INDUSTRY CULTURE
IN CONSTRUCTION AND MANUFACTURING

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ABSTRACT

National cultures (Hall 1990; Hofstede 1980, 1998, 2005; Trompenaars 1998, 2003) have been extensively researched. The same holds true for organizational culture (Cameron / Quinn 2005; Peters / Waterman 1982; Schein 1985). Nothing similar can be said about industry culture. While values are shaped by national cultures, the practices of engineers are formed by environments such as apprenticeship, technical school, university, work, and of course also by organizations. Nowhere in this regard is the cultural influence of professions as easily detectable as in studying the medieval guild system (Mackie 1988; Wagner 1867). Looking at the three frameworks set by Hofstede (2005), Riley / Clare-Brown (2001), and Woodward (1965) we evaluate the professional culture of civil engineers and mechanical engineers. These cultures are as distinctively different as are their organizations, their management, and their technology. Cultural change is not possible without change in these respective environments.

KEYWORDS

Culture, Professional Culture, Construction, Manufacturing Industry

INTRODUCTION

Schein (1985, 6) has given a definition of organizational culture that is as well applicable to professional culture: “The pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to these problems.” Outside and inside pressures form a professional culture in a similar way to an organizational culture. There are, however, different forces at work coining either a professional or an organizational culture. The two cultures that we are comparing are the construction and the manufacturing culture represented by an automobile producing company. We are using the words professional and industry culture as synonyms.

Technology and culture

Production in construction has often been described as project based unit production, contract production, and on-site production. Manufacturing is inversely characterized by mass production, stock production, and factory production (Barrie / Paulson 1992). Comparing this with the different technologies proposed by Woodward (1965), construction belongs to group I/II: unit production of technically complex units one by one. Manufacturing of consumer goods would be part of group II/VII: mass production. The ensuing industry cultures are given in table 1.
For the construction industry we would therefore expect an organic structure with flat hierarchies, a medium span of control, little administration, little formalization, and little centralization, all tied together by a high degree of verbal communication. The organizational dimensions of manufacturing industries are just the opposite and making the two industries an ideal pair for comparison.

Organizational Dimension	Unit Production	Mass Production
Levels of management	3	4
Span of control	23	48
Administrative ratio	low	medium
Formalization of written communication	low	high
Centralization	low	high
Verbal communication	high	low
Overall structure	organic	mechanistic

Table 1: Technology and organization (Woodward 1965)

Industry and culture

Riley / Clare-Brown have found that different manufacturing industries show similar cultures (2001), yet this group does not include continuous process production as in the chemical or oil industries (group III in Woodward's typology).
Results of the research by Riley /Clare-Brown (2001) are given in table 2. The authors found differences between an automobile manufacturer and a brewery to be negligible. However there are five categories with significant differences between a construction company and the group of the two manufacturing companies.

Organizational Dim.	Construction	Manufacturing
Culture	- not well defined - two cultures: headquarter vs. projects - company philosophy is not known on project level	- well defined - more innovative values - company philosophy is well known
Communication	- the voice of each employee is valued	- employees have no voice
Technology	- technically not very innovative	- technically more innovative
New products/processes	- little awareness	- high awareness
Structure	- steep hierarchy - not well known to everybody	- flat hierarchy

Table 2: Technology and organization (Riley / Clare-Brown 2001)

There is one remarkable difference between the two tables: one predicts a flat, the other one found a steep hierarchy in construction. It seems that this can be tied to the questionnaire used by Riley/Clare-Brown. They add the hierarchy on the project level with all subcontractors to that of the headquarter. Their description is not convincing at this point. There is little further research on comparative studies between industry cultures including the construction industry. Riley/Clare-Brown do not list a single source.

Dimensions of industry culture

A third framework for evaluating industry culture was proposed by Hofstede (2005). He uses four pairs of opposites: process vs. result orientation, organizational vs. professional culture, weak vs. strong control, normative vs. pragmatic approach. We assume, as a hypothesis that the construction industry has a result orientation with strong controls, is professional and pragmatic. The meanings and connotation of these labels are given in table 3. We feel that "strong controls" is an unfortunate choice of wording, yet the meaning ascribed by Hofstede to this label is understandable.

