

MEASURING CULTURE IN PRODUCT
DEVELOPMENT TEAMS:

development of an attribute
inventory method

by

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Submitted to the Department of Mechanical Engineering in
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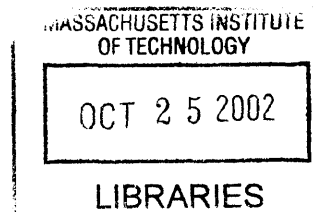
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ABSTRACT

Product development teams are increasingly valued as an essential component of successful businesses and institutions. As a result, teams have been studied in many disciplines, including psychology, social-psychology, organizational behavior, and business to explore what enables one product development team to perform better than another. Organizational culture has been recognized to be a significant factor driving organizational and product development performance, but the role of individual product development team culture has gone relatively unexplored.

A method for measuring product development team culture is needed that provides rapid, consistent cultural information and allows for comparison from one team to another. However, traditional tools used to understand culture, such as encyclopedic ethnography and narrative ethnography are time consuming and generate results that cannot be easily compared.

This thesis details the development of an attribute inventory method for measuring product development team culture. The attribute inventory method is a novel structured observation method using a coding scheme of attributes to record cultural information using a collection attributes, measurement scales, and specific definitions. This method allows researchers to generate cultural information about product development teams that is comparable and consistent, and can be collected rapidly by agents with minimal formal training.

The method fulfills the needs of researchers seeking to study product development team culture by providing a structured tool that can be used to rapidly generate comparable cultural information about different product development teams. It also facilitates the study of cultural attribute interaction, the interaction of product development team culture and organizational culture, and the impact of attributes on team performance.

Thesis Supervisor: David Wallace

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4. GLOSSARY

Agent: The individual or group whose purpose is to conduct the investigation into the culture of the *subject* individual or group.

Attribute: an item that, when quantified, describes an aspect of culture in a product development

Attribute Inventory Method (AIM): an efficient, systematic structured-observational method for measuring cultural information in product development teams using cultural attributes.

Culture: the set or system of common understandings that are manifest in beliefs, attitudes, acts and artifacts, and which are learned by members of a society (Redfield 1962).

Environment: understood to include all forces and activities external to the business organization, including but not limited to economic, political, military, national, religious, ethnic, technological, moral forces.

Factor: any object, person, practice, or mechanism that has an effect on the culture of a product development team.

New product development (NPD): a discipline of business education and study that is concerned with the leadership, management, and structure of product development teams and activities.

Organization: a collection individuals, usually in groups, organized to accomplish tasks external to the needs of the individuals or group itself, often possessing an administrative and functional structure.

Product: a physical object, substance, service, or idea created to satisfy a perceived customer need, market niche, or environmental necessity.

Product development (PD): the activity of transforming a perceived need or idea for a good or service into reality.

Product development process (PDP): a systematic method for transforming a perceived need or idea into goods or services, usually including needs assessment, concept generation, concept selection, detail design, prototyping, testing and modification, design of production, manufacturing and distribution, and service and disposal.

Service: An act or activity designed to satisfy the needs of an individual or group that produces no tangible product.

Subculture: a group exhibiting characteristic common understanding sufficient to distinguish it from other groups within an embracing common culture.

Subject: The individual or group whose culture is the target of an inquiry, usually conducted by an *agent*.

Team: a collection of individuals formed to complete specific tasks in concert.

5. INTRODUCTION

Humans have been engaged in product development for over 2 million years, though most anthropologists and archeologists have called it tool making. In the last 50 years the illusion that we are the only tool *users* has been shattered, but the activity of tool *making* seemed to be something that we, as humans, still did uniquely. Yet gorillas have been taught how to use sign language (Patterson and Bonvillian 1997), and several aquatic mammals, such as orca and dolphins use language as well (language being understood as a specialized communication tool) (Whitehead 2002). Pods of orca have even been shown to possess distinct cultures, practicing non-essential behaviors unique to their groups (Center for Biological Diversity 2002). Birds build highly complex nests, and the certain ant species ants of the Brazilian outback collect leaf cuttings to feed fungi that they grow as food (Tabor 1998). But using a tool, as these animals do, is far different from the activity of making tools. We have learned that chimpanzees, our closest genetic relatives, routinely make tools, forming sticks to extract termites from their nests and shaping stone tools to crack open nuts (Matsuzawa 1994). Tool-making in New Caledonian crows was reported on August 9, 2002 in the journal *Science*, demonstrating for the first time that tool making can be found outside of higher primates (Weir, Chappell et al. 2002). Still, this tool-making capacity as it is currently understood, is confined to three species out of the roughly 30 million species currently living on the earth (Capobianco 2002). Clearly this is something difficult, special, and rare.

Tool-making in humans is first documented in modern-day Ethiopia, and we have the artifacts of stone hand-axes created over 2 million years ago at the beginning of the Pleistocene period (Kowalski 2002). Though the process of tool-making in humans has come a long way from the beginning of chipping rocks to make knives, axes, arrowheads, and spears, it is still one of the most difficult activities undertaken by people, groups, and organizations in the world, as we will see below.

The difficulty of creating successful tools, or products, is evidenced by the high failure rate of new products in the marketplace. Over 40% of new consumer products are considered a failure. Of industrial products, 20% fail, and service products fail 18% of the time. If updates of current consumer products are considered, the failure rate increases to over 80% (Kotler 2002). With all of tool-making experience that has been accumulated over the past 2 million years, clearly this is not a well-understood task.

Part of the challenge of product development is that the environment in which products compete is dynamic and unpredictable. The effects of cultural, political, economic, and technological forces profoundly change the environment that products must be adapted to in order to survive.

And yet some products do survive, and others, beyond just surviving, thrive marvelously. Even more exceptional are the individuals, groups, and organizations that are able to adapt to the changing global environment and bring out successive successful products time and again in an environment that is shifting rapidly around them.

Beyond just being exceptional, the individuals, groups, and organizations involved in product development are the creative fuel for many of companies and institutions, and are responsible for a significant portion of the creation of wealth in the world. When the idea of a product is extended to include not only physical, manufactured goods but also services, including education, the scope of product development becomes large and the significance of its success profound.

This thesis is an effort to better understand the product development process, in particular, how to measure the unique culture that exists in a product development team. Significant effort on the part of business and academia since the beginning of the 20th century has increased our understanding of the product development process, and this effort has yielded significant results. The ability of many companies to release successful products in 6-month cycles is a tribute to the efficiency and efficacy of the modern product development process. Research into workgroup psychology, concurrent engineering, management and leadership science, trade-off analysis, and many additional topics has formed foundations this modern product development process.

5.1. MOTIVATION

The study of product development and the product development process has previously been concerned with issues such as leadership, decision-making, individual and group psychology, and work processes. Since the early 1960's the organizational culture that exists in businesses has been recognized as one of the critical contributors to success or failure (Case 1996). An area that has received relatively little attention is the culture that exists in product development teams. The culture in product development teams encompasses the set or system of common understandings that are manifest in beliefs, attitudes, acts and artifacts, and which are learned by members of the team (Redfield 1962). This thesis is an attempt to determine an inventory of attributes that contribute to and describe the culture in a product development team. Using this attribute inventory method, an individual or group is able to capture the culture of a product development team in a form comparable to other product development teams. Using methods already developed for capturing organizational culture (Robbins 2000, 513), the product development team culture measured using the attribute inventory method could be compared to organizational culture and environmental culture for the purposes of exploring constructive and destructive interactions, and their effect on performance. Finally, product development team cultures could be understood as a number of archetypal cultures: models of product development team culture of which all unique team cultures are but more specific variants. This archetypal classification would allow rapid identification of team culture, facilitate efficient comparison of product development team cultures, and improve the understanding of group-organization cultural interaction without having to treat each product development team as wholly unique.

The product of this thesis, the attribute inventory method for measuring product development team culture, will improve upon psychological, social-psychological, and anthropological methods used previously to measure culture in other contexts. The methods used by psychology and social psychology researchers include controlled-variable experiments, surveys, structured and semi-structured interviews, and case studies, but these methods have not been used to capture cultural information in general or product

development teams in particular. The methods used for capturing cultural information by anthropologists include encyclopedic ethnography and narrative ethnography. These methods are time consuming (in the context of 6-36 month product development cycles) and suffer in comparability and replicability of measurements. The attribute inventory method is a semi-structured interview method designed to efficiently capture cultural information that is easily replicable and comparable, without the use of highly trained ethnographers.

5.2. RESEARCH CONCEPT

The aim of thesis, and the work described herein, was to develop a structured method for measuring product development team culture in an efficient, systematic fashion, that minimizes agent and subject bias. This method is called the attribute inventory method (AIM). The purpose of measuring this cultural information is to allow cultural comparison of product development teams, facilitate research into interactions between the group and the organization and between the group and the environment cultural interaction, and to understand the impact of these interactions on product development team performance.

The first step in developing the attribute inventory method was to identify the attributes that are relevant to product development team culture. Because product development team culture varies with the larger cultures of the environment and the organization that surround the team, it is technically a subculture, and will in general reflect the most outstanding aspects of the organizational and environmental cultures that surround it. Because national culture tends to have larger effect on employees than organizational culture (Adler 1997, 61-63), the relevance of this study must be confined to product development teams within the USA, since even Canada, which might be assumed to reflect similar national culture as the USA, differs sufficiently from the USA in measures of power distance, individualism, quality of life, uncertainty avoidance, and long-term orientation to warrant separate treatment (Hofstede 1993, also see Table 8-1).

To identify attributes, a semi-structured interview method was used to collect data from individuals with significant experience working on product development teams as members, direct managers or leaders, or high-level managers. Highly structured sequences were used to obtain standard factual biographical material. To collect cultural information, which has a high degree of structural variability, a branching topic method was used, with cues for the agent to guarantee coverage of all items (Cliff, Sparks et al. n.d.). The subjects were then asked to evaluate any attributes that they did not comment on either explicitly or implicitly in the course of the interview.

Next, the interviews were transcribed from recordings and analyzed for attribute content. This analysis consisted of documenting explicit and implicit descriptions used by the subjects to describe the product development teams and team cultures in which they had participated, as well as the subject response to the attributes presented in the latter half of the interview. Implicit descriptions were those descriptions that the agent perceived the subject to be making, but were not explicitly named by the subject. New attributes mentioned by the subjects were also recorded.

This list of initial and new attributes was then aggregated and analyzed for recurrence and strength of descriptions. Those attributes that were described more often, in greater detail, and accorded more importance by the subjects were accorded higher significance scores in the analysis process. The higher ranked attributes were considered the primary descriptors of product development team culture, and were organized to form the attribute inventory that is the result of this thesis.

6. PROBLEM DEFINITION

Create a structured method for sampling product development team culture that is accurate, complete, consistent, allows for comparison, minimizes the impact of agent and subject bias, and is rapid enough to match the pace of product development.

Accuracy refers to the congruence between the sampled culture and the “true” culture of the product development team.

Completeness refers to the agreement between the attributes measured by the attribute inventory method and the complete set of attributes that would be required to fully describe the “true” culture of the product development team.

Allow for comparison refers to the repeatability of the study, so that the same product development team sampled by two different agents, or two product development teams sampled by the same agent, would all be sampled consistently.

Minimal agent and subject bias refers to the degree to which the culture and assumptions of the agent and subjects divert the accurate sampling of the product development team’s culture.

Rapidity refers to the speed at which a sample of product development team culture can be taken.

7. BACKGROUND

To understand and study of product development team culture, several definitions and areas of research are relevant. The field of organizational behavior (OB) has developed substantial research on the psychology of work groups and work teams, including theories of individual motivation, leadership theories, and stages of group development. We will also explore a definition of culture, the differences between psychological and cultural inquiry, differences between product development teams and other teams, the product development process, measuring of product development team performance, and factors influencing product success.

7.1. A DEFINITION OF CULTURE

Culture is an elusive term, explained in the field of anthropology by theories such as diffusionism, cultural evolutionary theory, ecological-adaptive theory, structural-functionalism, historical-particularism, and symbolic/mental-construct theory. Despite all of these theories of culture, a stable definition for the term has been and continues to be elusive. By 1952 A. L. Kroeber and Clyde Kluckhohn had accumulated over 100 different definitions for the word (Kroeber and Kluckhohn 1952).

In this study I have chosen to use a definition of culture written by the anthropologist Robert Redfield, adapted to the study of product development teams.

Culture in product development teams encompasses the set or system of common understandings that are manifest in beliefs, attitudes, acts and artifacts, and which are learned by members of the team.

(Redfield 1962)

It is important to recognize that culture can often be largely held in the unconscious. Similar to grammar, people follow the “rules” of culture, often unconsciously, but if pressed to explicitly define the rules they follow, would be hard pressed to do so without resorting to example and counter example. Even then, the agent attempting to learn about culture from a subject explaining the “rules” must cautiously view this information as just another piece of data (Agar 1996, 237).

Culture in product development teams must further be understood to be a subculture of both the environmental culture and the organizational culture that surrounds the product development team. As a subculture, it will, in general, take on the core cultural values of the embracing environmental and organizational cultures, usually in that order. It may add additional cultural values that do not conflict with the embracing cultures and it can also possess cultural values in opposition or conflict with the embracing cultures. The assumption that product development team culture would not possess cultural values that conflict with its embracing cultures has long been an assumption of product development

team research in organizational behavior. One of the original studies of group effects at the Hawthorne plant of the Western Electric Company in the late 1920's found that some groups enforced norms (an aspect of culture that is explored in Section 8.2.6) about work behavior that were consistent with organizational norms while other groups did the opposite (Roethlisberger and Dickson 1939). The study made no attempt to explain the mechanisms of the deviant groups, and the assumption in the field of organizational behavior that groups will inherit and follow the core beliefs and practices of the parent culture has persisted ever since.

This study does not assume that team culture will be a pure subculture of either the organizational or environmental culture. The potential for variation in product development team culture and the unknown quantity of interaction effects between product development teams and both the organization and the environment make this topic worthy of study, and is a strong motivation for this research.

7.2. DIFFERENCES BETWEEN PSYCHOLOGICAL AND CULTURAL INQUIRY

In general, inquiry into organizations and organizational behavior has been conducted by psychologists, sociologists, and social-psychologists. Only recently have anthropologists applied the tools of ethnography to organizational studies. Psychology and sociology have contributed to the understanding of group behavior in formal complex organizations, group dynamics, design of work teams, formal organizational theory and structure, communications, power and conflict, and studies of change behavior. Another discipline that has made attempts to understand group behavior is anthropology, which has contributed to the current understanding of organizational culture, environments, and national differences that can affect tactical and strategic decision-making (Robbins 2000).

The study of work groups and work teams, has, for the most part, been the domain of psychology. As a result of this, very little cultural orientation is found in the generally accepted theories of group behavior. Recently, awareness of national cultural differences has thrown into question many of the generally applied theories of leadership and management developed in Western countries, and particularly in the USA, where strong individualism, low power distance, high quantity of life, low uncertainty avoidance, and short-term orientation differentiate it from many of the cultures in which these management and leadership theories might be applied (Hofstede 1993).

Psychological and sociological methods employ controlled experiments, surveys, structured and semi-structured interviews, and case studies. These methods, in combination with statistical analysis, have enabled human systems to be subject to traditional hypothesis testing, providing for testing and validation of organizational behavior theories. The weak point of these methods is that they are unable to accommodate highly complex systems, and can only test a small number of variables at one time.

In anthropology, the techniques of encyclopedic ethnography (where the agent seeks to identify universal cultural rules and document variance) and narrative ethnography (where the agent documents specific events and constructs a snapshot of a culture in time) provide a rich description of highly complex human systems (Agar 1996, 8). There are few

mechanisms for validation in these ethnographic methods, because the subject group is unique in time and both the agent and subject bias are incorporated into the results. Also, the time required to produce an encyclopedic ethnography varies from one to three years, on average.

7.3. PRODUCT DEVELOPMENT TEAMS VS. OTHER TEAMS

A work team is a group of individuals brought together for the purpose of collective performance, with the potential for synergy through complementary skills. This immediately differentiates work teams from work groups, which are also a collection of individuals, but differ in that the purpose of gathering is to share information to allow each individual to complete their own work (Kinlaw 1991).

A product development team is a particular type of work team. Product development teams are usually cross-functional. Functions refer to the traditional technical departments that used to dominate technology-business organizations. By bringing individuals from different technical departments together in a focused team the intention is to allow information to be shared between the technical disciplines early in the product development process. This is important because the decisions made early in the product development process have the greatest effect on the success of the product and also strongly affect the cost of development and production (Ulrich and Eppinger 2000). By involving all of the disciplines that will have to deal with the product throughout its lifetime, from concept to retirement and recycling, product development teams seek to incorporate the viewpoints and wisdom of the departments in making a more successful product.

Product development teams are unique in the business world because they usually involve a representative from all functions of the organization at one time or another in the lifetime of the product. In product development organizations the products that a business produces are usually the primary revenue source, therefore all disciplines have interest in and responsibility for the successful product development. Indeed, finance, sales, legal, marketing, purchasing, service, industrial design, mechanical design, electrical design, and manufacturing disciplines all play a part in development of a successful product (Ulrich and Eppinger 2000, 5).

Because of the large amount of coordination required to design and produce a finished product, product development is recognized as one of the most difficult business activities. Of new product developed, 40% will fail, and when revisions of existing products are included, the failure rate rises to 80% (Kotler 2002). What makes product development difficult are a number of very challenging tasks and environmental conditions, which include trade-offs, the dynamic nature of the market, the requirement for detail orientation, time pressure, and the large investments required to conduct product development. Nevertheless, the appeal of product development is powerful as well. It is a creative act that has the potential to satisfy societal and individual needs, it is a team-oriented activity, and may evoke strong feelings of camaraderie from the team members involved. (Ulrich and Eppinger 2000, 6-7).

7.4. THE PRODUCT DEVELOPMENT PROCESS

Humans have been making tools and other products for over 2 million years (Kowalski 2002), however the structured process used today to create products is a much more recent development. The product development process is a series of steps that organizations use to transform a perception of a customer need into a product design, and finally into a product that is suitable for consumption by the customers whose needs were perceived in the first place. The product development process is broken into 10 steps (Dally, Schmidt et al. 1998, 35; Ulrich and Eppinger 2000, 16).

