interaction with the planning procedure used by the group – leads to the first reasonably fitting model 2, with adjusted multiple R^2 of 0,27, F-statistic 2,329, significant at $p<.05$.

In model 2 average drawing skills lead to higher evaluation ($p<.05$), furthermore groups with higher values for conscientiousness (PCO) reached significantly inferior results ($p<.01$) in integrated planning procedures, while in general high conscientiousness of the group has no such effect. Adding the planning specific personality traits attitudes toward teamwork, cooperation and communication (and their interaction with the planning procedure) did not lead to a better model and therefore is not reported, however, adding perceived level of conflict did lead to our final model 4. Given the high positive correlation of perceived workload and perceived conflict obviously not both should be included in one model.

With the insights from the previous models systematic variation led to the final model 3, which best fits the data and explains the reasons for good performance evaluation by the jury, with adjusted multiple R^2 of 0,38, F-statistic 3,997 significant at $p<.01$ and lowest with 116,086 lowest AIC of all models – see Table 3. The average drawing - skills are as in all models of importance ($p<.05$), the average progress in the study contributes insignificantly ($p\sim.15$) but according to adjusted lower R^2 and higher AIC in a model without this explaining variable should be kept in the model. Furthermore a high group value for openness to experiences leads to better results.

The planning procedure, the conscientiousness of the group and its perceived level of conflict for themselves have no influence on the outcome but their interaction has. Highly conscientious groups perform worse in integrative planning, which indicates that this planning procedure is adverse to their working habits. On the other hand high conflict level leads to better results in integrated planning. This procedure seems to be able to better handle conflict and transform it into valuable outcomes.

4 Discussion and Conclusion

The laboratory experiment reported in this paper was motivated by interest to find procedures that improve especially the quality of outcomes of building design processes. Literature argues that this can be achieved by integrated planning. However, first analyses of the results of our experiment did not support this general link, so we investigated the key success factors of collaborative planning process in more detail in this paper.

We found comprehensible positive effects of group experience (progress in the study) and skills (drawing-skill) and relevant personality traits average ‘openness for experience’, which enables more creative and novel outcomes. However, consistently with preliminary analyses we found no direct positive influence of integrated planning on the evaluation of the outcomes reached with this planning procedure.

What we found were two interaction effects with the planning procedure. On the one hand groups with high conscientiousness reach worse result with the integrated planning procedure; on the other hand groups that perceive a high level of conflict – or workload as these two measures were highly correlated as shown in Table 2 – reach better results with the integrated planning procedure.

What can be the reasons for these findings and what is their relevance for theory and practice? Integrated planning could interrupt an accomplishment of tasks in the form the highly conscientious group members prefer and therefore lead to inferior results. Furthermore, group think might undermine the identification of the participants with, and the feeling of responsibility for, the results achieved in the work group. It is therefore necessary to adjust the planning procedure to individual personality traits to avoid such effects e.g. by the use of IT (like building information modelling - BIM) in the group coordination, so that the different professions can work together in some phases of the planning process, but in others can focus on their own subtasks.

Concerning conflict and workload both are not for themselves negative to a work groups result, by contrast, if handled correctly a high workload can lead to a lot of work done and conflicts, if settled successfully lead to an integration of different perspectives and thereby maybe better results. This seems to be the case when high perceived conflict and workload are dealt with by integrated planning procedures. The easier interaction makes it easier to reallocate and coordinate work load in the group and also to exchange information and discuss different perspectives. Both can result in positive impulses for the resulting output. For practice it is necessary to establish a culture of positive conflict. Especially engineers – as a kind of a professional culture – often prefer to work within the restrictions of a given design, however, bringing in new ideas based on the specific expertise the profession contributes could lead to better results in an adequate planning procedure.

In planning projects where experts represent firms in inter-firm collaboration, the personality of the group members from different firms still has a significant impact on group functioning; however, organizational culture might be an influencing factor as well in such constellations. The existence and strength of this relation calls for future research.

The presented analyses focus on aggregate work group characteristics (average values over all members as measure for the whole group). Diversity might be a critical point with this regard. For group composition it is an interesting question whether the diversity between group members in demographics, background, experience etc. are rather beneficial or harmful to the success of the work group and whether different planning procedures can help to realize or avoid these positive or negative effects.

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