Cultural Dimension	1	2
(1) Process vs. (2) result orientation	- means oriented - risk avoidance - limited personal input - repetitive tasks	- goals oriented - risk acceptance - high personal input - changing tasks
(1) Organizational vs. (2) professional	- norms of the organization are universal - identity is provided by organization - family life is important - personally short term orientation	- private life and business life are separate - task competence is important - personally long term orientation
(1) Weak vs. (2) strong control	- costs are unimportant - meetings do not commence on time - many jokes about the company and work	- cost oriented - meetings are on time - few jokes about the company and work
(1) Normative vs. (2) pragmatic	- keeping the rules - keeping the procedures - dogmatic view of ethics	- customer orientation - result is more important than procedures - pragmatic view of ethics

Table 3: Dimensions of industry cultures (Hofstede 2003)

We will use these described three frameworks (Woodward, Riley/Clare-Brown, Hofstede) to evaluate the results of our independently conducted research. They provide the hypotheses against which our research is evaluated. It needs to be stressed that we only looked at the theory after obtaining and interpreting our data. This is a standard procedure when using grounded theory (cf. methodology) to gather and evaluate data. It serves the purpose not to "contaminate" the data analysis by preconceived ideas.

Hofstede makes an additional important point when illustrating that there is a change in emphasis when comparing national, industry and organizational culture: the shift is from values to practices (cf. fig. 1). An industry culture shows accordingly an equally weighted set of values and practices. When comparing the construction with the manufacturing industry, we are looking for differences in values and practices.

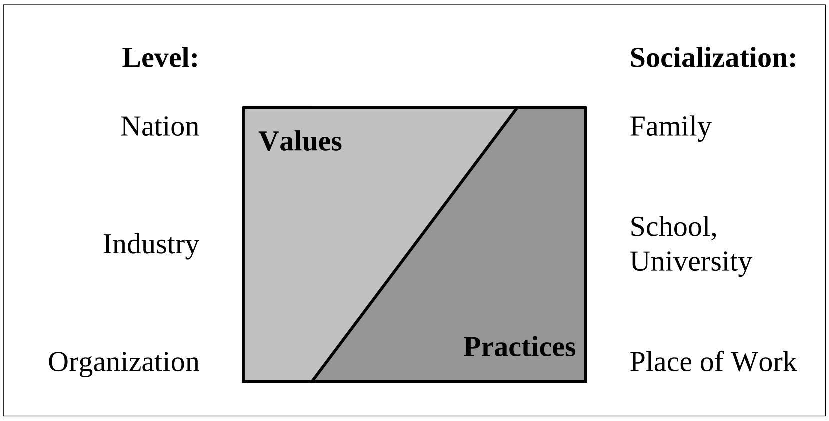

Fig. 1: Values and Practices at Different Levels of Culture

External environments

If culture is the "software of the mind", then the environment is the programmer. How different are the environments in the construction and the automobile industry? This can be organized into two lines: input criteria and process criteria.
The inputs are labor, materials, and plant. For Germany the percentage of the total cost are 58% (construction) vs. 19% (automobile) for labor costs, 26% (construction) vs. 67% (automobile) for material costs, and 2% (construction) vs. 4% (automobile) for plant depreciation (Dstatis 2004). The remainders are other costs. In sum, construction is by this comparison three times as labor-intensive, 0.4 times as material-intensive, and 0.5 times as plant-intensive as the automobile industry.
The different process criteria are: site construction vs. assembly line production, mechanized vs. automated construction, discontinuous vs. continuous production, unit vs. mass production.
It is evident that many of these criteria form the basis for the framework of Woodward, but they also have an influence in the other two.

METHODOLGY

We have conducted ten interviews in the construction industry and ten in the automobile industry. The construction companies were either mid-size companies in Bremen or subsidiaries of large-size companies in Germany. These produce the full range of construction projects: residential, building, industrial and heavy civil construction. The automobile company is one of the well-known German high-class automobile producers. In Bremen they assemble sports cars.
The hierarchical rank of the interviewees were as follows: two branch managers (construction) and three division heads (automobile); five construction managers and four team managers (automobile); three specialists (both in construction and automobile). Since we compare large to mid-size construction companies with a global automobile producer we have taken the different organizational hierarchies into account and al-

lowed for a shift in rank to arrive at the pairs above.
The interviews were partially structured. The answers have been evaluated statistically where possible, otherwise by using grounded theory.
A word is required at this place concerning the German university system. Civil engineers work in the construction industry, mechanical engineers in the automobile industry. Construction engineering management (CEM) is taught as a part of civil engineering programs, not separately. Everybody shares in the same basics and specializes later in some areas. The same holds true in a different context for mechanical engineers. The label “civil engineer” includes CEM, “mechanical engineer” automobile design and manufacturing. Many engineers have gone through an apprenticeship before entering into the universities. In our sample this holds true for six interviewees in civil and four in mechanical engineering.