- 1) **Planning**
- 2) **Problem definition**
- 3) **Concept development**
- 4) **Concept selection**
- 5) **System-level design**
- 6) **Detail design**
- 7) **Testing and refinement**
- 8) **Production ramp-up**
- 9) **Distribution**
- 10) **Revision, service and disposal**

Most product development organizations follow some version of this process, though it may be documented differently or not at all.

7.5. MEASURING OF PRODUCT DEVELOPMENT TEAM PERFORMANCE

Developing successful products, as we have seen, is a complex and challenging task, that with great effort, produces successful new product only 40% of the time (Kotler 2002). This statistic tells us about the success of the products, but is product success the same as product development success?

Viewed from the perspective as a business activity, the purpose of product development is to create a return on investment superior to that which could be had by using the money in an organization in other ways. To create this return on investment, companies attempt to create products that can be produced and sold at a profit. The factors that most often influence profitability in products are product quality, product cost, development time, development cost, and development capability (Ulrich and Eppinger 2000, 2-3).

- **Product quality** refers to how well the product satisfies customer needs. This usually involves robustness, reliability, and value. The extent to which the product satisfies customer needs is reflected in the market share and selling price of the product.
- **Product cost** refers to the manufacturing and materials cost of the product, including fixed costs in equipment and overhead as well as the variable cost of the materials used in the product.
- **Development time** refers to time required for the product development team to complete the product development process. In general, the company that brings a given product to market first will enjoy an advantage in price and market share, so long as product quality has not suffered too much in the effort to bring the product to market quickly.
- **Development cost** refers to cost incurred in the product development process. This can be a significant portion of the investment in the product development process, varying from tens of thousands to billions of US dollars.
- **Development capability** refers to the experience gained by the team as result of the product development project that was undertaken, and is can be indication of future success in similar products and product development in general.

7.6. FACTORS INFLUENCING PRODUCT DEVELOPMENT SUCCESS

Having defined the measures of new product development success above, we now ask, what makes one product successful where others fail? Or more appropriately, what makes two out of every five new products fail, and four out of five new and revised products fail? Henard and Szymanski (2001) created a meta-analysis of 60 empirical studies that documents the statistical relationships between the proposed antecedents of new product performance and actual new product success. Out of the 24 initial predictors, 11 were found to be dominant drivers of performance, and are listed below in order of significance.

- **Market potential:** anticipated growth in customers/customer demand in the marketplace.
- **Dedicated human resources:** focused commitment of personnel resources to a new product initiative.
- **Marketing task proficiency:** proficiency with which a firm conducts its marketing activities.
- **Product meets customer needs:** extent to which product is perceived as satisfying desires/needs of the customer.
- **Product advantage:** superiority and/or differentiation over competitive offerings.
- **Predevelopment task proficiency:** proficiency with which a firm executes prelaunch activities (e.g. idea generation/screening, market research, financial analyses).
- **Dedicated R&D resources:** focused commitment of research & development resources to a new product initiative.
- **Technological proficiency:** proficiency of a firm's use of technology in a new product initiative.
- **Launch proficiency:** proficiency with which a firm launches the product/service.
- **Order of entry:** Timing of marketplace entry with a product/service.
- **Product technological sophistication:** perceived technological sophisticated (i.e., high-tech, low-tech) of the product.

Thus, the organizations and teams that concentrate their effort in executing these aspects of product development to the best of their ability will, according to the results of Henard and Szymanski, have the greatest chance of success. This is no small task, but for product development organizations committed to succeeding, it is the task at hand.

7.7. LESSONS FROM ORGANIZATIONAL BEHAVIOR

The fields of organizational behavior and work psychology have contributed significantly to our understanding of individual motivation, leadership and group development. To understand product development teams and the processes of cultural development in those teams it is important to understand the motivations and experiences of the members and leaders of those teams, as well as the steps of group development that take place throughout the lifetime of the team.

7.7.1. INDIVIDUAL THEORIES OF MOTIVATION

Theories of individual motivation seek to understand why the employee, and in our context, the team member, chooses to be a part of the organization, chooses to stay in the organization, and perhaps of the most interest, chooses to work in particular ways and not in others.

Maslow's Hierarchy of Needs

Any discussion of individual motivation would be incomplete without mentioning Abraham Maslow's hierarchy of needs. Maslow characterized the needs of all humans as falling into five levels (Maslow 1954; Robbins 2000, 156-157).

- 1) **Physiological:** hunger, thirst, shelter, sex, warmth, and other physical survival needs.
- 2) **Safety:** includes security and protection from physical and emotional harm.
- 3) **Social:** includes affection, belongingness, acceptance, and friendship.
- 4) **Esteem:** includes internal esteem factors such as self-respect, autonomy, and achievement; and external esteem factors such as status, recognition, and attention.
- 5) **Self-actualization:** the drive to become what one is capable of becoming; including growth, achieving one's potential, and self-fulfillment.

Implicit in the hierarchy is the assumption that all of the needs for a given level must be fulfilled before an individual can move on to the next level, and if a need in a lower level goes unfulfilled, then the individual will regress to that level. Though Maslow's theory has received little empirical support (Korman, Greenhaus et al. 1977, 178), it is so widely recognized and referenced by the general public that it constitutes a language of motivation all its own that most team members will understand, and is therefore worth treating.

Motivation-Hygiene Theory

Herzberg, Mausner, and Snyderman's (1959) theory of individual motivation posits that many factors previously believed to be motivators, most notably pay, were not motivators at all, but instead were best described as hygienic factors. The distinction made between motivational and hygienic factors is that hygiene factors have the power to cause dissatisfaction if they are insufficient or unpleasant, but that when the hygienic needs of an employee are met, the only consequence is the absence of dissatisfaction, and not necessarily motivation. Motivating factors on the other hand, do not cause dissatisfaction when they are absent, but simply do not provide satisfaction. When motivating factors are present, as their name implies, they provide employees with motivation.

Hygiene operates to remove health hazards from the environment of man. It is not curative; it is, rather, a preventive. Similarly, when there are deleterious factors in the context of the job [supervision, interpersonal relations, physical working conditions, salary, company policies and administrative practices, benefits, and job security], they serve to bring about poor job attitudes.

(Herzberg, Mausner et al. 1959, 123)

The factors identified as motivators by Herzberg et. al. are listed below in order of importance.

- **Achievement**
- **Recognition**
- **Work itself**
- **Responsibility**
- **Advancement**
- **Growth**

The factors identified as hygienic are listed below, again, from most significant to least significant.

- **Company policy and administration**
- **Supervision**
- **Relationship with supervisor**
- **Work conditions**
- **Salary**
- **Relationship with peers**
- **Personal life (continues)**
- **Relationship with subordinates**
- **Status**
- **Security**

By distinguishing between hygienic and motivating factors, we can understand that oversatisfying hygienic needs will not produce more intense work. To engender high-performance work behavior the manager and/or leader would do better to reward the motivating factors instead.

Cognitive Evaluation Theory

The idea that rewarding employees with pay contingent upon their performance has been a tenet of business management for many years. Cognitive evaluation theory challenges this assumption.

It has been generally assumed that intrinsic motivators, things such as achievement, responsibility, and competence (essentially Herzberg's motivating factors from above) are independent of extrinsic motivators such as pay, promotions, good supervisor relations, and pleasant working conditions (Herzberg's hygiene factors). Cognitive evaluation theory suggests that these two types of motivators are not separate, and specifically, that introducing extrinsic motivators into an environment where before intrinsic motivators were the primary reward will decrease the effectiveness of the intrinsic rewards, and the employee's work performance in general (de Charms 1968).

The explanation for this comes from the shift in the how the individual's explains their own behavior to themselves. The theory assumes that people do not tolerate feeling or being seen as absurd. An employee who must perform a tedious task for little pay cannot tolerate the absurdity of doing something unpleasant for little compensation, and so that employee will create intrinsic reasons to explain the behavior to him or herself. When an extrinsic reward is introduced into this scenario the intrinsic explanation to avoid feeling or being seen as absurd is no longer necessary. The intrinsic motivation and rewards that existed before no longer operate to provide the individual with motivators such as achievement, responsibility, and competence, as described above.

Some exceptions have been found to the generally positive empirical support for the cognitive evaluation theory (Robbins 2000, 165). Jobs with very high levels intrinsic motivation have been found to be more resistant to the cannibalistic effects of introducing extrinsic motivators (Arnold 1976). Also, even in jobs with high intrinsic motivation, the expectation of some extrinsic rewards still exists, particularly pay (Staw 1977). Another study showed that on tasks with high repetition and low work variability the introduction of extrinsic rewards increased employee motivation (Calder and Staw 1975, 176)

7.7.2. STAGES OF GROUP DEVELOPMENT

This model of group behavior comes from B. W. Tuckman, who defined the stages of group development that most groups pass through in their development. Tuckman (1965) proposed a five-stage model of group development. The five stages of group development are:

- **Forming:** characterized by uncertainty about purpose, structure, and leadership. Members are “testing the waters” to determine what behaviors are acceptable. This stage is complete when members have begun to think of themselves as part of a group.
- **Storming:** characterized by intragroup conflict, in this stage members exhibit resistance to the normative influence on individual behaviors. Competition for leadership and control is also common. This stage is complete when the roles of members are relatively clear, especially leadership.
- **Norming:** this stage is about defining the norms which will regulate behavior in the team. This stage is complete when group structure solidifies and the group has determined what constitutes correct member behavior.
- **Performing:** this stage is the goal state of most teams, once the previous formative stages have been completed. This stage allows the team to focus outward and focus on the problem that the team was formed to solve.
- **Adjourning:** in this stage the group prepares to disband. The concern shifts from accomplishing tasks to wrapping up group activities.

Descriptions adapted from (Robbins 2000, 219)

This five-stage model of group development applies quite well to product development teams that come together with little previous experience and only loosely defined roles. In organizations where roles and behaviors are consistent across the organization, different group formation patterns may emerge. Ginnett (1990) identified the case of an airline cockpit crew, coming from what he described as a high-context organization. Their organization defined the roles and responsibilities of the flight crew in very specific terms that were consistent across the organization, and as a result the flight crew was able to go from complete strangers to functional work team in a matter of minutes, bypassing Tuckman’s group development stages. In general, product development teams are more likely to follow Tuckman’s five stages of group development because of the unique nature of most projects as well as the changing membership and roles common to most product development teams.

7.7.3. THEORIES OF LEADERSHIP

Trait theories of leadership

The original theories of leadership were trait theories. These theories rested on the belief that there were particular personality traits that made certain individuals better suited to leadership than others. Charisma is the most commonly cited trait attributed to leaders, but since the search for consistent leadership traits began in the 1930's no consistent traits have been identified in all leaders. Even though no trait was *always* found to be present in the leaders studied, there were a number of traits that were often associated with successful leaders. These were ambition, energy, the desire to lead, honesty, integrity, self-confidence, intelligence, and job-relevant knowledge. Since these traits were only *associated* with leaders, they indicate, but do not guarantee a successful leader (Robbins 2000, 314-315).

Fiedler Model of Leadership

The Fiedler model of leadership was the first contingency model of leadership, which took into account the environment and qualities of the people to be led as well as the qualities of the leader (Fiedler 1967). Fred Fiedler defined three situational factors to identify different leadership situations. These factors are group acceptance of the leader (sometimes referred to as leader-member relations), how well-defined is the task structure, and the level of formal authority. Fiedler defined two states for each of these variables, creating eight possible leadership situations, numbered I-VIII. His theory supposes that different leaders would do best in different situations. A leader who was more task-oriented would do best in situations I, II, VII, and VIII, while a leader with better relationships with the group would do better in situations III, IV, V, and VI. These relationships are shown in Table 7-1.

Table 7-1 Fiedler Model of Leader Performance

Leader-type	Task	Task	Relation/ Task	Relation	Relation	Relation/ Task	Task	Task
Category	I	II	III	IV	V	VI	VII	VIII
Group acceptance of leader	Good	Good	Good	Good	Poor	Poor	Poor	Poor
Task structure	High	High	Low	Low	High	High	Low	Low
Formal authority	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong

Situational Leadership Theory

Situational Leadership Theory, or SLT, is a contingency theory that focuses on the state of readiness of the members or followers by recognizing the choice that followers make in accepting or rejecting the authority of the leader (Hersey and Blanchard 1974). SLT has been compared to the developing relationship between parent and child. At the initial stages of development a child requires significant attention and care, but as the child matures it requires more freedom to act on its own. SLT suggests that the model for group leadership is similar. As the group moves through different stages of development the role of the leader should change to suit the needs of the group at that stage. The popularity of SLT is evidenced by its incorporation into the training programs of 400 of the Fortune 500 companies (Robbins 2000, 322)

Borrowing the task and relationship scales from Fiedler (1967) above and the five stage group development model from Tuckman (1965), we will detail the responsibilities of the leader according to SLT. This information is also shown in Table 7-2, on the following page.

Forming: In the forming stage, the members tend to be concerned with relationship factors in the team and have relatively little concern for the project that the team was formed to address. Thus, it is up to the leader to maintain as much focus on the project as possible by being highly task focused.

Storming: As the team moves into the storming stage the members are even more concerned with sorting out relationship issues, and it is up to the leader to maintain high task orientation to keep focus on the project and to have a high relationship orientation as well to facilitate the resolution of the relational issues are the hallmark of the storming stage.

Norming: Moving into the norming stage the leader is able to relax in his or her task focus and concentrate on creating and reinforcing positive standards of behavior in the team, keeping a high-relational orientation.

Performing: Once the team has arrived at the performing stage, the leader is able to relax both task and relational orientations and focus on participating in the work. The leader no longer has to provide the container in which the team accomplishes work because the members have matured to stage where they are able to do this for themselves (Marshall 2002a).

Table 7-2 Situational Leadership Theory Leader Roles

	Task Orientation	Relational Orientation
Forming	High	Low
Storming	High	High
Norming	Low	High
Performing	Low	Low

7.7.4. CONCEPTUAL FRAMEWORK

7.8. ATTRIBUTE INVENTORY METHOD

The attribute inventory method is a novel structured observation method using a coding scheme of attributes to record cultural information. An initial set of attributes was derived from the product development team cultural factors analysis (Section 8.2), academic sources, and the intuition and experience of the author. These attributes were tested for validity in an exploratory observational stage, which informed and confirmed the attribute list. The final list of attributes is included in the attribute inventory for product development culture, which is the product of this thesis.

7.8.1. GOALS OF ATTRIBUTE INVENTORY METHOD

The goal of the attribute inventory method is to capture product development team culture with a high accuracy, completeness, consistency, and comparability, minimize the impact of agent and subject bias, and capture cultural information quickly. Because it is an observational method, it will suffer from the flaws of all observational methods, which are selective attention, selective encoding, selective memory, and interpersonal factors.

7.8.2. COMPARISON TO EXISTING CULTURAL MEASUREMENT METHODS

Existing methods used in psychological, social-psychological, and sociological research include quantitative techniques such as controlled-variable experiments, as well as qualitative techniques such as surveys, structured and semi-structured interviews, case studies, and observation techniques. These methods possess many of the traits desirable for an attribute inventory method, such as high consistency and comparability, minimal agent and subject bias, and the ability to capture large amounts of information quickly, but have been criticized for their accuracy (Robson 1993, 193). As a criticism of survey accuracy, Agnew and Pyke suggested that “on a questionnaire we only have to move the pencil a few inches to shift our scores from being a bigot to being a humanitarian” (Agnew and Pyke 1982, 129). Observational techniques improve upon this accuracy weakness, but in general, observational techniques mean an increase in the time to capture cultural information.

Alternatives to the quantitative and qualitative methods described above come from anthropology. There are, in general, two dominant observational techniques: encyclopedic ethnography and narrative ethnography. Encyclopedic ethnography seeks to understand the overarching rules of the culture being studied, while documenting variation. Narrative ethnography focuses on a particular group and seeks to tell their story, collecting cultural information from idiosyncratic behaviors of the group (Agar 1996, 10). Both of these techniques require extensive fieldwork, usually in the range of one to three years, and are therefore inappropriate for the study of product development teams whose lifetime is often measured in months. Nevertheless, the paradigm of encyclopedic vs. narrative observation is useful to the understanding of the attribute inventory method, which comes much closer to the encyclopedic ethnographic model of observation.

7.8.3. ON JUDGING CULTURE

An impediment to using quantitative or structured qualitative methods for collecting cultural information in the past has been that these methods are designed to allow comparison of the traits of individuals or groups under study. In the academic community there has been resistance to comparative cultural studies that seek to make value judgments on the efficacy or superiority of one culture over another. This attitude is wholly appropriate for the study of environmental cultural systems, where diversity of national, ethnic, and other unique cultures are understood as beneficial for their own sake. In contrast, in business there is a desire to understand the role of product development team culture as a factor of performance, with little or no intrinsic value placed on the culture for its own sake, and there is little aversion to making comparative value judgments. In the opinion of the author, this makes the use of quantitative or structured-qualitative methods designed for comparison and value judgments appropriate and ethical.

7.9. PRODUCT DEVELOPMENT TEAM CULTURAL FACTORS ANALYSIS

In order to generate an initial set of attributes, one of the first activities was to understand what entities (people, groups, or forces) had an impact on product development team culture in the organization. Seven entities were identified that had an impact on shaping team culture. These are the initiator, the leader, the members, group experiences, the environment, team structure, and team processes.

Entities affecting team culture

- **Initiator:** the individual responsible for creating the team and delivering the first messages about its purpose and identity.
- **Members:** the individuals who are either permanently (core-members) or temporarily (peripheral-members) a part of the team.
- **Group experiences:** the sum of all shared events and interactions from the time the group is formed until it disbands.
- **Environment:** the entirety of people, groups, events, information, and other stimuli that surrounds the team, including the embracing organization and the larger world.
- **Structure:** the arrangement and organization of roles, responsibilities, and behavior in the team.
- **Processes:** systems of work and interaction that may be shared with other teams, the organization, or other external constituencies, or may be unique to the team.

7.9.1. INITIATOR

The initiator is the individual or group who has called for the creation of the team. This entity delivers powerful messages about the purpose and identity of the team. Because these messages come very early in the development of the team they may have a profound impact on the team's cultural development. We have identified four messages that the initiator most commonly delivers to a beginning product development team. These are the charter, the vision, the mission, and the level of autonomy of the team.

Charter

The team charter defines the goals of the team. These goals typically include the purpose of the team, a description of the product to be developed (if this is known), the measures of success that the team and the product will be subject to, and the context in which the team is acting (Collins and Porras 1991, 31-48). This final aspect of the charter, the context, is perhaps the most important, because it explains why the product is important to the various clients of the team, both inside and outside of the embracing organization. These clients might include individuals or groups within the organization, specific customers, the general public, regulatory or standards organizations, and potentially many others. Another aspect of the context is how the product fits in with the overall strategy of the organization. If the charter is clear, the team will possess understanding this overall strategy, which helps inform them of the larger priorities they should be concerned with beyond the specific technical aspects of the product, and hopefully guide them to better decisions.

Vision

The vision of the team embodies the core values of the team, and when delivered correctly has the power to “grab people in the gut and motivate them to work toward a common end” (Collins and Porras 1991, 31). Contained in the vision will be values and beliefs about the team's place in the world and how the team should see the world outside of their boundaries. This might include beliefs about employees, customers, products, management, and the organization. In addition to this “guiding philosophy” the vision also includes a “tangible image” which combines a mission and a vivid description to make the mission “come alive” (Collins and Porras 1991, 42). The mission is significant enough to merit separate treatment, and is covered below.

Mission

The mission of the team is the clear and compelling goal that motivates the members of the team to stretch themselves beyond the comfort-zone and achieve something exceptional. The best mission statements are very easy to understand, but are deeply meaningful to the members of the team (Collins and Porras 1991, 42). One of the most powerful mission statements was delivered by President John F. Kennedy at Rice University in 1962:

There is no strife, no prejudice, no national conflict in outer space as yet. Its hazards are hostile to us all. Its conquest deserves the best of all mankind, and its opportunity for peaceful cooperation may never come again. But why, some say, the moon? Why choose this as our goal? And they may well ask why climb the highest mountain. Why, 35 years ago, fly the Atlantic? Why does Rice play Texas?

We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.

*President John F. Kennedy
Address at Rice University in the Space Effort
September 12th, 1962
(Kennedy 1962)*

With this mission statement, President Kennedy catalyzed the efforts of a generation of engineers and scientists and was responsible for some of the most spectacular technical developments to this day, and exemplifies the power of the mission statement. Just as powerful is the potential for an unclear or uninteresting mission statement to confuse and discourage the members of the team. Thus, in this area, the initiator has great responsibility.

Autonomy

The final message that the initiator typically provides to the team is to define the scope of their autonomy. A team may have very little autonomy, selective autonomy or complete autonomy.

A team with very little autonomy might have no control over the concepts and design choices that they must execute, and are left only to complete the detail design of the product. In general, this is not very common, because it is recognized that some measure of

autonomy motivates the creative potential of a team and allows for more exceptional product development. Nevertheless, there are certainly some teams that are still run in this fashion.

A team with selective autonomy may have autonomy in some areas of the design, while not having any control over others. An example is an automobile design team that has control over all technical aspects of the design, but is not in control of the styling or interior industrial design.

A team with complete autonomy has complete control over all technical aspects of the design and may also be independently responsible for profit and loss of the products that they design.

7.9.2. LEADER

The leader is the second entity affecting group culture that we will treat. If any entity has the greatest impact on the culture of a product development team, it is likely the leader. Schein (1983) notes that entrepreneurial founders (entrepreneurial ventures at the founding stage very closely resemble product development teams) have a profound effect on the culture of the businesses that they start. They, more than anyone else in the company, “will have a major impact on how the group solves its external survival and internal integration problems” (Schein 1983, 17). The role of the leader in creating team culture cannot be underemphasized. Tuckman’s (1965) work on the stages of group development (forming, storming, norming, performing, adjourning) and Hersey and Blanchard’s (1974) Situational Leadership Theory (both covered in Section 7.7) allow us to understand that in the first two stages of group development the members of the team are more interested in figuring out one another than they are in the work or the team. It is the leader that must constantly provide the container in which work gets done, and remind the team of the context and purpose of the team (Marshall 2002a). The manner in which the leader carries out this work has a tremendous impact on the cultural development of the team, most notably in shaping roles, norms, structures, and processes of the team, which are covered in Sections 8.2.6 and 8.2.7.

Formal vs. actual leader

Leadership of a team doesn’t just come from the formally appointed leader, in fact, it can come from anywhere or anyone in the team. Leadership often *does* come from the formal leader of the team, who is sometimes, but not always, also the manager of the team (the difference between leadership and management is treated in the following section). If leadership does come from the formally appointed leader, it is also not necessarily the case that this is the only leader in the team (Rummler and Brache 1995). Leadership may come from any member of the team, even in the presence of a formal, appointed leader. Leadership may also be shared, with the formal leader performing certain duties while other leaders in the team lead where appropriate. This is not a sign of weakness, nor is it necessarily a strength, but where members share complimentary leadership abilities,

distributing the challenge and burdens of leadership, it often does become a strength when leadership is shared.

Management vs. leadership

Another important distinction is the difference between leadership and management. The two terms are often used interchangeably, and in the last two decades leadership duties have been, in general, assumed to be the domain of managers, but the terms describe very different activities that require distinct and separate skills sets (Marshall 2002a). Many managers do an excellent job leading, but even when they do, it is essential to realize that they are performing two very different tasks. John P. Kotter (1990b) captured the difference between management and leadership when he described management as the work of coping with complexity, while leadership is the work of coping with change.

A manager might be concerned with creating order, the division of labor, establishing and maintaining work processes, and monitoring the quality of work produced by the team, while a leader in the same team might be concerned with establishing the direction of the team, communicating the vision first proposed by the initiator, and inspiring members to realize that vision, assessing the context in which the work is being done and monitoring how well the team's work satisfies ever-changing customer needs (Kotter 1990a).

What do product development team leaders do?

Leaders in product development teams fill many roles, and it might be the large number and variety of these roles that account for the large impact that leaders have on product development team culture.

The first role that leaders play is as a connection to external constituencies. By representing the team to clients, senior management, and other teams or departments, the leader is the primary gatekeeper of external contact in the team. At times certain teams need to be shielded from the pressures of external constituencies, and at other times teams require information sharing and communication. The leader manages these interactions.

The second role that the leader plays is as a conflict manager. Whether the conflict is related to interpersonal relationships in the group, the task, or work processes (Jehn and Mannix 2001), it is usually the leader that mediates this conflict and attempts to steer the best course between excessive conflict and no conflict at all. As we will discuss later, the type and amount of conflict in a team can cause it to be an asset or a liability. In general, excessive conflict can inspire defensive emotional behavior on the part of the members, and insufficient conflict can set the stage for Groupthink or Groupshift.

The third role that the leader plays is as a coach. Unless the project is very well understood and highly repetitive, most members will be required to learn and grow in some capacity to meet the demands of the project. It is the leader's job to facilitate this learning and growth as much as possible. Coaching by the leader can take the form of directly

teaching the member the needed skills, pointing out the skills needed and leaving the member to learn on their own, or recommending a source that the member should seek out to facilitate learning.

The fourth role that the leader plays is as a storyteller. Part of the motivational power possessed by the leader is the ability to involve the members of the team in the “hero’s journey,” as described by the mythologist Joseph Campbell (1972). Casting the team as the “hero,” the team sets out from the realm of the familiar into the unknown. Through trial and hardship, the team accomplishes their “quest.” Upon returning to the familiar, the team realizes that it has changed. Some attributes have remained (these might be understood to be core attributes or values) and others attributes been modified by the experiences of the quest. By crafting a meaningful story, the leader creates a powerful fantasy ideology that can motivate members far beyond discretionary punishment or reward.

The fifth and final role that the leader plays is as a trust-builder. Trust is the positive expectation that another will not—through words, actions, or decisions—act opportunistically (Boon and Holmes 1991, 194; Robbins 2000, 336).

Without the trust of the members of the team, the leader will have great difficulty accomplishing the other roles of connector, conflict manager, coach, or storyteller, so the successful performance of this role critical to the success of the leader and the success of the team. The key dimensions that underlie the concept of trust have been identified as integrity, competence, consistency, loyalty, and openness (Schindler and Thomas 1993). A leader that incorporates these qualities into his or her behavior stands the best chance of building the trust required to lead a team in the other ways described above.

The type of trust that members feel towards the leader and towards each other tends to change as the group moves through the stages of group formation. At the beginning, when there is very little data on the trustworthiness of the leader and other members, deterrence-based trust is likely to dominate (Lewicki and Bunker 1996). The members will typically trust the leader, but only because of the formal authority and the potential for reward and punishment that the leader holds. This type of trust is very fragile because it is based on fear of reprisal on the part of the team members. They are only trusting the leader because they perceive a greater risk of punishment in the future if they do not.

The second and most common type of trust in product development teams is knowledge-based trust (Lewicki and Bunker 1996). This type of trust is based on a large number of interactions and a history of reliability on the part of the leader and members of the team. This type of trust is less fragile than deterrence-based trust because a long history of trustworthy behavior is not likely to be undermined by a single, isolated infraction.

The third and strongest type of trust is identification-based trust (Lewicki and Bunker 1996). This level of trust exists when the leader and members of a team share a mutual understanding of each other’s needs and intentions, and feel comfortable acting in place of one another when necessary. In teams that have worked together over many different projects for many years, this type of trust may exist, allowing team members to put complete

confidence in the decisions of the leader and the other members of the team because they are confident of the mutual understanding provided by this type of trust.

Cultural issues in leadership

Leadership roles will differ substantially depending on organizational and national culture. National culture has been shown to have a stronger effect on organizational roles than organizational culture (Adler 1999), and this applies just as much to leaders as it does to the product development teams they lead. Examples of cultural differences in leadership include the importance placed on rationality (e.g., rationality is valued in the USA, while it is not considered important trait in Iran), problem-solving orientation vs. situation-acceptance orientation (e.g., there is a greater tendency to accept situations as they are in Thailand and Indonesia), and individual vs. group orientation (e.g., group decision-making and acceptance is very important in Japan, while individuality is reward in the USA) (Adler 1997, 166-173).

7.9.3. MEMBERS

The members of the team bring with them many factors that affect team culture. The knowledge, skills, abilities, and personality of the members all shape their contribution to the culture of a product development team. Another major factor in an individual's contribution to the culture of the team comes from the memberships that person holds in other groups, both in the organization, and in the larger world.

Group membership outside of the product development team

To understand the social relationships of an individual, one of the most effective methods is to understand the groups in which the individual holds membership.

The groups to which an individual belongs identify the social universe of that individual and define his or her position within that universe. One's set of group memberships in an organization define a person's organizational location just as one's spatial position defines his or her location in the physical universe.

(Hackman 1992, 203)

A member of a product development team might hold membership in many social or organizational groups, such as their neighborhood community, alumni group, political organizations, enthusiast groups, national, racial, ethnic, or religious groups, groups with shared medical experiences, military groups, and many others. The character of these groups determines both the discretionary and ambient stimuli that members will be subject to, or excluded from, outside of the product development team. For example, some groups deal with physical materials, while others deal with ideas and plans (Hackman 1992, 204). Some groups may be predominantly male or female, and this gender composition creates a context

for member behavior that significantly affects the nature of the experiences of its members (Levine and Moreland 1990, 595-596).

Team members are also likely to belong to formal and informal groups within the organization other than the product development. These groups will have the same control over a portion of the discretionary and ambient stimuli the member is exposed to, contributing their own flavor the experiences the individual brings to the product development team.

Knowledge, Skills, and Abilities

This aspect of the members of a product development team describes the impact of lifelong learning and experience on team culture. Parents, peers, grade school through graduate school, job experiences, and many other life events teach members a variety of knowledge, skills, and abilities.

Knowledge includes technical information related to the project being addressed by the team, while skills describe how to apply that knowledge to gain a certain result. Ability refers to the capacity of a member to perform a given skill.

The knowledge, skills, and abilities that are relevant to the project are a good indicator of the likelihood that the member will be able to succeed at the product development tasks required for success. The possibility exists that a team with relatively unprepared members could still be successful through effective leadership and management as a team of well prepared members, but in general, group performance reflects member abilities and the opportunity that exists for success (Robbins 2000, 226)

Certain skills seem to be more important than others for group work in general. Interpersonal skills in particular have been found to be critical for high workgroup performance. These interpersonal skills include conflict management and resolution, collaborative problem solving, and communication (Stevens and Campion 1994; Robbins 2000, 226)

Personality

It is likely that many people, if asked what member trait contributed the most to team culture, would probably guess that it was the personality of the members. Clearly there are many other factors at least as important as personality, as shown above, but what about personality makes it such a tangible force in shaping team culture?

What has been learned about personality traits indicates that the traits that are generally valued in the national culture of the team will be valued by team. When members possess these traits, team performance improved. In the United States, traits such as sociability, initiative, openness and flexibility were found to correlate with group productivity, morale, and cohesiveness. Authoritarianism, dominance, and unconventionality were negatively correlated with the variables above (Kinlaw 1991; Robbins 2000, 226). The favorite traits will

change with national culture, but it is likely that if present, they will have the same reinforcing effect on performance.

7.9.4. GROUP EXPERIENCES

Just as the individual members of a team bring with them their experiences and learning, the team as a whole learns and gains experience from the moment it is formed. This group experience, especially in the initial stages of group development (forming, storming, norming), is critical to the formation of culture in the team. It is during this early period that the norms, structures, and processes particular to the team are developed. Once the group moves to the more stable performance stage of group development, learning continues based on the experiences of the group, but will tend to be single-loop learning (explained below). The factors that affect group experiences are learning, power dynamics, conflict interaction, group argot, and external validation.

Learning

Learning is acquiring knowledge, skills, or behaviors by study, instruction, or adaptation. All members, teams, and organizations are constantly learning because they are taking in new information, processing it, and assimilating or accommodating the new information into their existing understanding of the world. The type of learning that takes place in a product development team has an impact on its cultural development. Types of learning that can occur in product development teams are classified as single- and double-loop learning, phobic learning, and complacent-reinforcement learning.

Single-Loop and Double-Loop Learning

Kim (1993) distinguishes between two types of learning in teams, single-loop and double-loop learning. Single-loop learning treats new information in the context of existing understandings. For example, if errors are detected in some of the work that the team produces, then it will be corrected by applying routines and policies that have worked in the past.

Double-loop learning, on the other hand, treats new information as having the potential to change the existing understanding of the team. Thus, a team who is open to double-loop learning would question the routines and policies in the event of work errors, and possibly correct or modify the assumptions that underlie the routines and policies of the team. Double-loop learning more often leads to “radically different solutions to problems and dramatic jumps in improvement” (Robbins 2000, 559).

Phobic Learning

Another type of learning that can take place in product development teams is phobic learning. Phobias are high-anxiety responses to objects, situations, or thoughts (Elliot and Tyrell 2002). Just as individuals can develop phobias, so too can groups. When unconscious

or emotional learning takes place in response to high anxiety, seemingly irrational fears and behaviors can develop.

Usually phobic learning takes place when a high-anxiety state is paired with an object or specific situation. Thereafter, whenever this situation or an analogous situation arises, the high-anxiety state will return. An example of an individual phobia is the poet Robert Graves, who had a phobia associated with telephones because he was using a telephone when a bomb was dropped nearby during WWII (Elliot and Tyrell 2002).

Team phobic learning occurs when the team irrationally avoids certain behaviors because they may have led to failure or punishment in the past. For example, a product design using tungsten that failed because of brittle fracture might provoke phobic learning that would prevent the team from using tungsten in any aspect of a future design.

Complacent-Reinforcement Learning

Complacent-reinforcement learning occurs when the behaviors of a successful team become entrenched and the team is unable or unwilling to change in order to adapt to the changing needs of the organization and/or environment. Examples of organizations that succumbed to complacent-reinforcement learning include General Motors, J. C. Penny, Sears & Roebuck, Toyota (Weinberg 1996), and Motorola (Roth 1998). Complacent-reinforcement learning appears to occur more often in teams with strong cultures (where core values are intensely held and widely shared). Successful behavior in the past tends to become reinforced and incorporated in the strong team culture. This entrenched behavior leads to complacency and poor adaptation on the part of the team, with a strong negative effect on performance (Wiener 1988; Miller 1994).

Power dynamics

Power in product development teams is the capacity of one member of the team to influence the behavior of another (Bass 1990). Different types of power exist because the source or base of power is different. These different types of power are coercive power, reward power, legitimate power, expert power, and referent power (French and Raven 1959). Even though some of these bases of power possess positive or negative connotations (e.g. coercive power is usually associated with negative reinforcement) it is how these bases of power are used and to what ends that determines the positive or negative character of the power.

In an individual team member, coercive power is dependent on the ability “to exercise physical strength, verbal facility, or the ability to grant or withhold support from others” (Kipnis 1976, 78). Reward power stems from the ability of a member to give special benefits or fulfill another member’s need, and can be understood to be the positive counterpart of coercive power. Rewards can include anything that other members view as valuable, but in teams, rewards often include friendliness, acceptance, and praise (Robbins 2000, 354).

Legitimate power stems from authority granted to a member by the formal hierarchy of the organization. This base of power relies on the acceptance of the position of authority by other members of the team. Because this acceptance can be withheld, legitimate power usually cannot compel members of a team to perform actions to which they are strongly opposed (though normative effects can preclude an individual from speaking up) (Robbins 2000, 354-355).

When a team member exerts his or her authority based on expertise or specialization, this is a case of the expert power base. Referent power exists because of the admiration or respect that some members of the team have for another member. When the respected member makes recommendations or arguments, the referent power base exerts influence beyond the value of the recommendations or arguments by themselves.

Conflict interactions

The traditional view of conflict is that it is a symptom of a dysfunctional team. Recently it has been shown that the type and level of conflict determines whether the conflict actually improves group function or is an obstacle to group function. Jehn and Mannix (2001) identified three types of conflict: task conflict, relationship conflict, and process conflict. Task conflict is centered on decisions surrounding the work of the team. The goals that have been chosen by the team are often the topic of task conflict in product development teams. When the interpersonal relationships between members generate conflict, this is relational conflict. Process conflict is conflict surrounding the way that work gets done in the team. The levels of these types of conflict in the team will determine whether the conflict is functional or dysfunctional.