RESULTS

The results are presented in two parts, first quantitative and then qualitative results.

Quantitative results

The first set of questions pertained to the characteristics of civil or mechanical engineers (Question 1: What characteristics should a civil/mechanical engineer typically have? Question 2: What characteristics apply to you?). There was a list of possible answers in four categories:

- way of thinking (rational, innovative, flexible, analytical)
- behavior (considerate, polite, direct, firm)
- interaction (team-oriented, open for conflicts, communicative, fair)
- purposefulness (motivated, consistent, committed, ambitious)

The results are given in table 4. The respondents were asked to choose five characteristics out of the set of 16, and to weigh these from high (5) to low (1). Since there were ten respondents in each group, a maximum value of 50 (5x10) could be reached in theory.
The data obtained by these questions are about values not practices. Civil and mechanical engineers are different with regard to their values. There is quite a variance between the idea how things should be (question 1) and how they are (question 2). This is definitely more pronounced for mechanical than civil engineers. The sum of all deviations is (22 + 8 + 28 + 4 = 62) for civil and (46 + 8 + 38 + 5 = 97) for mechanical engineers. Civil engineers perceive themselves to be markedly closer to their ideal.
Most important for engineers are: Analytical thinking (36), innovativeness (23), team orientation (19), and commitment (17). The order for mechanical engineers is: Analytical thinking (44), innovativeness (27), and rationality (16). Most of these characteristics belong to the group “way of thinking”
Behavior does not play a role for either of the two groups.
Interaction is important and civil and mechanical engineers have a “better” view of themselves compared to the norm. They are more team-oriented (+5/+21), more communicative (+19/+4), and fairer (+3/+12).
Purposefulness is also important with commitment being in the top spot for both groups. In this part there are the smallest deviations between ideal and actual perceptions.
Most predominant in the perception of actual values of civil engineers are: Analytical

thinking (34), team orientation (24), communication (21) and commitment (17). For mechanical engineers the order is: Analytical thinking (35), team orientation (31), fairness (12), and communication (11). While civil and mechanical engineers have quite a few values in common, there are also differences.
The biggest differences are that civil engineers see themselves as more communicative (+10), more flexible (+9), not as fair (-9), less team-oriented (-7), more engaged (+7), more motivated (+6), and less consistent (-5).

Category	Civil Engineers		Mechanical Engineers	
	Question 1 (others)	Question 2 (self)	Question 1 (others)	Question 2 (self)
Way of Thinking				
Rational	8	2	16	2
Innovative	23	9	27	7
Flexible	13	13	1	4
Analytical	36	34	44	35
Behavior				
Considerate	0	5	5	8
Polite	0	0	0	2
Direct	0	1	0	0
Firm	2	0	6	3
Interaction				
Team-oriented	19	24	10	31
Open for Conflicts	7	8	6	7
Communicative	2	21	7	11
Fair	0	3	0	12
Purposefulness				
Motivated	8	10	4	4
Consistent	6	5	7	10
Committed	17	17	10	10
Ambitious	4	3	1	3

Table 4: Evaluation of Characteristics for Civil and Mechanical Engineers

The data of table 4 are presented in the following two bar charts. The first one (fig. 2) depicts the comparative results for the perceived ideal characteristics (question 1). The second (fig. 3) illustrates the results of the perceived actual values (question 2). The differences between the two groups of engineers are evident. The graphs include only values of 10 or higher for either of the two groups.

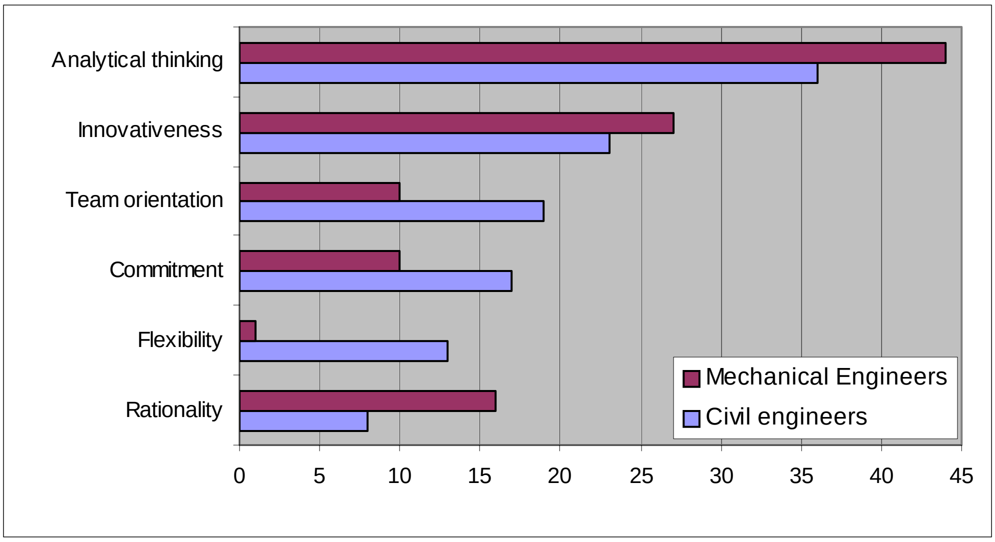

Fig. 2: Ideal Characteristics of Civil and Mechanical Engineers

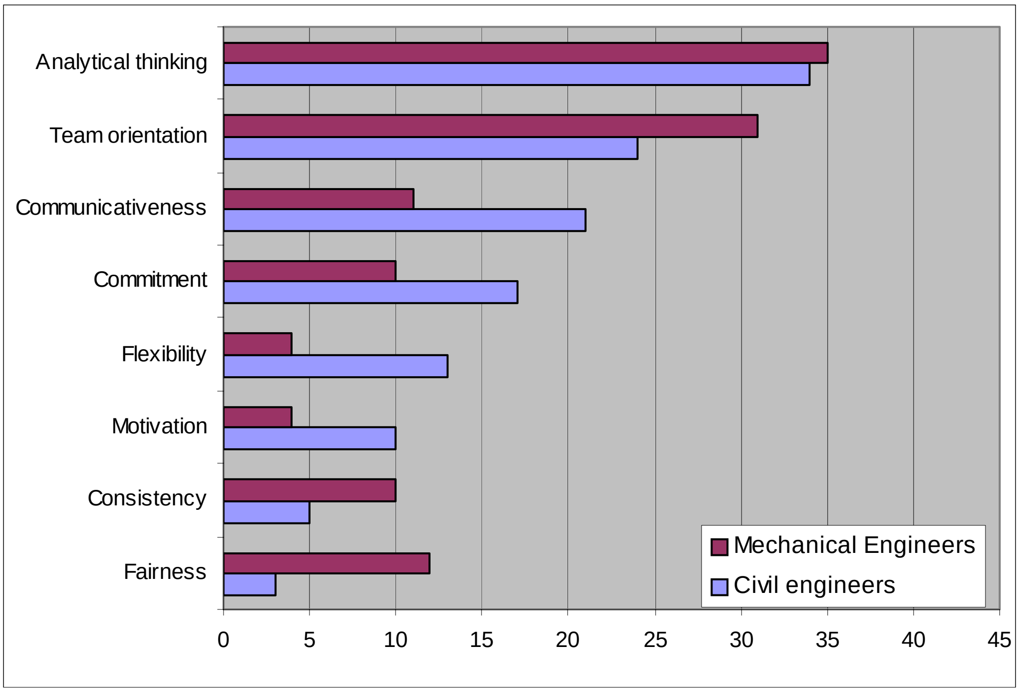

Fig. 3: Perceived Actual Characteristics of Civil and Mechanical Engineers

Qualitative results

- Ethics are deemed to be important to both groups of engineers. Yet civil engineers see a close connection between ethical behavior and the attainment of career goals.
- Identification: Mechanical engineers identify themselves strongly with their company, civil engineers identify themselves strongly with their work as civil engineers, i.e. their industry.
- Motivation: Most motivating for civil engineers is a good place of work. Both groups thrive with the idea that they add value with their own work. Civil engineers hate administrative tasks, mechanical engineers leadership problems.
- Hierarchy: There is a stronger hierarchy felt by mechanical engineers. They make often use of the slogans of their company.

- Satisfaction: Important for the satisfaction is for both groups constructive teamwork and a well functioning organization.
- Uncertainty: Both groups do not enjoy living with uncertainty.
- Controls: The upper echelons in the automobile industry see controls as positive, all the other engineers as negative.
- Job descriptions: They are prevalent for mechanical engineers, non-existent for civil engineers.
- Culture: Mechanical engineers define this as the way they deal with each other, i.e. as their company culture. Civil engineers think of music or art, i.e. they do not have such a concept.