Dysfunctional conflict includes high levels of any type of conflict. High relational conflict decreases empathy in the team and engenders defensive emotional responses to criticism. High task conflict often creates confusion over who is responsible for what, and as a result members may be working on the same tasks without knowing it, while other tasks are left incomplete. High process conflict leads to confusion similar to high task conflict, except the confusion is about how things should be done instead of who should be doing them (Jehn and Mannix 2001).

Functional (healthy) teams often exhibit some conflict. In fact, some teams suffer because of insufficient conflict. Low levels of task and process conflict have been shown to stimulate creative thinking and serve to constantly question the efficacy of roles and processes in the team (Jehn and Mannix 2001).

Team argot

Language develops in a product development team as a part of culture. Team members will tend to bring some specialized language from the organization and the environment, but as team members spend more time and do more work together, a specialized language unique to the team will develop. This is called the team argot. Teams just like organizations,

“often develop unique terms to describe equipment, offices, key personnel, suppliers, customers, and products that relate to their business” (Robbins 2000, 526).

This specialized language reflects team culture, but at the same time it also shapes the culture in the team. Members of the team use their specialized language to describe common artifacts that members of other teams experience as well. The specialized language carries information content beyond just describing reality. For example, a supervisor referred to as “Darth Vader” by one team will be perceived differently than the same supervisor, referred to by another team as “Big Bob.” The descriptive content of the team argot will shape the way the members of the team perceive their environment as well as how they are perceived by others.

External validation

The final factor affecting the experiences of the group is external validation. External validation describes the messages that the team receives from outside its boundaries. Validation can come from the embracing organization, from either above or below the team in the organizational hierarchy, and it can also come from outside of the organization, possibly from the general public or the client of the team.

One of the most powerful expressions of external validation is when the practices of the team are copied by other parts of the embracing organization. If others, whether in senior management or the members or leaders of other teams, are seen to value the team’s practices and ideas, this will have a strong confirmatory effect and reinforce the culture in the team.

7.9.5. ENVIRONMENT

The environment describes all factors affecting team culture that lie outside of the boundaries of the team. These factors can be divided into those that fall within the embracing organization and those that are a part of the larger world.

Organization

Each team has a unique culture due to the members, leader(s), resources, demands, and experiences of the team. But the team doesn’t exist in a vacuum, it exists in the context of an embracing organization. That organization created the team to achieve certain goals, and as a result the team is subject to certain external conditions imposed by the organization. The external conditions pertaining to the organization we will discuss are organizational strategy, authority structures, formal regulations, resources, and organizational culture (Robbins 2000, 224).

Organizational Strategy

The organization, like the team, has a charter, vision, and mission statement, and with these come the goals, critical tasks, and a strategy for accomplishing the critical tasks.

Organizational strategy is a unique, high-level solution to the problems that organization has chosen to solve.

The choices made in defining organizational strategy will impact team culture because the strategy determines the importance of and power accorded to the team, the status of its leader and members, and the resources available to the team compared to other teams. The organizational strategy also embodies core values emphasized by senior management (though these can be accepted or rejected by the team, in whole or in part) (Robbins 2000, 224).

The broad and deep reach of organizational strategy also tends to shape the structure of the organization, and vice-versa. An organization that wishes to change its strategy will find its current strategy embodied in the structure of the organization. While it is relatively easy to change the espoused strategy of a company, it is far more difficult to change the structure of the organization to reflect that new strategy (Chandler 1962).

Authority Structures

When an individual describes the hierarchy of the organization (e.g., who is their superior, who is their subordinate, who is allowed to make what decisions and who is accountable for those decisions) that individual is describing the authority structure of the organization. Most of the formal roles and relationships in an organization are defined by the authority structure. The much-maligned organization chart is the graphical embodiment of the authority structures present in the organization.

Formal Regulations and Guiding Principles

Formal regulations are the explicit and codified behaviors that all members of an organization must practice. In general, it is acceptable to practice any behavior not explicitly forbidden by the letter and spirit of formal regulations. These regulations define the space within which product development teams can behaviorally differentiate themselves.

Modern, organic organizations with relatively flat authority structures tend to employ guiding principle instead of traditional formal regulations. Guiding principles offer a small number of norms (low in letter, high in spirit) that are intended to guide the many decisions that formal regulations would typically cover explicitly. The advantage of guiding principles is that as work changes rapidly, guiding principles tend still to apply, whereas formal regulations must be written explicitly for each new situation.

Resources

The resources provided (or not provided) by the organization to the team affect team culture. Resources include, most notably, personnel, but also include capital, raw materials, equipment, space, and others. Resources are a hygienic factor in how they affect team performance. Without sufficient resources a team will have a more difficult time meeting a given level of performance. A team with sufficient resources only has the ability to perform at a high level.

Physical work setting

The arrangement and quality of the physical work setting has been shown to have a profound effect on how work get done in organizations. Likewise, in teams, how the members are arranged and the nature of their work areas will affect the culture that develops in the team. Allen (1997) showed that communication dropped off sharply after two coworkers were separated by 50 meters, and closed offices and being on separate floors exaggerated this effect. Open atriums between floors, and escalators instead of stairs or elevators reduced the severity of the effect of being on separate floors.

The arrangement of the work area also sends a message to employees about how work gets done in the organization. In the public accounting firm Lipschultz, Levin, and Gray, employees were located in separate offices, as is traditional in most accounting firms. There was little communication or collaboration between employees and also little creativity in creating new products and services. Lipschultz, Levin, and Gray went from 55 employees to 26 and moved into a workspace 60% smaller than before with no walls, cubicles, or offices, locating employees directly next to each other. Profits increased and several new business units were added to serve new markets and clients (Austin 1999; Robbins 2000, 456).

Organizational Culture

Organizational culture is a topic at least as rich as the topic of product development team culture covered in this thesis. If any element of the environment surrounding the product development team affects the culture of that team the most, it is likely to be the organizational culture. In general, most researchers have simply conclude that product development team culture is a pure subculture of the embracing organizational culture, and that team culture must follow the cultural “rules” in much the same way that all employees must obey the formal regulations of an organization. But, just as most employees understand that formal regulations, the rules, can be bent or even broken, so must we understand that product development team culture bends or even breaks the cultural “rules” of the organization that surrounds it. One of the pioneering works in organizational behavior, the Hawthorne studies at the Western Electric Company’s Hawthorne Works noted this rule-breaking tendency in the late 1920’s, yet the assumption of pure subculture in work teams has, for the most part, persisted (Roethlisberger and Dickson 1939; Hackman 1992, 200). This thesis and its product, the attribute inventory method, do not assume that product development team culture is a pure subculture of organizational culture. In fact, dispelling this assumption is one of the motivations for the creation of the attribute inventory method.

Recognizing that team culture may be distinct from organizational culture, the culture in the organization still has a very powerful effect in shaping the culture in the team. In fact, situations where team culture is in direct conflict with organizational culture are rare, but this does not pardon ignoring such instances, for in fact they provide some of the most interesting examples of team culture.

Organizational culture can be described by seven characteristics, which are shown below. These characteristics are analogous to the attributes collected in this thesis for describing product development team culture (O'Reilly, Chatman et al. 1991; Chatman and Jehn 1994; Robbins 2000, 510-511).

- **Innovation and risk taking:** the degree to which employees are encouraged to be innovative and take risks.
- **Attention to detail:** the degree to which employees are expected to exhibit precision, analysis, and attention to detail.
- **Outcome orientation:** the degree to which management focuses on the outcomes rather than on the techniques and processes used to achieve these outcomes.
- **People orientation:** the degree to which management decisions take into consideration effect of outcomes on people within the organization.
- **Team orientation:** the degree to which work activities are organized around teams rather than individuals.
- **Aggressiveness:** the degree to which people are aggressive and competitive rather than easy going.
- **Stability:** The degree to which organizational activities emphasize maintaining the status quo in contrast to growth.

These characteristics can be used to describe the culture of an organization by rating each characteristic using a measurement scale similar to the one used in the attribute inventory method developed in this thesis (Section 10.1). The organizational culture will, in general, be part of the foundation of the culture of any team in the organization. To assume that it is the only factor affecting product development team culture (as do most current treatments of group culture) would be to ignore the other factors outlined in this section. Organizational culture is but one among many factors that affect team culture.

The Larger World

Though organizational culture has recently received significant attention as one of the key sustainable competitive advantages that companies can maintain in the marketplace, research by Adler (1997) has shown that the culture outside of the organization (mostly the national culture) has an even larger impact on employee behavior and experience than the organizational culture.

The most important aspect of the culture of the larger world, hereafter referred to as environmental culture, is the national culture in which the organization exists. Each nation possesses a unique combination of cultural factors far too numerous to list individually, and many subcultures that could fill books by themselves. Luckily, a framework for assessing

cultures exists to categorize cultures in five areas, shown below (Hofstede 1993; Robbins 2000, 66-67).

- **Power distance:** the degree to which people in a country accept that power in institutions and organizations is distributed unequally. Ranges from relatively equal (low power distance) to extremely unequal (high power distance).
- **Individualism vs. Collectivism:** individualism is the degree to which people in a country prefer to act as individuals rather than as members of groups. Collectivism is the equivalent of low individualism.
- **Quality of life vs. Quantity of life:** quantity of life is the degree to which values such as assertiveness, the acquisition of money and material goods, and competition prevail. Quality of life is the degree to which people value relationship, and show sensitivity and concern for the welfare of others.
- **Uncertainty avoidance:** the degree to which people in a country prefer structured over unstructured situations. In countries that score high on uncertainty avoidance, people have an increased level of anxiety, which manifests itself in greater nervousness, stress, and aggressiveness.
- **Long-term vs. Short-term orientation:** People in cultures with long-term orientations look to the future and value thrift and persistence. A short-term orientation values the past and present, and emphasizes respect for tradition and fulfilling social obligations. Table 8-1 shows the variation in cultural factors across different nationalities. Note the differences between countries Europe, North America, and Asia that might be assumed to be the same, but were found to differ in the dimensions measured.

Table 7-3 Differing environmental cultural factors by nationality

Country	Power Distance	Individualism	Quantity of Life	Uncertainty avoidance	Long-term orientation
France	High	High	Moderate	High	Low
Germany	Low	High	High	Moderate	Moderate
Netherlands	Low	High	Low	Moderate	Moderate
Russia	High	Moderate	Low	High	Low
China	High	Low	Moderate	Moderate	High
Hong Kong	High	Low	High	Low	High
Japan	Moderate	Moderate	High	Moderate	Moderate
Indonesia	High	Low	Moderate	Low	Low
Canada	Low	High	Moderate	High	Low
USA	Low	High	High	Low	Low
West Africa	High	Low	Moderate	Moderate	Low

This table adapted from (Hofstede 1993, 93; Robbins 2000, 67)

Other factors besides those noted in the Hofstede (1993) study can affect environmental culture. Though far from a complete list (this would require an attribute inventory of truly substantial proportions), some factors likely to affect environmental culture are listed briefly below.

- **Intellectual climate**
- **Moral climate**
- **Technological developments**
- **Business events**
- **Legal events and precedents**
- **Social movements**
- **Political events**
 - Elections
 - Appointments
 - Coups
 - Majority attitudes
- **Military events**
 - War
 - Terrorism
 - New military technology
- **Natural events**
 - Natural disasters
 - Climactic changes
 - Environmental changes

7.9.6. STRUCTURE

Structure in product development teams defines many of the “rules” we’ve spoken about in the sections above. These rules take a number of forms, but in general they are the standards of behavior that members of a team follow and the patterns by which teams are organized. These structures allow members to make sense of the many different situations that they encounter on a daily basis because the structures are repeated throughout the organization and must only be learned once. Likewise, some structures are so common that they exist in almost all organizations, in business and non-business alike, as we will show below.

The structures relevant to product development teams are roles, norms, status, size, and cohesiveness, which are explored below.

Roles

A role is a “set of expected behavior patterns attributed to someone occupying a given position in a social unit” (Robbins 2000, 227). In simpler terms, roles are the parts we play everyday. In the context of product development teams, each member is usually expected to play a number of roles. In the role of leader, a member might be expected to initiate ideas or concepts for a design, provide relevant information on issues concerning team decisions, seek opinions and request facts, clarify alternatives, provide examples to support another member’s statements, test the degree of agreement in the team, and summarize related ideas in an effort to arrive at a decision.

Each role, such as the leadership role described above, has an identity, perceptions, and expectations associated with it. There is also the potential for role conflict when a person is asked to play two roles with different and incompatible demands.

Role Identity

Role identity is the actual attitudes and behaviors that it takes to play a certain role. This is different from role perceptions, which are the ideas individuals hold about what it means to play a given role. In fact, when playing a role, most individuals will take on the characteristics that they associate with that role, creating a role identity from their own role perceptions. Philip Zimbardo’s (1973) famous prisoner/prison guard experiment demonstrated in striking fashion how quickly college students with similar psychological and personality profiles assumed the roles of prisoner and prison guard without being told much more than the titles of the roles they were expected to play. This study exemplified the power of role identity in shaping behavior, as well as the varied and pervasive role perceptions that exist in most individuals.

Roles in product development teams exist that are just as powerful as the roles Zimbardo’s prison. Roles are created in a group as its culture develops. In organizations with a high organizational context members may import roles ready-made from the organization. An example of a high-context organization is the cockpit crew of an airliner, which “within

10 minutes can move from being three strangers assigned to fly together for the first time to a group capable of successfully performing the complex and demanding job of flying an airplane” (Ginnett 1990).

Role Perceptions

Role perceptions are a member’s idea of how he or she is supposed to behave in a certain role. These perceptions are inherited from people we see performing the roles every day. By building a picture of what it means to play certain roles, each person builds his or her own library of role perceptions.

Role Expectations

Role expectations are how others believe a role should be carried out, and can be understood as the counterpart to role perceptions. The members of a team usually have role expectations for the leader of the team, and likewise the leader has his or her own role expectations for the members in the team.

Role Conflicts

Conflicts can occur when an individual is asked to perform roles whose requirements are contradictory. A law enforcement officer who accepts bribes has certainly assumed two roles with a host of conflicts. In fact, most individuals manage many roles, and most roles have at least some conflict. Trade-off decisions are often used, as are behavioral techniques such as withdrawal, stalling, and negotiation or the individual might attempt to redefine his or her role perceptions to reduce the dissonance caused by conflicting role demands (Robbins 2000, 229).

Norms

Norms are a structural characteristic of groups that summarize and simplify a group’s influence on its members, and serve to regulate and regularize member behavior (Bates and Cloyd 1956). Norms have often been confused with culture, because they provide many of the same rules, but norms and culture are not the same. The difference is that norms only regulate behavior, and do not apply to private thoughts and feelings, while culture affects behavior, attitudes, beliefs, goals, and practices (Hackman 1992, 235). Thus, norms are understood to be a part of culture.

Norms are an efficient, pervasive method of controlling member behavior. The alternative, managing discretionary stimuli, in effect rewarding and punishing individuals for specific behaviors that are acceptable or unacceptable to the group is inefficient compared to the self-regulating normative approach, especially for larger groups (Hackman 1992, 235).

Not all norms are created equal. Each norm has two characteristics associated with it: its level of crystallization in the group, and the intensity of responses that the norm generates. The degree to which members comply with norms depends on the norm itself (its levels of

crystallization and intensity), the personal characteristics of the member, and the role of that person in the group.

The norm

A norm that is well-crystallized has a high degree of consensus from group members as to the level of approval or disapproval appropriate for the behaviors associated with that norm. When a norm is well-crystallized, members will take concerted action to enforce the norm when a member deviates from the boundaries of acceptable behavior.

The intensity associated with norms describes the strength of approval or disapproval associated with the behaviors the norm regulates (Hackman 1992, 240).

If a member tests the limits of a well-crystallized and intensely-held norm, the results is likely to be an almost unanimous and strong response from the other members of the group. The normative power of groups is striking, as demonstrated by Asch (1955) in his study on individual conformity under normative pressure, where a subject gave answers that they knew to be false because all other members gave the same false answer.

The person

A person will tend to submit to normative pressures when the reward or punishment is sufficient to warrant compliance. In general, the more an individual identifies with a group, the more likely he or she will want to conform to the norms of that group. In effect, the individual would like to make the group part of his or her identity, and thus compliance reinforces the sense, by both the group and the individual, that the behavior that satisfies the group norms is “natural” (Allen 1965).

The role

The role of the individual who is subject to normative pressure also has an impact on the level of compliance. Different members of a team, playing different roles, possess what Hollander (1958) termed *idiosyncrasy credits*. These credits permit a member to deviate from the behavioral boundaries specified by norms to an amount determined by the amount of idiosyncrasy credit that the member possesses. Credit is accrued by status, either imported from previous accomplishments, or awarded because of a position of power in the group. Credit can also be gained by good group behavior, though much more slowly (Hollander 1960). Thus, higher status members are able to resist the normative pressures of a well-crystallized, intensely-held norm better than low-status members.

The importance of status also varies across national culture. The status consciousness of the national culture is reflected in the level of privilege accorded to status holders. The source of status varies by nationality as well. Status in Latin America and Asia is granted largely based on formal roles in the organization and family status. In the United States, status tends to be awarded based on accomplishments (Harris and Morgan 1996).

Team Size

The size of the product development team has varied tremendously over time and between industries. In the American automotive companies, teams numbering in the hundreds were common until very recently, while the initial development of Microsoft's MS-DOS and the original Apple computer were both accomplished by product development teams made up of two members. At Stanley Tools, an electric screwdriver product required three people, while the development of the Boeing 777 airplane required the concerted efforts of roughly 10,000 people (Ulrich and Eppinger 2000, 6).

Clearly, different tasks require different size groups because of the number of specialties needed to solve particular problems. The concept of core size and peripheral size describes the technique where a smaller "core" group follows the project from start to finish, and a host of "peripheral" members contribute to the team when and where their specialties are appropriate and necessary.

The size of groups in general has been found to affect their work behavior. Smaller groups (from five to seven members) have been found to be faster at completing tasks and taking action, while large (12 or more members) groups have the advantage in problem solving and fact finding (Robbins 2000, 234).

The diffusion of individual responsibility that occurs in all groups has been found to increase with the size of the group, regardless of whether the group is high-performing or low-performing. This effect has been dubbed *social loafing*, and it challenges the generally accepted idea that well-functioning teams are able to perform at a higher level than the sum of individual efforts would produce independently. To provide a quantitative measure of the effect of social loafing, Kravitz and Martin (1986) found that groups of three produced results equal to two-and-a-half times the average individual performance. Because social loafing affects larger groups more intensely, this divide between individual and group performance should widen for larger teams (Robbins 2000, 235).

Cohesiveness

Cohesiveness is the “degree to which members are attracted to each other and are motivated to stay in the group” (Keyton and Springston 1990, 234). Using this definition, several factors have been found to affect the cohesiveness of the team (Gibson, Ivancevich et al. 1994). These factors are listed below.

- **Group size:** smaller groups are more cohesive
- **Goal crystallization:** agreement with group goals promotes cohesion
- **Time spent together:** more time spent together makes teams more cohesive
- **Status of group, actual and perceived:** the higher the actual and perceived status of the group the more cohesive the members
- **Competition with other groups:** competition against a common enemy will allow the members to bond together
- **Group vs. individual rewards:** giving rewards to the group promotes group cohesion
- **Physical isolation:** isolating the group will bring the members together

The importance of cohesion to the formation of product development teams in general, and team culture in particular, is that cohesion has been conditionally correlated with performance. The relevant condition is whether performance-related norms, such as level of work output, level of work quality, and level of cooperation with individuals outside of the group are present in the team. The relationship between cohesiveness and performance-related norms is illustrated in Table 8-2.

Table 7-4 Cohesiveness and group productivity

	High Cohesiveness	Low Cohesiveness
High Performance Norms	High productivity	Moderate productivity
Low Performance Norms	Low productivity	Moderate to low productivity

Table 8-2 adapted from (Robbins 2000, 238) and (Evans and Dion 1991)

7.9.7. PROCESSES

Group processes describe the systems designed to get work done. These systems, much like team culture, may be inherited from the organization or be created within the product development team itself. The processes specifically relevant to product development team culture are idea-generation and decision-making, discussed below.

Idea generation

Generating creative, viable ideas is one of the most critical tasks for a product development team, and the use of teams is often justified entirely by the perceived benefit teams provide in creative idea generation. But do teams really produce more creative ideas than individuals working alone?

In fact, groups do produce *more* creative ideas than individuals, and groups also produce more *creative* ideas than individuals. But groups also “cost” more than individuals (Allen 2001). When we compare a group with five members to five individuals working alone, we find that the five individuals produce *more* creative ideas than the group, and surprise, surprise, five individuals also produce more *creative* ideas than the group.

Why doesn't the group come up with greater quantity and quality of creative ideas than the same number of individuals working alone? The answer lies in the nature of creative ideas themselves. Creative ideas, in their infancy, are very close to being bad or crazy ideas, and even in a group that reserves judgment and attempts to be as nurturing as possible, members will self-censor in ways that they do not when working alone. This self-censorship happens because individuals anticipate what the other members might think of them if they were to voice their “bad” or “crazy” ideas. With creative ideas, it takes very little discouragement, even unvoiced discouragement, to kill the fragile, creative ideas at birth (Allen 2001).

Individual risk-taking

As we can see, idea generation is affected by the risk-taking orientation of the members of the group. Individuals are so averse to risking humiliation for voicing “crazy” ideas that they will censor themselves even when there is no voiced criticism. In the national culture of the USA it is generally understood that success is rewarded and failure is punished. Despite this apparently simple system that would seem to encourage success and discourage failure, many organizations reward something other than success. This rewarded behavior is non-failure. In many organizations the reward for non-failure is more appealing, and perhaps more easily won, than the reward for success. Thus, many group members would rather pursue non-failure than risk the possibility of failing publicly in the pursuit of success.

Other nationalities share these conundrums, and add their own. In the United Kingdom there is an even stronger cultural stigma associated with failure than in the USA, but in addition there is a stigma associated with success. Embedded in the national culture of the UK is the zero-sum philosophy of success, so that if one person is doing very well, then

others must be doing poorly as a result. The consequence is a stigma for both failure and success. These stigma have resulted in significantly lower rate of entrepreneurship (certainly a risky endeavor) when compared to the USA, even though in other respects the cultures share many attributes (Preston 2001).

Group-risk taking

While individuals experience very powerful pressure not to be seen failing, groups as a whole exhibit very different behavior when it comes to risk taking. The decisions of groups tend to shift towards greater risk, and this effect has been dubbed Groupshift. The attitudes of individual members tend to be exaggerated in the group environment, so that conservative members become more conservative while risk-tolerant members will tend to venture into areas of even greater risk. This position polarization does not, however, explain the general trend toward greater risk by itself. Several explanations exist for the shift toward greater risk. The first explanation is that if risk-taking is valued in the national or larger environmental culture then a member may exhibit risk-taking behavior to appear more admirable. Another explanation is the diffusion of responsibility that exists in groups. Since the group is taking the risk, no individual will be held directly responsible for the consequences of the decision, and thus the consequences of risk-taking are less tangible to the members (Wallach, Kogan et al. 1962; Kogan and Wallach 1967; Clark 1971).

The question remains, then, how best to generate creative ideas in the context of the product development team? There is no simple answer. Groups generate more and better creative ideas, but at higher cost, while eliminating the most creative ideas through normative effects. Individuals have access to the most creative ideas, but may not be able to explore these ideas as fully as could a group. One solution to this dilemma is to use a hybrid idea generation method, where individuals devise ideas on their own, allowing for an incubation period where fragile ideas are given time to grow. The ideas are then presented to the group for brainstorming, where the consequences and possibilities of the ideas can be fully explored (Allen 2001). This method attempts to preserve the best elements of both individual and group idea generation, but will likely be even more costly than either of the methods by themselves. Whether access to the very creative ideas of individuals is worth this additional cost must be decided by each product development team.

A final alternative for idea generation is the traditional “expert” method, where the appointed expert for a given technical area is given the task of devising a creative solution to the problem at hand. This “expert” idea generation is likely to preserve the advantages of individual idea generation, but difficulty arises when the creative ideas of different experts on the team must be integrated into a working, unified concept.

Decision-making processes

The final topic we will treat in this section on the impact of processes on product development team culture is decision-making.

If asked, “Why use groups?” most businesspeople would probably answer that groups provide better idea generation and better decision-making. We’ve explored idea-generation above, and found that although groups have certain advantages over individuals, they are not clearly superior in generating creative ideas. What about decision-making? Are groups really better than individuals at decision-making? The US legislative branch places the decisions of law in the hands of 100 senators and several hundred representatives; most colleges and universities decide whom to admit, and whom not to admit, by committee. Likewise, the many complex decisions required in product development are, in most cases, currently being made by a group.

But as in idea generation, it is not always clear that group decision-making is superior to individual decision-making. The consequences of normative effects in groups show themselves in group decision-making just as they do in all group activities. The consequence of these normative effects in decision-making is that groups will tend to make decisions in accord with the organizational culture that they represent. If a decision would benefit from the potential to run counter to organizational culture, then the decision is better left to individuals (Maier 1967).

Let us look into more detail at the advantages and disadvantages of group decision-making

Advantages of Group Decision-Making

To their credit, groups generate more complete information and knowledge when presented with a problem. By taking advantage of diversity of experience in the membership of the team, the decision will tend to be better informed. If the decision applies in any way to members of the team there is likely to be higher acceptance of the decision. Even if the decision applies to others, group members will be more likely to attempt to convince others of the efficacy of the decision because of their personal involvement in the decision-making process (Robbins 2000, 240).

Disadvantages of Group Decision-Making

Group decision-making is not without its liabilities. Decisions that must run counter to the organizational culture are not well-suited to group decision-making, because the normative power of the group will tend to amplify the embracing organizational culture and preclude decisions outside of its core values.

Group decision-making also tends to be slower than individual decision-making precisely because it draws upon the diverse views of the members of the team. Including these views takes time, and in addition to merely hearing diverse views, often clarification and

confirmation are required. These steps are responsible for many of the advantages of group decision-making described above, but the cost in time cannot be ignored. In situations where more rapid decisions can be more valuable than more correct or better-accepted decisions, individual decision-making may be appropriate. An example of individual decision-making that exemplifies the need for rapidity over acceptance is front-line military command.

Conformity pressures are also a disadvantage of group decision-making. The pressure to accept decisions made by the group, and to adapt ones views so as to fit into the perceived norms have a chilling impact on questioning of group decisions. The terrible consequences of conformity pressures in group decision-making can be seen in mob violence, and the infamous decision to invade the Bay of Pigs in Cuba, by President John F. Kennedy and his cadre of advisors.

Finally, the impact of diffusion of responsibility impacts the risk-taking orientation of individuals involved in group decision-making, just as it does in idea generation activities, described above. The same Groupshift towards decisions of greater risk is likely to occur, with the same likely causes: admiration-seeking risk-taking behavior and diffusion of responsibility.

Groupthink

The final topic to be considered in decision-making processes is the phenomenon of Groupthink. Groupthink describes the negative consequences of group pressures on mental efficiency, reality testing, and moral judgment (Janis 1982; Robbins 2000, 242).

The symptoms of Groupthink are shown below.

1. *Group members rationalize any resistance to the assumptions they have made. No matter how strongly the evidence may contradict their basic assumptions, members behave so as to reinforce those assumptions continually.*
2. *Members apply direct pressures on those who momentarily express doubts about any of the group's shared views or who question the validity of arguments supporting the alternative favored by the majority.*
3. *Those members who have doubts or hold differing points of view seek to avoid deviating from what appears to be group consensus by keeping silent about misgivings and even minimizing to themselves the importance of their doubts.*
4. *There appears to be an illusion of unanimity. If someone doesn't speak, it's assumed that he or she is in full accord. In other words, abstention becomes viewed as a "Yes" vote.*

(Robbins 2000, 242)

The antidote to Groupthink is to allow and even encourage low-level task and process conflict as well as confrontation between members while precluding reprisal by any member of the team.

8. METHOD

This section describes the method used to construct and confirm the attribute inventory method for measuring product development team culture. The intention in creating the attribute inventory method was to create a tool that would enable accurate, complete, consistent, comparable, and rapid collection of cultural information while minimizing the impact of agent and subject bias.

8.1. DESIGNING THE ATTRIBUTE INVENTORY METHOD

8.1.1. SELECTION OF DATA COLLECTION METHOD

A structured observational method was chosen for the attribute inventory method at the outset of this research after considering the merits of other quantitative and qualitative methods, such as controlled-variable experiments, surveys, case studies, interviews, and ethnography. As described in Section 8.1, the structured observational method provided for rapid data collection (a weakness of traditional encyclopedic and narrative ethnographic methods), which matched the time scale of product development teams, more often measured in months, not years.

Controlled-variable experimentation was deemed inappropriate because of the large number of variables and the difficulty in establishing any reasonable “control” condition for product development teams or culture. Surveys, interviews, and case studies were all seriously considered, as they provide many of the same benefits as the structured-observational method, such as consistent, comparable data, rapid collection of data, and minimal agent and subject bias. The structured-observational method was chosen above these other methods because of the accuracy and completeness provided by observing the team as a whole instead of attempting to assemble a picture of the group from the points of view of individuals (as would be the case from surveys or interviews). A pre-structured case study described the same method as our chosen structured observational method. An open ended case study was not chosen because of its inherent focus on a single “case,” with little concern for the consistency and repeatability of findings from one case to the next. By choosing a structured method we improve consistency and repeatability at the expense of possibly missing some aspects of a product development team’s culture that are not defined in the framework.

Commenting on the dilemma of structure vs. looseness, Robson states, “There is no obvious way out of this dilemma” (Robson 1993, 149). However, the structured observational method is able to deliver consistency, comparability, and is able to capture cultural information quickly, and thus, the dilemma is resolved.

8.2. RESEARCH METHOD OVERVIEW

To construct and validate the attribute inventory method, the chief challenges were to determine what attributes should be present in an inventory of product development team culture, to develop a method for validating these attributes, and to add any attributes that

were missing from the initial list. To determine these attributes, an initial set of assumed attributes was assembled from the product development team cultural factors analysis in Section 8.2, academic references, and the experience and intuition of the author. To confirm the attributes in the initial list, product development experts were interviewed to collect significance information on the initial attributes and to solicit ideas for new attributes. The product development experts described their own product development experiences. These accounts were analyzed for attribute content and significance information associated with each attribute. The interviewees were also asked to comment on the significance of any attributes that were not explicitly or implicitly noted in their product development experiences. Finally, ideas for new attributes related to product development team culture were solicited from the interviewees. The attribute significance data for the initial attributes was analyzed for rank and subject to selection criteria to determine the final set of attributes to be included in the attribute inventory.

8.3. INTERVIEW DESCRIPTION

To confirm and validate the initial attributes and to make the list of attributes more complete, a series of exploratory interviews were conducted with individuals who have significant experience in product development, which we defined as 10 years or more. These individuals varied in the type of product development they practiced, ranging from traditional physical product development and software development to education, medicine, coaching, and consulting. The positions that they held in product development teams varied as well. Team members, team leaders, general managers, team and leadership coaches, and business owner/CEOs were all represented by the interviews, providing many perspectives on and sources for cultural attributes appropriate to product development teams.

The interview was structured in three stages. The first stage of the interview collected routine factual biographical material. The second stage of the interview was designed to allow the interviewees to recount their product development experiences, with a focus on the cultural factors or attributes that were relevant to their experience and the performance of the team. This storytelling period allowed for the interviewees to provide unsolicited explicit and implicit attribute information through their own experiences. Descriptive and significance scale information was recorded for all attributes, and new the attributes introduced by the interviewees were also recorded.

Once this unsolicited resource was exhausted, the third stage of the interview questioned the interviewees about their opinion of any attributes that they had not explicitly or implicitly mentioned in their account of their own experience, and directly solicited attributes that they had not mentioned but that they believed to be significant.

Interview Structure

- 1) Factual biographical information**
- 2) Product development experience**
- 3) Direct attribute questioning**

8.4. SELECTION OF INTERVIEWEES

Interviewees were selected based on the type and amount of product development experience. In general, interviewees had 10 years or more product development experience. Where additional interviews were available on the same team or organization, such as in the case where access was available to the CEO/owner, a program manager, and a team member, the 10-year-experience criteria was ignored in favor of additional perspectives. Breadth of experience was also a consideration. Those interviewees who had experience in a variety of different product development activities were favored above those with an equal amount of time spent in the same product development area.

8.5. INITIAL ATTRIBUTES

This section contains the list of initial attributes assembled from product development team factors analysis, academic references, and the experience and intuition of the author. Where appropriate, the academic references that inspired the attribute are noted.

Social network in group: A closed social network is where most members have relationships with the relations of the other members. An open social network is when a members relations have few and weak ties to other members. A social network must either be open or closed (Baker 2001; Sparrowe, Liden et al. 2001).

- **Open**
- **Closed**

Messages from initiator: The initiator is the person who was responsible for creating the group. Typically this person delivers the messages that tell the group who they are, what they are to do, how they should do it, and the power they can exercise to achieve their goals. The initiator is not necessarily the leader of the team.

- **Charter:** Defines the purpose, product, and measures of success of a team
- **Vision:** The message, delivered by the initiator, of the place of the team in the world, usually including overarching principles that might guide difficult decisions.
- **Mission:** Similar, but not identical to vision, the team mission is the overarching goals of the team, such as "improve the length and quality of life for dialysis patients" for a group concerned with medical equipment.
- **Authority:** A measure of how much the initiator defines the limits of the authority of the team. For example, a high authority score would mean that a team has a very clear understanding of the scope of its authority.

Personality of leader: This is a measure of the strength of the personality of the leader. A leader with a strong personality will seek to communicate his or her biases on how to fulfill the goals put forth, assumptions about the nature of the world, human nature, truth, relationships, time, space, etc (Schein 1983).

- **Personality communication**

Competitiveness: This attribute is a description of competitive behavior and attitudes of individuals within the group.

- **External:** External competition describes the degree to which individuals or the group as a whole behaves out of competition with external constituencies. These constituencies can lie within the organization or outside of it.
 - **Internal:** Internal competition refers to competitive behavior by individuals or subgroups within the group.
- Power distance:** Power distance refers to the degree to which members accept the power in the group is distributed unequally. High power distance refers to extremely unequal level of power between leaders and members (Hofstede 1993).
- **Between leader and members**
- Social distance:** Social distance refers to the actual or perceived "class" difference between two groups. In general, military officers and enlisted men maintain significant social distance, while non-commissioned officers will maintain significantly less social distance from their enlisted soldiers (Johns 1986).
- **Between members**
 - **Between leader and members**
- Idea generation:** This attribute describes the types of idea generation that take place in the team (Allen 2001).
- **Brainstorming:** Brainstorming refers to spontaneous idea generation in a group where judgment is reserved.
 - **Individual:** Individual idea generation refers to the technique where ideas are conceived individually and brought to the group for evaluation.
 - **Combination individual/brainstorming:** Combination idea generation is when ideas are conceived individually then brought to the group for brainstorming.
 - **Expert:** Expert idea generation is when idea generation is left to the functional expert in the area where ideas are required.
- Idea treatment:** This attribute refers to the of group members to new, unusual, or disruptive ideas (Allen 2001).
- **Nurturing**
 - **Critical**
- Job flexibility:** This attribute is a measure of job flexibility in members of the team. Will members go outside of their traditional job description or work boundaries to complete tasks that are important to the team?
- **“Not my job”**
 - **“Whatever’s necessary”**
- Group argot:** The argot is the specialized language of the group. A high argot presence indicates a large amount of specialized language.
- **Argot presence**
- Decision-making technique:** This attribute identifies different decision-making techniques. The significance of the decision-making technique refers to the effect its presence or absence has on the culture of the group.
- **Formal authority:** Decisions are left to those whose formal titles assign them the authority to make the decisions.
 - **Data-based:** Decisions are made using information only.

- **Intuition-based:** Decisions are made on the mostly uninformed hunches of members of the team.
- **Expert:** Decisions are left to the functional experts who know the most about the decision at hand.
- **Collaborative:** Formal decision-makers involve other members by asking them to inform the decision makers on decision factors.
- **Consensus:** The group attempts to reach a mutually agreeable solution to problems through presentation of ideas and compromise.
- **Democratic:** Decisions are decided by voting, where a set percentage of votes will decide the decision. Sometimes formal authorities or experts are assigned tiebreaker privileges or veto power.
- **Autocratic:** The formal leader makes the decision based on his or her own information, experience, or opinion.