While the quantitative data have provided insights into the differences in values, the qualitative ones provide mostly explanations for different practices.

EVALUATION OF RESULTS

First and most important of all, our data reconfirms strongly that there are significant cultural differences between the construction and the manufacturing industries, both in values and practices. Based on the previously given definition by Schein (and in accordance with the overall discussion on culture) we tie these differences to two distinct external and internal environments.

- Woodward: The data confirm the observations by Woodward with regard to structure of the organization. Since we were not looking specifically at structure, not all points were touched, however. The fewer levels of management (a flatter hierarchy), less formalization, less decentralization, the importance of verbal communication, and a more organic structure could be validated for the construction industry.
- Riley / Clare-Brown: Their observations are only partially proven correct: The culture in construction companies is less defined; the company philosophy is little known, verbal communication is very important. A sharp difference can be found for the levels of hierarchy. The statement that construction companies have a steeper hierarchy than automobile manufacturers is not corroborated. Riley / Clare-Brown make according to their paper the mistake to compare a multi-organizational construction project with an automobile company. While it is understandable that the multi-organizational project indeed has a steeper hierarchy (if following the line of command from the project to the head of the construction company), this does not hold true for the construction company. In addition there are scant differences with regard to innovativeness in our data. Civil engineers place the normative value a little lower (23 vs. 27), yet the actual value higher (9 vs. 7) than mechanical engineers. Striking here is the disparity between norm and actual value. It is significantly higher for the automobile industry (20) than for the construction industry (14). There seems to be a lot more talk about innovativeness in both industries than fact, much more so in the automobile industry. An explanation can be found in the structures of the automobile industry. There are design departments responsible for an innovative product. Everybody identifies with this product, but the engineers in production are not asked for further innovation but for controlled quality.
- Hofstede: Again, having conducted a partially structured interview, we have not obtained data to all the dimensions given by Hofstede. The ones we have fit well into his framework and let us conclude that construction companies have a result

orientation, are professional with “strong controls” and a pragmatic approach. Automobile companies have a process orientation, are organizational with “strong controls” and a normative outlook.

This evaluation is based on the dichotomy high personal input, changing tasks (construction) vs. limited personal input, repetitive tasks (automobile) for process or result orientation. The mechanical engineers accepted the norms of their organization and identified with it (organizational culture), civil engineers do neither but they identify with their work (professional culture). Both groups stress adding value with their work, which signifies what Hofstede calls “strong controls”. In the automobile industry keeping the rules (job descriptions) and a dogmatic view of ethics are prevalent (normative culture), in the construction industry ethics are pragmatically treated as a way to advancement (pragmatic culture). Overall our hypothesis of culture in construction has been validated.

CONCLUSION

Dealing with external and internal pressures, engineers in construction and automobile companies have developed different cultures. This fact shows up when comparing the values and practices of the two groups. The differences in the environments and cultures are summarized in table 5.

Construction industry	Automobile industry
Environment	
Higher labor intensity	Lower labor intensity
Lower material intensity	Higher material intensity
Lower plant intensity	Higher plant intensity
Site production	Assembly line production
Mechanized production	Automated production
Discontinuous production	Continuous production
Unit production	Mass production
Structure	
Fewer levels of management	More levels of management
Not formalized	Formalized
Decentralized	Centralized
Much verbal communication	Little verbal communication
Organic structure	Mechanistic structure
Culture	
Not well defined	Well defined
Highly communicative	Little communication
Result oriented	Process oriented
Professional	Organizational
Pragmatic	Normative

Table 5: Differences in environment and culture between construction and automobile industries

The purpose of the paper is to be a starting point for further research. While it gives strong indications of different cultural values of civil and mechanical engineers, its base is too small. If these cultural differences are accepted, we would need research on the implications for projects where both groups work together, such as in the oil industry.
The data are gathered for both groups from German companies. The companies are located in the same city and interviewees hold comparative ranks within their respective organizations. More important, the data are mostly conclusive with previous research. Where this does not apply, we found good alternatives as explanation.
In a joint endeavor by the CIB task group data are collected around the world describing the construction industry. The instrument used is the OCAI-questionnaire by Cameron / Quinn (2005). It would be interesting to see, if our results could be confirmed when using this questionnaire within the automobile industry.

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