Risk-taking: This attribute describes how risk-taking behavior is treated in the group, including whether the group engages in risky behavior and the consequences of risk taking behavior (Wallach, Kogan et al. 1962; Kogan and Wallach 1967; Clark 1971).

- **Risk-taking attitude:** Does the group take risks? A high amount indicates high risk-taking, while a low-amount indicates risk-aversion.
- **Positive consequence of success:** To what degree does the group punish success (Preston 2001)?
- **Negative consequence of success:** To what degree does the group reward success (Preston 2001)?
- **Positive consequence of failure:** To what degree does the group reward failure?
- **Negative consequence of failure:** To what degree does the group punish failure (Preston 2001)?
- **Positive consequence of no failure:** To what degree does the group reward the absence of failures?

Autonomy: The freedom from external control that the group enjoys (Dally, Schmidt et al. 1998).

- **Functional team:** The team exists within a functional department and is managed by a manager from within the functional department. This team enjoys the least autonomy.
- **Modified-functional team:** A modified functional team draws members from various technical departments, meets in a separate area, but is managed by a functional manager.
- **Balanced team:** A balanced team draws members from functional departments, members are colocated, and has a dedicated manager.
- **Independent team:** Similar to a balanced team, and in addition the team is remotely located and a separate business entity from the parent organization.

Resemblance to embracing cultures: How much has the group culture inherited the core cultural values of the embracing cultures. A group culture with differing or conflicting core values would thus have low amount of resemblance (Adler 1997).

- **Organizational culture:** The culture of the organization within which the group exists.

- **Environmental culture:** The culture of the larger world, including economic, political, technological, and other forces.

Stakeholder orientation: Stakeholder orientation indicates the attention paid to the various stakeholders listed, thus, a high customer stakeholder orientation indicates that the group is highly concerned with the satisfaction of the customer.

- **Customers**
- **Employees**
- **Sales**
- **Procedures**

Conflict orientation: How does the team view conflict (Jehn and Mannix 2001)?

- **Conflict tolerant:** Can the team tolerate conflict without distress?
- **Conflict avoidant:** Does the team avoid conflict at the expense of other needs?
- **Process conflict:** The amount of conflict surrounding the processes followed by the group.
- **Relationship conflict:** The amount of conflict surrounding the tasks
- **Task conflict:** The amount of conflict surrounding the tasks undertaken by the group.

Membership exclusivity: How difficult is gaining membership in the team, how is membership perceived by outsiders, and how is exclusivity generated?

- **Real:** Is the exclusivity due to difficult standards of entrance or an exemplary record of performance?
- **Perceived:** Is the exclusivity due to false information or fabricated performance?

8.6. RANKING TECHNIQUE

The attribute inventory method consists of a list of attributes with corresponding descriptions. Each attribute has two measures, a descriptive measure and a significance measure. The descriptive measure directs the agent to record information in one of following four scales: amount, presence, choice, or open-ended description. The significance measure directs the agent to record the significance of the attribute to the culture of the product development team. By observing a product development team and recording descriptive and significance measures for each attribute, an agent is able to capture the culture of the team.

In order to validate the initial set of attributes, experts in product development were asked to describe their most outstanding product development experiences. From these experiences the significance information of the initial attributes was recorded based on the explicit and implicit statements made by the interviewees. The significance of each attribute to product development team culture was recorded using the significance scale, shown below. Since the interviewees were being used to describe the general significance of the attributes for general product development team culture, the descriptive information pertaining to their particular product development team experiences was not recorded.

The significance scale indicates the impact of the attribute on the product development team's culture, and is scored similarly to the amount scale, above.

- 0, none
- 1, marginally significant
- 3, significant
- 9, very significant

8.6.1. RANKING AND SELECTION OF ATTRIBUTES

The significance numbers assigned to each of the initial attributes by each interviewee were averaged and the attributes sorted from highest to lowest. The attributes were then subject to numerical selection criteria (ranking cutoff). Those attributes that were below the cutoff but whose presence was supported by established research were retained.

In addition to the 54 initial attributes, the interviewees generated 109 additional attributes in the course of the interviews. Using the screened initial attributes and the interviewee-generated attributes, an affinity diagram was constructed to group the attributes into descriptive categories, with redundant attributes eliminated.

After pruning and rewording this screened list of attributes forms the final attribute inventory for measure product development team culture.

9. ANALYSIS

9.1. DESCRIPTION OF INTERVIEWEES

The following persons were interviewed to provide confirmation of the initial attributes and to augment the initial attributes with additional attributes provided by the experiences of the interviewees in product development teams or observing product development teams. The roles that each person has played in product development and their educational or professional discipline are shown below.

Shaun Abrahamson

Role: team member

Discipline: software development

Graceanne Adamo

Role: team leader, team member

Discipline: standardized patient medical education, fine arts education

Scott Ahlman

Role: team member

Discipline: vehicle dynamics, mechanical engineering

Laura Cleminson

Role: team leader

Discipline: program management, customer service, telecommunications, entrepreneurship

Oliver Eslinger

Role: team coach, individual coach

Discipline: sports psychology

Bart Hogan

Role: team leader, team member

Discipline: mechanical engineering

Matthew Kressy

Role: team leader, team member

Discipline: industrial design

Chris Magee

Role: initiator, general manager

Discipline: systems engineering, basic research design

Lisa Marshall

Role: team coach, individual coach

Discipline: neurolinguistics, communication studies, organizational behavior

Shaun Meredith

Role: team leader, team member

Discipline: nuclear engineering, software engineering, environmental science

Ben Powers

Role: team member
Discipline: mechanical engineering

Mike Timm

Role: team leader, team member
Discipline: software development

Doug Vincent

Role: senior manager, team coach, team leader, team member
Discipline: mechanical engineering

Aubrey W. Williams

Role: ethnographer
Discipline: cultural anthropology

9.2. INITIAL ATTRIBUTE SIGNIFICANCE RANKINGS

The table below (table 11-1) shows the averages of the significance measures (ranked from 1-9) provided by the interviews. The total average of significance measures was 6.80, and the mean value of average significance measures was 7.15, indicating a positively skewed distribution.

If a cutoff of significance 8.00 is taken, then only 10 of the 52 initial attributes remain, or 19%, indicating that if a variation of one point is allowed, then 19% of the attributes were considered highly significant (defined as a significance measure of 9).

Only one attribute's significance measure fell below 4.00, this was *internal competitiveness*. The significance measure of 3 was defined as moderately significant, thus if a variation of one point is allowed in either direction (2-4) then all scores except *internal competitiveness* were considered more than moderately significant since they all fell above a score of 4.00.

This positive skew indicates that the interviewees felt that the initial attributes were all (but one) at least moderately significant, and some were highly significant. This did not allow for culling of attributes from the list due the lack of low significance measures by the interviewees, and therefore all of the initial attributes were retained.

Table 9-1 Initial attribute significance rankings from interviews

Attributes	Average	Attributes	Average
Social network in group		Risk-taking	
Open	5.77	Risk taking attitude	8.08
Closed	5.77	Positive consequence of success	5.15
Messages from initiator		Negative consequence of success	7.00
Charter	7.33	Positive consequence of failure	7.00
Vision	8.08	Negative consequence of failure	6.54
Mission	7.33	Positive consequence of no failure	6.08
Authority	6.83	Autonomy	
Personality of leader		Functional team	5.62
Personality communication	7.00	Modified-functional team	5.62
Competitiveness		Balanced team	5.77
External	5.15	Independent team	5.77
Internal	3.92	Resemblance to embracing cultures	
Power distance		Organizational culture	7.00
Between leader and members	6.08	Environmental culture	4.54
Social distance		Stakeholder orientation	
Between members	8.08	Customers	8.08
Between leader and members	7.62	Employees	8.54
Idea generation		Sales	7.62
Brainstorming	8.08	Procedures	7.46
Individual	7.15	Conflict orientation	
Combination individual/brainstorming	5.92	Conflict tolerant	8.08
Expert	7.62	Conflict avoidant	8.08
Idea treatment		Process conflict	6.69
Nurturing	7.46	Relationship conflict	7.15
Critical	7.00	Task conflict	7.15
Job flexibility		Membership exclusivity	
"Not my job"	7.62	Real	6.08
"Whatever's necessary"	7.15	Perceived	6.08
Group argot		Member-generated	4.08
Argot presence	4.85	Leader-generated	4.23
Decision-making technique			
Formal authority	8.08		
Data-based	7.62		
Intuition-based	7.62		
Expert	7.62		
Collaborative	7.62		
Consensus	7.62		
Democratic	7.62		
Autocratic	8.08		
Total average			
	6.80		
Median of averages			
	7.15		

9.3. DISCUSSION OF HIGHEST-RATED ATTRIBUTES

The highest-rated attributes shown in Table 11-2, at right, are of interest because out of the ten attributes to receive an average significance measure above 8.00, no category of attributes dominated.

Orientation to employee needs scored the highest, indicating that the interviewees felt that it was the most significant attribute to affect group culture. *Orientation to customer needs* was also part of the top 10 attributes with a score of 8.08, while *orientation to sales needs* and *orientation to procedural needs* received significance scores of 7.62 and 7.46 respectively

Vision from initiator (8.08) was one of the attributes to receive the second highest score. Other messages from the initiator were *charter from initiator* (7.33), *mission from initiator* (7.33), and *authority from initiator* (6.83).

Social distance between members also received a score of 8.08, with *social distance between leader and members* just below the 8.00 cutoff at 7.62. Interestingly, *power distance* received a noticeably lower score of 6.08.

Brainstorming idea generation (8.08) rose above other idea generation techniques in the interviewee's opinions of significance to product development team culture. *Expert idea generation* (7.62) and *individual idea generation* (7.15), both scored relatively high, while *combination individual/brainstorming idea generation* (5.92) scored noticeably lower.

Two decision-making styles made it into the top ten, *formal-authority decision-making* (8.08) and *autocratic decision-making* (8.08), rose above other decision-making styles in the interviewee's opinion on their significance to team culture. The remaining decision-making attributes, *data-based*, *intuition-based*, *expert*, *collaborative*, *consensus*, and *democratic decision-making* all scored 7.62.

Risk and conflict attributes filled out the top-ten attributes, with *risk-taking attitude*, *conflict tolerant*, and *conflict avoidant* all scoring 8.08. The conflict type attributes of *relationship conflict* and *task conflict* both scored 7.15, while *process conflict* scored lower at 6.69.

Table 9-2 Sorted initial attributes

Attribute	Average	Attribute	Average
Orientation to employee needs	8.54	Task conflict	7.15
Vision from initiator	8.08	Personality communication from leader	7.00
Social distance between members	8.08	Critical idea treatment	7.00
Brainstorming idea gen	8.08	Negative consequence of success	7.00
Formal authority decision-making	8.08	Positive consequence of failure	7.00
Autocratic decision-making	8.08	Resemblance to organizational culture	7.00
Risk taking attitude	8.08	Authority from initiator	6.83
Orientation to customer needs	8.08	Process conflict	6.69
Conflict tolerant	8.08	Negative consequence of failure	6.54
Conflict avoidant	8.08	Power distance	6.08
Social distance between leader and members	7.62	Positive consequence of no failure	6.08
Expert idea gen	7.62	Real membership exclusivity	6.08
"Not my job" attitude	7.62	Perceived membership exclusivity	6.08
Data-based decision-making	7.62	Combination individual/brainstorming idea gen	5.92
Intuition-based decision-making	7.62	Open social network	5.77
Expert decision-making	7.62	Closed social network	5.77
Collaborative decision-making	7.62	Balanced team autonomy	5.77
Consensus decision-making	7.62	Independent team autonomy	5.77
Democratic decision-making	7.62	Functional team autonomy	5.62
Orientation to sales needs	7.62	Modified-functional team autonomy	5.62
Nurturing idea treatment	7.46	External competitiveness	5.15
Orientation to procedural needs	7.46	Positive consequence of success	5.15
Charter from initiator	7.33	Argot presence in group	4.85
Mission from initiator	7.33	Resemblance to environmental culture	4.54
Individual idea gen	7.15	Leader-generated membership exclusivity	4.23
"Whatever's necessary" attitude	7.15	Member-generated membership exclusivity	4.08
Relationship conflict	7.15	Internal competitiveness	3.92

9.4. NEW ATTRIBUTES

The following attributes were generated in the course of the interviews and grouped into affinity categories using an affinity diagram method.

Team Definition

Is the charter clear?
Is the charter compelling?
Is the charter complete?
Does the charter explain why the work is meaningful to the organization and client?
Level of technical challenge
Type of challenge
Internal or external client
Specificity of client request
Frequency of changes to request by client

Project Description

Length of project
Project alignment with organizational culture
Level of technical challenge
Type of challenge
Internal or external client
Specificity of client request
Frequency of changes to request by client

Group-level attributes

Average member tenure
Member tenure distribution
Creation-refinement orientation
Infrastructure-building orientation
NIH syndrome
Core team size
Peripheral team size
Hierarchical layers in team
Selection process for team members
Selection process of group by members
Level of separation between team and organization
Duration of separation of team from organization
Resources available to team for exploration
Product focus
Technology focus
Level of creativity
Level of discipline
Level of excitement in team
Number of simultaneous projects for team
Formal job-scope orientation
Informal job-scope orientation
Team oriented to customer needs
Team oriented to team needs
Team oriented to product success
Team oriented to process accuracy

Group Norms

Dress code
Boundaries of acceptable work level
Work process formality
Is the team inclusive or exclusive towards new members?

Autonomy

Effect on autonomy when team encounters difficulties
Areas of autonomy

Leadership

Congruence of nominal and actual leadership
Leadership criterion: seniority
Leadership criterion: age
Leadership criterion: group tenure
Leadership criterion: reputation/status
Leadership criterion: appointment
Optimism of leader
Willingness of leader to commit resources for exploration
Peter Pan leadership archetype
Ruler leadership archetype
Magician leadership archetype
Sage leadership archetype
Fool leadership archetype
Attention to reasons for success
Attention to reasons for failure
Leader openness to pushback from members
Emotional investment of leader in success of project
Availability of leader to group needs
Availability of leader to member needs
Distribution of credit/ownership: breadth
Distribution of credit/ownership: equity
Leader acceptance of member idiosyncrasies
Leader's attention to status
Do members feel invited to join the team
Are members made to feel exceptional once they have joined the team?
Leader personality communication
Power distance
Social distance between leader and members

Members

Optimism of members
Member's technical self-confidence
Members' familiarity with team work environment
Level of member specialization
Willingness to work outside of specialization
Level of relevant member experience
Level of member buy-in
Member responsibilities outside of team
Level of shared mental models by members
Members' previous experience with one another
Members' previous relevant technical experience
Member acceptance of member idiosyncrasies
Member attention to status
Physical/geographical distribution of members
Member willingness to learn/adapt to new work processes

Communication

Leader to member communication formality
Leader to member communication frequency
Leader to member communication depth
Member to member communication formality
Member communication depth
Member communication frequency
Stigma associated with members asking questions
Stigma associated with leader asking questions
Defensive response to criticism
Relevance of communication to project
Client formal communication with team
Client collaborative communication with team
Differing member jargon
Level of unique team argot

Decision-making

Decision-making objectivity
Decision-making self alignment
Decision-making group alignment
Decision-making project alignment
Diffusion of decision-making responsibility

Learning

Leadership orientation: experienced teaches inexperienced
Leadership orientation: inexperienced teaches experienced
Leadership orientation: young teaches old
Learning orientation: old teaches young
Member comfort with learning from other members
Attention to reasons for failure
Attention to reasons for success
Mentoring in team

Evaluation

Team-level reward/punishment
Team-level evaluation by process
Team-level evaluation by manager
Team-level evaluation by client
Team-level evaluation by product success
Member-level reward/punishment
Member-level evaluation by process
Member-level evaluation by manager
Member-level evaluation by client
Member-level evaluation by product success

Risk & Conflict

Risk-tolerance of client

9.5. ATTRIBUTE SELECTION

The new attributes were screened for redundancy and reworded, then compared with the initial attributes for redundancy. We choose to use the affinity headings generated with the new attributes for the final attribute inventory because they were more descriptive than the many headings used in the initial attribute set. Initial attributes were reworded to convey the same information that before had been conveyed by the headings and attribute descriptions together.

Since the new attributes were not subject to the significance test that the initial attributes had been subject to, we chose to search for confirmation of these attributes in three ways. The first and most reliable method was to find support for the attributes in academic research, and many of the new attributes were supported in this way. The factors analysis

conducted in Section 8.2 of this thesis also confirmed some of the new attributes. Other attributes were included because they were confirmed by the experience and of the author.

9.6. FINAL ATTRIBUTES

New attributes are shown in red.

<p><u>Team Definition</u></p> <hr/> <p>Charter clarity Is the charter compelling? Charter completeness Vision Mission Definition of team authority</p> <p><u>Project Description</u></p> <hr/> <p>Length of project Project alignment with organizational culture Level of technical challenge Type of challenge Internal or external client Specificity of client request Frequency of changes to request by client</p> <p><u>Group-level attributes</u></p> <hr/> <p>Resources available to team Average member tenure Distribution of member tenure Creation-refinement orientation Infrastructure-building orientation NIH syndrome Core team size Peripheral team size Hierarchical layers in team Selection process for team members Selection process of group by members Product focus Technology focus Level of creativity Level of discipline Level of excitement in team Number of simultaneous projects for team Social network in team External competitiveness Internal competitiveness Formal job-scope orientation Informal job-scope orientation Team resemblance to organizational culture Team resemblance to environmental culture Team oriented to customer needs Team oriented to team needs Team oriented to product success</p>	<p>Team oriented to process accuracy Real team exclusivity Perceived team exclusivity</p> <p><u>Group Norms</u></p> <hr/> <p>Boundaries of acceptable work level Work process formality Positive consequence of success Negative consequence of success Positive consequence of failure Negative consequence of failure Positive consequence of non-failure</p> <p><u>Autonomy</u></p> <hr/> <p>Effect on autonomy when team encounters difficulties Areas of autonomy Team structure</p> <p><u>Leadership</u></p> <hr/> <p>Peter Pan leadership archetype Ruler leadership archetype Magician leadership archetype Sage leadership archetype Fool leadership archetype Congruence of nominal and actual leadership Leadership criteria Optimism of leader Attention to reasons for success Attention to reasons for failure Leader openness to pushback from members Leader buy-in Availability of leader to group needs Availability of leader to member needs Breadth of distribution of credit/ownership Equity of distribution of credit/ownership Leader acceptance of member idiosyncrasies Leader's attention to status Do members feel invited to join the team? Positive description of other members upon group formation Leader personality communication Power distance Social distance between leader and members</p>
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Members

Optimism of members
Member's technical self-confidence
Members' familiarity with team work-environment
Level of member specialization
Willingness to work outside of specialization
Level of relevant member experience
Member buy-in
Member responsibilities outside of team
Group membership outside of organization
Level of shared mental models by members
Members' previous experience with one another
Members' previous relevant technical experience
Member acceptance of member idiosyncrasies
Member attention to status
Physical/geographical distribution of members
Member willingness to learn/adapt to new work processes
Social distance between members

Communication

Level of unique team argot
Differing member jargon
Leader to member communication formality
Leader to member communication frequency
Leader to member communication depth
Member communication formality
Member communication frequency
Member communication depth
Client communication formality
Client communication frequency
Client communication depth
Client collaborative communication with team
Stigma associated with members asking questions
Stigma associated with leader asking questions
Defensive response to criticism

Decision-making

Decision-making objectivity
Decision-making individual alignment
Decision-making group alignment
Decision-making project alignment
Diffusion of decision-making responsibility
Other decision-making styles

Dominant decision-making style

Learning

Member comfort with learning from other members
Leadership orientation (experienced teaches inexperienced)
Leadership orientation (inexperienced teaches experienced)
Leadership orientation (young teaches old)
Learning orientation (old teaches young)
Attention to reasons for failure
Attention to reasons for success

Evaluation

Team-level reward/punishment
Team-level evaluation by process
Team-level evaluation by manager
Team-level evaluation by members
Team-level evaluation by client
Team-level evaluation by product success
Member-level reward/punishment
Member-level evaluation by process
Member-level evaluation by manager
Member-level evaluation by members
Member-level evaluation by client
Member-level evaluation by product success

Idea generation

Brainstorming
Individual
Combination individual/brainstorming
Expert
Nurturing treatment of new ideas
Critical treatment of new ideas

Risk & Conflict

Risk-tolerance of client
Risk-tolerance in team
Team conflict tolerance
Level of team relationship conflict
Level of team process conflict
Level of team task conflict

10. RESULTS

10.1. FINAL ATTRIBUTE SCALES

Each attribute is to be recorded using two scales, a descriptive scale and a significance scale. There are four types of descriptive scales, and after each attribute the type of descriptive scale to be used is indicated by either an (A), (P), (C), or (D), which stand for amount, present/not present, choice, and description respectively.

10.1.1. DESCRIPTIVE SCALES

(A) Amount scale

The amount scale describes to what extent an attribute is present in the team, and has a range from 1 to 5

- 1 none**
- 2 low amount**
- 3 moderate amount**
- 4 high amount**
- 5 very high amount**

(P) Presence scale

The presence scale indicates whether an attribute is present or not.

- 1 present**
- 0 not present**

(C) Choice scale

The choice scale indicates a choice of items provided by the attribute. The items are listed using the letter a), b), c), etc. If more than one choice is present, list all choices and indicate with an amount score the extent that each choice is present in the team. If none of the choices describes the team, use a (D) scale to describe the team in the context of the attribute.

(D) Descriptive scale

When the descriptive scale is indicated, the agent is to describe the attribute in an open-ended fashion. Any attributes using the (D) scale will have guidance on what to describe in the attribute description

10.1.2. SIGNIFICANCE SCALE

The significance scale is the second measure recorded for each attribute. The significance scale uses a 5-point scale similar to the amount scale, as shown below.

- 1 not significant**
- 2 marginally significant**
- 3 moderately significant**
- 4 highly significant**
- 5 very highly significant**

10.1.3. SAMPLE ATTRIBUTE RECORDINGS

Below are shown two examples of how an agent would record attributes. The first attribute, *charter completeness*, demonstrates an attribute that uses the “(A) amount” descriptive scale, the most common scale. The second attribute, *type of challenge*, demonstrates the “(D) description” descriptive scale.

Charter completeness – A: 5, S: 3

Explanation: by indicating an score of 5 on the amount scale (A: 5) the agent is indicating that the team charter is very complete, meaning that it defines the purpose of the team, describes the product in sufficient detail, explains the measures by which the team will be judged, the context in which the product is being developed and why the project is important to the organization and to the client. The agent observed that the charter is moderately significant (S: 3) in shaping the culture of the team.

Type of challenge – D: the project is challenging because it employs unproven technology, the product is to be used in a harsh marine environment, and the team must deliver the product in 6 months. S: 4

Explanation: this attribute describes the type of challenge that the team is facing, and indicates that the type of challenge is very significant (4) in shaping the culture of the team?

10.2. FINAL ATTRIBUTES WITH DESCRIPTIONS

Below is the final list of attributes that an agent would use to measure the culture of a product development team. Attributes are grouped into categories, and each attribute has the type of descriptive scale to be used indicated after the title of the attribute. Explanations of these descriptive scales can be found in Section 12.1 of this thesis. In addition, each attribute has a description, which is intended to clarify the meaning of the attribute to the agent. Where appropriate, attributes are cited with reference to the interviews conducted for this thesis, or with reference to academic sources.

Team Definition

Charter clarity (A): can the charter be explained to an outsider, and from that description could the outsider determine whether or not the charter is being carried out (Marshall 2002a)?

Is the charter compelling? (A): Is the message of the charter meaningful and motivating to the members of the team (Marshall 2002a)?

Charter completeness (A): the team charter should define the purpose, product, measures of success of a team, and the relevance of the project to the stakeholders (Marshall 2002a).

Vision (A): A guiding philosophy, delivered by the initiator, that communicates the core values and beliefs about employees, customers, products, management, and the purpose of the organization, including a vivid description of the mission. (Collins and Porras 1991).

Mission (A): Part of the vision of the team, the team mission is the clear and compelling goal of the team, difficult yet achievable, that translates the abstractness of the vision into concrete, tangible goals, usually including a timeframe for completion (Collins and Porras 1991).

Definition of team authority (D): In what areas does the team possess authority (Magee 2002)?

Project Description

Length of project (D): How long is the project expected to take to completion?

Project alignment with organizational

culture (A): Is the project aligned with the critical tasks and strategy of the organization (Tushman and O'Reilly III 1997)?

Level of technical challenge (A): how difficult is the challenge put before the team, based on previous experience and performance of the team, its leader, and its members (Magee 2002)?

Type of challenge (D): Why is the project challenging? Possible reasons include time, new technology, integration, unfamiliarity, tight budget, and others.

Internal or external client (C): Is the client for the project within the organization (internal) or outside of the organization (external).

Specificity of client request (A): How specific is the client in defining what they want the project to deliver?

Frequency of changes to request by client (A): How often has the client changed the specifications of the deliverables.

Group-level attributes

Resources available to team (A): to what extent does the team receive the resources it needs to explore possibilities and to execute concepts effectively?

Average member tenure (D): what is the average time that a member has been part of the team (Katz and Allen 1982)?

Distribution of member tenure (D): What is skew of member tenure, if any? Negative, positive, neutral (Katz and Allen 1982)?

Creation-refinement orientation (A): is the team oriented towards creating new products and technologies or is the team oriented towards refining existing ideas? A higher amount indicates creation orientation (Shiba 2001).

Infrastructure-building orientation (A): How oriented is the team towards creating lasting technology, processes, and knowledge for the organization to reuse (Hogan 2002)?

NIH syndrome (A): does the team seek out and accept information and learning from outside of the boundaries of the team, in other words, avoiding the Not-Invented-Here syndrome (Katz and Allen 1982)?

Core team size (D): Of the total members of the team, how many are a part of the core group, involved in all or almost all stages of the product development?

Peripheral team size (D): Of the total members of the team, how many are a part of the peripheral group, involved in only one or several stages of product development?

Hierarchical layers in team (D): Is the team divided into hierarchical layers? If so, how many (Magee 2002)?

Selection process for team members (A): Is there a selection process for admitting members to the team? If so, how complex is this process, how rigorous?

Selection process of group by members (A): Do the members select the group? If so, how complex is this process, and how rigorous?

Product focus (A): How focused is the team on accumulating knowledge and expertise on subjects directly related to the product being developed (Allen 2000)?

Technology focus (A): How focused is the team on accumulating knowledge and expertise on subjects related to the general areas of technology being used in the product being developed (Allen 2000)?

Level of creativity (A): To what extent does the group reward creative ideas and activities (Vincent 2002)?

Level of discipline (A): To what extent does the group reward rigorous, disciplined thinking and activities (Vincent 2002)?

Level of excitement in team (A): Are members excited to be a part of the team, going above and beyond their nominal duties out of enthusiasm for and commitment to the project?

Social network (C): Is the social network of the team members a) open, or b) closed? An open social network is where most of the social connections of team members lie outside of the team, while a closed social network would have most members having the majority of their social connections with other members of the team (Baker 2001; Sparrowe, Liden et al. 2001)?

External competitiveness (A): To what extent do individuals and the team as a whole display competitive behavior against groups outside of the team?

Internal competitiveness (A): To what extent do individuals in the team display competitive behavior against other team members?

Formal job-scope orientation (A): Are members of the team concerned mostly with fulfilling the formally defined duties of their job?

Informal job-scope orientation (A): Are members concerned mostly with doing what needs to be done to accomplish the goals set forth in the charter, with little concern for the formal duties of their job?

Team resemblance to organizational culture (A): To what extent does the team culture resemble the general organizational culture (Adler 1997)?

Team resemblance to environmental culture (A): To what extent does the team culture resemble the general environmental culture (Adler 1997)?

Team oriented to customer needs (A): To what extent is the team oriented to satisfying the needs of the customers of the product being developed?

Team oriented to team needs (A): To what extent is the team oriented to satisfying the needs of the team itself and its members?

Team oriented to product success (A): To what extent is the team oriented to satisfying the requirements for the product to be successful in the marketplace?

Team oriented to process accuracy (A): To what extent is the team oriented to satisfying the formal processes set forth for product development in the organization?

Real team exclusivity (A): How difficult does the organization, initiator, leader, or members make it for a new member to join the team?

Perceived team exclusivity (A): How does the organization perceive the difficulty of gaining entry to the team?

Group norms

Boundaries of acceptable work level (D): how much work is expected of each member of the team?

Work process formality (A): how closely are members expected to follow the rules, written or unwritten, on how work is to be done in the organization?

Positive consequence of success (A): To what degree does the group punish success (Preston 2001)?

Negative consequence of success (A): To what degree does the group reward success (Preston 2001)?

Positive consequence of failure (A): To what degree does the group reward failure?

Negative consequence of failure (A): To what degree does the group punish failure (Preston 2001)?

Positive consequence of non-failure (A): To what degree does the group reward the absence of failures?

Autonomy

Effect on autonomy when team encounters difficulties (A): Does the team experience reduced autonomy when it is perceived to encounter difficulties (Magee 2002)?

Areas of autonomy (D): describe the areas of product development over which the team has autonomy and those areas that it does not (Magee 2002)?

Team structure (C): a) Functional team structure (the team exists within a functional department and is managed by a manager from within the functional department. This team enjoys the least autonomy.) b) Modified-functional team structure (a modified functional team draws members from various technical departments, meets in a separate area, but is managed by a functional manager.) c) Product-focused team structure (a product-focused team draws members from functional departments, members are collocated, and has a dedicated manager.) d) Independent team structure (similar to a product-focused team, and in addition the team is remotely located and a separate business entity from the parent organization.) (Dally, Schmidt et al. 1998).

Leadership

Peter Pan leadership archetype (A): A style of leadership that is characterized by the character Peter Pan, where youth and charisma are valued above wisdom and experience, there is little thought to the consequences of the decisions being made. When confronted with obstacles or hardship this leadership styles tends to exhibit little resiliency (Marshall 2002b).

Ruler leadership archetype (A): A style of leadership concerned with duty, loyalty, responsibility, has the ability to be wrong, understands own dark side, a stately process where success is expected and delivered (Pearson 1991).

Magician leadership archetype (A): A style of leadership concerned with the transformation of lesser into better realities, strong power of naming and storytelling in the organization, a team that made something extraordinary happen with very little resources (Pearson 1991).

Sage leadership archetype (A): A style of leadership concerned with understanding the world, not changing it (Pearson 1991).

Fool leadership archetype (A): completely in the moment and playful, not concerned with external evaluation (Pearson 1991).

Congruence of nominal and actual leadership (A): to what extent is the person named as leader (if any) the same person who carries out the actual leadership duties in the team (Marshall 2002a)?

Leadership criteria (D): describe the criteria that qualifies the leader as eligible for their position in the context of the team and its members. Possible criteria include organizational seniority, age, team tenure, reputation/status, and/or appointment (Williams 2002).

Optimism of leader (A): does the leader explain successes of the team as due to permanent, pervasive, and specific to the team (Seligman 1998)?

Willingness of leader to commit resources (A): to what extent is the leader willing to commit the finite resources of the team to elements of the product development process that are perceived to involve risk?

Attention to reasons for success (A): to what extent does the team seek to learn and understand the reasons it has succeeded in the past and incorporate that learning into future work?

Attention to reasons for failure (A): to what extent does the team seek to learn and understand the reasons it has failed in the past and incorporate that learning into future work?

Leader openness to pushback from members (A): how comfortable is the leader with being challenged by group members on technical and project related issues and decisions?

Leader buy-in (A): to what extent is the leader of the team personally emotionally invested in the success of the project and committed to the vision and mission of the team?

Availability of leader to group needs (A): how much of the leader's total work time do they make available for the needs of the group?

Availability of leader to member needs (A): how much of the leader's total work time do they make available for the individual needs of the members of the group?

Breadth of distribution of credit/ownership (A): to what extent does the leader give credit to all members of the team for achievements of the team or individuals within the team?

Equity of distribution of credit/ownership (A): how accurately is credit and ownership accorded to members of the team who are responsible for specific team achievements?

Leader acceptance of member idiosyncrasies (A): to what extent does the leader accept deviant behavior of members of the team (Hackman 1992, 243)?

Leader's attention to status (A): to what extent does the leader grant greater latitude in member behavior to higher-status members (Harvey and Consalvi 1960)?

Do members feel invited to join the team (A): to what extent were members made to feel that they had been invited to play on the team because they were the best candidates for the job?

Positive description of other members upon group formation (A): Were other members of the team described as impressive, capable, responsible, etc., so that members were excited about the people they would be working with?

Leader personality communication (A): a measure of the strength of the personality of the leader. A leader with a strong personality will seek to communicate his or her biases on how to fulfill the goals put forth, assumptions about the nature of the world, human nature, truth, relationships, time, space, etc (Schein 1983).

Power distance (A): the degree to which members accept the power in the group is distributed unequally. High power distance refers to extremely unequal level of power between leaders and members (Hofstede 1993).

Social distance between leader and members (A): refers to the actual or perceived "class" difference between leader and members. For example, commissioned military officers and enlisted men maintain significant social distance, while non-commissioned officers will maintain significantly less social distance from their enlisted soldiers (Johns 1986).

Members

Optimism of members (A): to what extent do the members explain successes of the team as due to permanent, pervasive, and specific to the team (Seligman 1998)?

Members' familiarity with team work environment (A): how much experience do the members of the team have with working in a team environment?

Level of member specialization (A): how specialized are the members in their technical disciplines, for example, a PhD member will tend to be more specialized than a member with a BS or BA level education.

Willingness to work outside of specialization (A): how willing are the members of the team to work in areas outside of their specialization, or apply their specialization in unfamiliar ways.

Level of relevant member experience (A): how much experience do members of the team have with problems similar to the problem being addressed in the current project?

Member's technical self-confidence (A): how confident are members in the abilities specific to their technical discipline (Powers 2002)?

Member buy-in (A): to what extent is the leader of the team personally emotionally invested in the success of the project and committed to the vision and mission of the team?

Member responsibilities outside of team (A): do members have other responsibilities that place more, equal, or fewer demands on their time and resources?

Level of shared mental models by members (A): to what extent do the members share mental models relevant to the problem being addressed by the team?

Members previous experience with one another (A): to what extent do the members have significant experience working with one another on previous projects or in other contexts?

Member acceptance of member idiosyncrasies (A): to what extent do the members accept deviant behavior of members of the team (Hackman 1992, 243)?

Member attention to status (A): to what extent do the members grant greater latitude in member behavior to higher-status members (Harvey and Consalvi 1960)?

Physical/geographical distribution of members (D): how are members of the team organized physically in the workplace, or if not in the same workplace, where are they located geographically (Allen 1997).

Member willingness to learn/adapt to new work processes (A): how open are members to learning new work processes or incorporating new norms into the team (Kressy 2002).

Social distance between members (A): refers to the actual or perceived "class" difference between members. Members with high social distance will tend to practice very formalized interaction, while low social distance usually indicates

informality and less structured communication (Johns 1986).

Communication

Level of unique team argot (A): to what extent has the team developed unique language and mental models (Magee 2002).

Differing member jargon (A): does the technical language of the members differ significantly (Adamo 2002)?

Leader to member communication

formality (A): formal communication is usually characterized by low-information content and transactional relationships, which provides for high communication efficiency if both parties share common assumptions. Informal communication is characterized by high-information content, a relational relationship, and inefficiency of communication because the differences in assumptions are explored. A high measure on this attribute indicates high formality, while a low measure indicates informality (Adamo 2002).

Leader to member communication

frequency (A): how often do the leader and members communicate (Adamo 2002)?

Leader to member communication depth

(A): How detailed is the information communicated between leader and members (Adamo 2002).

Member communication formality (A):

formal communication is usually characterized by low-information content and transactional relationships, which provides for high communication efficiency if both parties share common assumptions. Informal communication is characterized by high-information content, a relational relationship, and inefficiency of communication because the differences in assumptions are explored. A high measure on this attribute indicates high formality, while a low measure indicates informality (Adamo 2002).

Member communication frequency (A):

how often do the members communicate with one another (Adamo 2002)?

Member communication depth (A): how detailed is the information communicated between members (Adamo 2002)?

Client communication formality (A): to what extent is communication with the client low in information-content, transaction, and ritualized. A high amount on this attribute indicates high formality (Vincent 2002).

Client communication frequency (A): how often does the client communicate with the team (Vincent 2002)?

Client communication depth (A): how detailed is the information communicated between the client and the team (Vincent 2002)?

Client collaborative communication with team (A): to what extent is the communication between the client and the team collaborative (usually low formality, high in frequency, high depth, and relational) (Vincent 2002).

Stigma associated with members asking questions (A): Is there shame or disdain associated with members asking questions related to the project of the leader or other members of the team (Cleminson 2002)?

Stigma associated with leader asking questions (A): is there shame or disdain associated with the leader asking questions related to the project of the members of the team (Cleminson 2002)?

Defensive response to criticism (A): do the members of the team react in an emotionally defensive manner when an aspect of their contribution to the project comes under criticism (Adamo 2002)?

Decision-making

Decision-making objectivity (A): to what extent are decisions explicitly made using objective factors (implicit favoring and skew of objective factors is assumed)? A low measure on this attribute indicates explicitly subjective decisions dominate the decision-making in the team (Adamo 2002).

Decision-making self alignment (A): how much emphasis do members put on the impact that decisions will have upon them as individuals?

Decision-making group alignment (A): how much emphasis do members place upon the impact of decisions on the team?

Decision-making project alignment (A): how much emphasis do members place upon the impact of decisions on the success of the project?

Diffusion of decision-making responsibility (A): to what extent are decisions made by the team as a whole?

Dominant decision-making style (C): indicate which of the following decision-making styles is used most frequently by the team; a) formal authority, b) data-based, c) intuition-based, d) expert, e) collaborative, f) consensus, g) democratic, h) autocratic, i) other (D) (please note what decision-making style was used).

Other decision-making styles (D): describe circumstances for which the dominant decision-making style is not used, and indicate which style was used in this case.

Learning

Member comfort with learning from other members (A): how comfortable are members of the team learning from one another in the context of the problem that the team is addressing (Powers 2002)?

Learning orientation (experienced teaches inexperienced) (A): to what extent is it within the group norms for an experienced member to teach an inexperienced member (Vincent 2002)?

Leadership orientation (inexperienced teaches experienced) (A): to what extent is it within the group norms for an inexperienced member to teach an experienced member (Vincent 2002)?

Leadership orientation (young teaches old) (A): to what extent is it within the group norms for a younger member (individual's elapsed lifetime, in years) to teach an older member (Vincent 2002)?

Learning orientation (old teaches young) (A): to what extent is it within the group norms for an older member (individual's elapsed lifetime, in years) to teach a younger member (Vincent 2002)?

Attention to reasons for failure (A): how successfully does the team incorporate learning from past failures into current practices (Marshall 2002a)?

Attention to reasons for success (A): how successfully does the team integrate learning from past successes into current practices (Marshall 2002a)?

Evaluation

Team-level reward/punishment (A): to what extent is the team rewarded or punished as a whole?

Team-level evaluation by process (A): to what extent is the team evaluated on how closely it follows the team-defined or organizationally-defined processes?

Team-level evaluation by manager (A): to what extent is the team evaluated according to the satisfaction of the team manager?

Team-level evaluation by client (A): to what extent is the team evaluated according to the satisfaction of the client?

Team-level evaluation by product success (A): to what extent is the team evaluation according to the success of the product in the marketplace?

Member-level reward/punishment (A): to what extent are members rewarded or punished individually?

Member-level evaluation by process (A): to what extent are members evaluated for their individual adherence to team-defined or organizationally-defined work processes?

Member-level evaluation by manager (A): to what extent are the members individually evaluated according to the satisfaction of the manager?

Member-level evaluation by client (A): to what extent are the members individually evaluated according to the satisfaction of the client?

Member-level evaluation by product success (A): to what extent are the members individually evaluated according to the success of the product in the marketplace?

Idea generation

Brainstorming (A): how frequently is this idea generation method used? Brainstorming refers to spontaneous idea generation in a group where judgment is reserved.

Individual (A): how frequently is this idea generation method used? Individual idea generation refers to the technique where ideas are conceived individually and brought to the group for evaluation.

Combination individual/brainstorming (A): how frequently is this idea generation method used? Combination idea generation is when ideas are conceived individually then brought to the group for brainstorming.

Expert (A): how frequently is this idea generation method used? Expert idea generation is when idea generation is left to the functional expert in the area where ideas are required.

Nurturing treatment of new ideas (A): to what extent do group members nurture ideas that are new, unusual, or disruptive (Allen 2001)?

Critical treatment of new ideas (A): to what extent are group members critical of ideas that are new, unusual, or disruptive (Allen 2001)?

Risk & Conflict

Risk-tolerance of client (A): how tolerant is the client of the risks of failure associated with product development (Vincent 2002)?

Risk-tolerance in team (A): how tolerant is the team of risk in exploring novel ideas or strategies (Wallach, Kogan et al. 1962; Kogan and Wallach 1967; Clark 1971)?

Team conflict tolerance (A): how tolerant is the team of conflict between members or factions within the team?

Level of team relationship conflict (A): how much conflict exists surrounding the interpersonal relationships between members in the team (Jehn and Mannix 2001)?

Level of team process conflict (A): how much conflict exists surround how work gets done in the team (Jehn and Mannix 2001)?

Level of team task conflict (A): how much conflict exists surrounding the content and goals of the work (Jehn and Mannix 2001)?

11. CONCLUSION

11.1. SUMMARY OF RESULTS

The product of this thesis is a structured observation method for measuring culture in product development teams. Using a collection attributes, measurement scales, and specific definitions, this method allows researchers to generate cultural information about product development teams that is comparable and consistent, and can be collected rapidly by agents with minimal formal training.

To arrive at this result, we generated a set of initial attributes. We then conducted interviews with product development experts to elicit significance information about these attributes and to collect additional attributes. The confirmed initial attributes were combined with the new attributes, then pruned and further structured to form the final attribute list.

All but one of the initial attributes received an average confirmation above a level of 4.00 from the interviewees (on a scale from 1 to 9, where 1 is “not significant,” 3 is “moderately significant” and 9 is “highly significant”). The one attribute below 4.00 scored 3.92, and was included because of references supporting the attribute as an important cultural factor. The new attributes that were collected in the interviews proved to be more valuable than anticipated, and at least as valuable as the significance information collected to confirm the initial attributes. The interviewees generated 109 new attributes, which were added to the initial 54 attributes. These were combined, reworded, pruned, and organized in an affinity diagram under new headings. The choice to include some new attributes and exclude others was made on the basis of references supporting the attributes, how often the attributes were mentioned by the interviewees, and the experience of the author.

This final list of attributes includes a total of 121 attributes grouped in to thirteen categories, listed below.

- Team definition
- Project description
- Group-level attributes
- Group norms
- Autonomy
- Leadership
- Membership
- Communication
- Decision-making
- Learning
- Evaluation
- Idea generation
- Risk & conflict

Two scales describe each attribute: a descriptive scale and a significance scale. There are four descriptive scales that are used alternately with each attribute. The most common descriptive scale is the amount scale, which describes how strongly an attribute is present on

a scale of one to five. The other descriptive scales are present/not present (which describes whether an attribute is present or not), choice (where there are several choices of descriptions and one or more must be chosen), and description (where an open ended description is required). The second scale is the significance scale. This scale records how much impact an attribute has on the culture of the team.

To use the attribute inventory method an agent would observe a product development team for a period of time, usually in the range of one to four weeks, and use the attribute inventory to measure the culture of the team by recording attribute information on the descriptive and significance scales for each attribute.

Because cultural information is collected using a structured observational method the culture measurement of a team can be compared to previous measurements of the same team, to record cultural shift, and it can also be compared to other teams. This consistency and comparability is the strength of the attribute inventory method over other quantitative and qualitative methods such as surveys, case studies, and ethnography. In addition to consistency and comparability, the ability to capture cultural information quickly makes it a novel tool to learn about the relationships between product development team culture and other areas of interest, such as organizational culture, national culture, and product development performance.

The attribute inventory method is different from tools used to measure team behavior or team effectiveness because it does not contain any bias concerning what is “good” or “bad” culture in a product development team. Instead, it is designed to allow managers and researchers to learn about the culture in product development teams in the context of the embracing organizational culture and the environment of the larger world. Hopefully, this will facilitate learning what works in which situations, and will allow decision-makers to act from an informed point of view.

11.2. CHALLENGES AND LIMITATIONS

While every effort was made to make this measurement method as complete and rigorous as possible, there are some limitations to this work.

To date, there has been no test developed to compare the measure of a group’s culture with the “true” culture that exists in that group, and in the opinion of the author such a test is likely never to be developed. Thus, the extent to which this method captures culture accurately is very difficult or impossible to gauge.

Culture exists because it is experienced, and while it is a characteristic of a group, all groups are made up of individuals. Those individuals all experience the culture of the group differently, so any idea of “true” culture could at best be true only for one person. Furthermore, the ability of an individual to articulate a complete cultural inventory is highly unlikely because so much of culture exists in the unconscious.

And yet, we would like to be able to make measurements of culture, to the extent that the cultural predictors of performance that we identify and then measure correlate with the

performance measures of product development that we believe to be important for product success. In this context, there is still much to be done to understand the relationship between cultural attributes and performance. The attribute inventory method is the first step in increasing our understanding in this area, because it allows for consistent measurement of cultural attributes in and across product development teams.

A weakness of this method, and of any observational method, is that the data recorded must pass through a human agent. The usual weaknesses apply, such as selective attention, selective encoding, selective memory, and interpersonal factors. We have made our best effort to provide detailed descriptions of each attribute to minimize the variation in how agents interpret the meanings of different attributes. To improve the consistency of cultural measurement, an improvement to the method developed in this thesis would be to provide detailed descriptions of each point on the descriptive scale for each attribute. Thus, each attribute would have an attached qualitative or quantitative description of what a very high (5) score looks like, what a high (4) score looks like, and so on. This greater structure would significantly improve the consistency of measurement by different agents, and could be tested by allowing two agents to measure the culture of the same team, and comparing the measurements with and without the attribute specific scales.

Another challenge in attempting to describe team culture using attributes is that there is no way to know if one has a complete set of attributes for the culture in question. It could be argued that only an infinite number of attributes could completely describe product development team culture, and then only from an individual's point of view. As this method is used in the field, it is the intent of the author that the attributes and descriptions be modified, added, and removed as necessary to continuously improve the accuracy, consistency, and comparability of the method. If there were a way to measure the completeness of the attributes assembled here, it would please the author if we have accounted for 80% of the theoretical total attributes required.

Because this method was developed specifically for product development teams in the United States, it cannot be used on other types of teams or in other countries with confidence. It has been shown that even Canada, the closest cultural relative of the United States, differs significantly enough in measures of power distance, individualism, quality of life, uncertainty avoidance, and long-term orientation to warrant separate treatment (Hofstede 1993). To apply this method to other types of teams or groups and in other countries requires development of culturally appropriate attributes inventories. The method described in this thesis could easily be used to generate attribute inventories for any group in any country, but the specific attribute inventory product of this thesis would not be useful.

Finally, it is important to clarify what this method cannot do. This method is not designed to explain attribute interactions, and by itself provides no understanding of cultural interaction between the team and the organization, or between the team and the environment. It also does not directly provide any information on the impact of attributes on team performance. What it *does* do is allow researchers to study all of these things, by providing a tool to measure product development team culture in a consistent, comparable, and rapid way. It is the hope of the author that this tool might be used to improve *scientific* understanding of the importance of attributes, above and beyond the many pseudo-scientific

lists of “best practices” that have questionably been the state of the art in this area for far too long.

11.3. FUTURE WORK

While providing a structured method for measuring culture in product development teams is an essential first step in any rigorous understanding of the impact of culture on product development team performance, it is very far from the ultimate goal of understanding the impact of team culture on performance.

The first step towards that goal is the product of this thesis: a method for measuring product development team culture that is consistent, comparable, and rapid. To improve upon the comparability of the method, an improved system of descriptive scales should be developed. These scales should provide benchmarks, or descriptions of what each point on the descriptive scale would resemble for each attribute. By adding more resolution to the descriptive scale and reducing the need for agent interpretation, this modification should improve the comparability of cultural information collected by different agents.

A confirmation test for this method, as well as any improved methods, should be to compare the attribute inventories of two teams collected by the same agent (to test comparability) and then to compare the attribute inventories of two agents measuring the same team (to test consistency).

There are many uses for this method. Some of the most interesting future work might include research into the interaction between attributes, which could be accomplished by building causal networks that map attribute interaction. Other research of interest using this method might include studies of the interaction between team culture and organizational culture as well as team culture and environmental culture. Also of interest would be research into the cultural attribute predictors of product development team performance. Any research of this type would have to take into account the organizational and environmental cultures surrounding the team, thus the need for research on team/organization and team/environmental interaction.

Finally, researchers might arrive at a set of archetypal product development team cultures. With these archetypes a product development team might be categorized using a smaller set of attributes that would bracket the team. The interactions between the team’s archetype and archetype of the surrounding organizational culture might be generally understood, providing rapid information on team needs and the impact of team culture on performance.

Thinking more broadly, the method of attribute inventory development shown in thesis might be used to develop other attribute inventories. Since this attribute inventory was developed specifically for product development teams in the United States, separate attributes would have to be identified if a researcher wished to study sports teams or think-tank groups in Cameroon and the Netherlands. Nevertheless, the method of identifying attributes and using an inventory of attributes to measure culture could easily be generalized.

12. ABOUT THE AUTHOR

Aubrey Philip Rhys Williams is a native of Washington, D.C., and spent his childhood variously in Silver Spring, Maryland, Mitla, Oaxaca in southern Mexico, Tampere, Finland, and a short while in Brooklyn, NY. With plans to become a writer, he pursued an education in creative writing, journalism and television production until his insatiable appetite for learning was whetted by the study of physics. This led him to the University of Maryland, College Park, where he earned a bachelor's degree in mechanical engineering.

While at the University of Maryland he founded the Human Powered Vehicle Project to compete in the 1999 ASME Human Powered Vehicle Competition. The University of Maryland team placed 1st place overall, 1st place design report, 1st place practical vehicle, 3rd place speed vehicle against 27 other universities. His experience as the HPV Project Manager over 17 months, managing 13 engineering students, as well as his position as Mechanical Integration Manager for the 2000 FutureTruck Team (which placed 1st overall, and was awarded excellence in renewable fuels, best off-road performance, and lowest regulated tailpipe emissions) catalyzed his interest in the study and practice of product development.

Working as a faculty research assistant for the Gyrokystron Project at the Institute for Research in Electronics and Applied Physics, he designed and built novel engineering solutions to support ultra-high vacuum, high-power microwave source research for linear particle accelerators.

At the MAN B&W Diesel Company in Copenhagen, Denmark, he was a part of the design team responsible for the largest internal-combustion engine in the world: a 93,000 horsepower marine diesel with a 98cm cylinder bore. He also headed a safety redesign of the turning gear maintenance platform for the large-bore engine line.

At the Massachusetts Institute of Technology he is part of the Computer Aided Design Laboratory (CADlab), run by Dr. David Wallace. Over the course of two years he has pursued a masters degree with a focus on product development, including courses such as Management Psychology, Designing and Leading the Entrepreneurial Organization, Entrepreneurship Lab, Manufacturing Processes and Design (earning 1st place in the CAD/CAM/CAH competition), Product Design and Development, and Human Factors Engineering.

Academic interests include product development, system design, organizational behavior, ethics of complex organizations, anthropology, psychology, historical product development, leadership, innovation, neuro-lingual processing, sports psychology, periodic training for peak performance, sustainable development, environmental technologies, and vehicle technology.

Personal interests include road cycling, mountain biking, bicycle touring, fishkeeping (freshwater mbuna from Lake Malawi), literature, Scandinavia, Central and South America, backgammon, Wei-Chi (Go), alpine skiing, art and art history (modern, pre-raphaelite, art nouveau), human sexuality, southern California-style Mexican food, computer games, movies and cinema, Shakespearean theater (tragedies), bartending (especially cordials), automobile and motorcycle racing, child psychology and child development, and world politics.

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14. APPENDIX

14.1. ATTRIBUTE INVENTORY CONFIRMATION INTERVIEW

Purpose: to determine what attributes are confirmed by product development experts and to solicit additional attributes.

Permission to record interview:

“Is it ok if I record this? I want you to know that I won’t be publishing the recording or the transcript verbatim and that I will only be using the interview in an aggregate form. If you’d like to talk about something that requires more confidentiality than that, that is fine, just let me know beforehand and that information will be kept confidential.”

If interviewee agrees, then proceed, if not, then conduct interview without recording, still respecting specific requests for confidentiality.

Part I: factual biographical material

1. Could you tell me about yourself?
2. Could you describe your education?
 - a) level of education achieved
 - b) subject of bachelor’s degree and graduate degrees, if any
 - c) note any groups
3. Could you describe your career?

Part II: product development experiences

4. Could you describe the product development experience’s you had?
 - a) record all significant product development experiences (3 months or longer, or those emphasized by the individual)
5. Could you describe the culture in those teams? (ask in relation to all experiences identified in 4., pursue unclear statements)
 - a) record all relevant attribute information, ask for clarification of significance if needed

6. What do you think was responsible for this culture? (ask in relation to all experiences identified in 4., pursue unclear statements)
 - a) record all relevant attribute information, ask for clarification of significance if needed
7. What do you think the impact of that culture was on the team? (ask in relation to all experiences identified in 4., pursue unclear statements)
 - a) record all relevant attribute information, ask for clarification of significance if needed

Part III: unmentioned attributes and additional attributes

8. Note any attributes that have not been touched on throughout the discussion. Ask the interviewee to comment on the amount or presence and significance of these attributes in the experiences listed in question 4.
9. What do you believe are the attributes of a team that affect the culture in that team?
 - a) record all new attributes
 - b) ask for amount or presence and significance in product develop experiences mentioned in 4.

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