People As The Key For Success In An International Scientific Organization

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INTRODUCTION

ATLAS Collaboration at CERN is a scientific collaboration of 169 universities and over 2500 researchers from 37 countries. An organization of this size and complexity could be assumed to have a detailed strategy implemented through a clear organizational hierarchy. There is no codified strategy in ATLAS but still the organization has succeeded well in its task to build a giant particle detector. The management and strategy formation of ATLAS were tried to be perfected by theories originating from business life but this approach had of limited help for the ATLAS management (Santalainen & al. 2007). This raises the question whether strategy theories used successfully in business organizations are applicable in organizations of different kind. The present study addresses the question, why ATLAS does not have a codified strategy.

The approach used in this study is theory bound. The study is based on seven semi-structured interviews with leaders on the different organizational levels in the ATLAS experiment. The study also exploits ethnographic methods as documents and observations made within the organization are used as information sources.

BACKGROUND

The aim of the High Energy Physics (HEP) is to enhance knowledge about the early Universe and its basic building blocks, namely matter. In experimental high energy physics two types of devices are needed to carry out research: accelerators and detectors, also called experiments. Modern HEP accelerators and experiments are among the biggest and most complex machines ever built.

The accelerators and experiments are crucial not only for the advancement of science but fostering the scientific community as well. First, they are unique and customized, designed, built and operated by their users unlike laboratory facilities in general. Second, it is claimed that the devices shape HEP research organizations and even research questions – they are not seen only as machines but also as key informants (Traweek 1988). Third, designing and building a detector is an intensive and time-consuming process that affects also on researchers' identity and their lives outside the work (Knorr–Cetina 1999, Traweek 1988).

In HEP, collaborations are like a basic unit because of the resources and equipment needed. Large HEP collaborations may involve several thousands of people. A definition to HEP collaborations is a *"movable, semi-detached corporations located somewhere between a social movement and an organization in the vocabulary of social categories, but identical with neither"* (Knorr–Cetina 1994). The HEP collaborations are quite unique organizations as they are strongly based on personal relations and trust among the researchers (Traweek 1988, Knorr–Cetina 1994; 1999). The number of HEP researchers is modest: 20 000 - 30 000 researchers worldwide so most people know each other at least by names or by having common acquaintances. New collaborations often emerge quite spontaneously, based on previous collaborations and cooperation.

The collaboration structure in HEP differs from many other organizations. They are often characterized by words such as consensus, democratic decision-making and flat structures; being highly egalitarian and based more likely on mutually recognized memoranda than legally binding documents (Chompalov & al. 2002). There are certain similarities with business organizations but equity fails, as scientists tend to regard and treat each other as professional equals (Krige 1991). The role of the scientists in the experimental physics is multifaceted. On the one hand, (s)he is like an autonomous craftsperson and on the other, like a factory worker (Chompalov & al. 2002, Krige 1991). The collaborative experiments in HEP can be characterized as post-traditional communitarian formations or structures that emphasize collective work instead of individual work contribution and which is not based neither on altruism nor on communality (Chompalov & al. 2002, Knorr–Cetina 1998).

CERN And ATLAS

CERN, the European Organization for Nuclear Research is among the most remarkable research institutes in the world, hosting several more or less autonomous research collaborations. It is one of the oldest co-European undertakings, dating back to 1954 and situated astride the Franco–Swiss border near Geneva. It has 20 Member States, eight Observers and several other countries involved in its research activities. At the moment, researchers at CERN are discovering fundamental particles that are smaller than atoms. A new accelerator LHC (Large Hadron Collider) is just completed. In the LHC sub-atomic particle beams are accelerated almost at the speed of light in a circular tunnel of 27 kilometers long before colliding them with each other with even 14 TeV of energy in six experiments (CERN 2008). For two biggest experiments, ATLAS and CMS, a principal aim is to find the Higgs boson, a sub-atom particle that would complete the Standard Model.

ATLAS Collaboration started in 1992. The organization was not formed deliberately but it emerged little by little (Tuertscher 2008). Two phases can be distinguished: the detector construction phase which is lately completed and the operating phase to be started. The ATLAS collaboration is loosely coupled network of independent research institutions without traditional structures which makesit a very typical example of a research organization in HEP (Tuertscher 2008). As an organization it isinteresting and unique, a one-of-a-kind emergent technological system (ibid.), not aimed at making money or providing any goods or services but to fulfill its scientific mission. Efficiency and profitability in ATLAS cannot be measured by using pure economic indicators as progress is sometimes made by stepping back by renegotiating, correcting mistakes and changing design parameters (Santalainen & al. 2007, Tuertscher 2008).

The member institutes (i.e. universities) participate in the project in three ways: by contributing part of the detector hardware or software, paying their share of the common budget and by providing workforce for the collaboration. The costs are not shared equally but fairly, taking into account the available resources of each member. Participants coming from rich countries contribute thus more than those coming from the poorer countries. Most of the people working for ATLAS are paid and directed by their home institutes even though the work is physically carried out at CERN. Respectively, a large part of the research and design work related to ATLAS is not carried out at CERN but in the member universities all over the world.

The cornerstone of the collaboration is the Memorandum of Understanding (MoU) that defines the Collaboration and its objectives, the rights and obligations of the member institutes and the organization of the Collaboration. The leading principles of the organizational structure are democracy, separation of policy-making and executive powers, minimal formal organization and the limited terms of office (ATLAS Collaboration 1998). The most important decision making levelsand the corresponding bodies are the following:

- The Collaboration Board (CB) is the police-making body, meeting four times a year. Every member institution has one representative and one vote in the CB, with an exception of the largest institutions that may have two representatives but still one vote. The decisions are taken by consensus or by a vote. All votes except from elections are open. The CB meetings are preceded by Plenary Meetings that are open to every single member of the collaboration and in which the issues to be decided in the CB are discussed beforehand.
- The Executive Board is composed of the ATLAS Management, the System (subproject) project leaders and coordinators, the CB Chairperson and Deputy Chairperson as ex officio and some additional members chosen to ensure an overall balance and competence in the EB. The EB meets about once a month and its members are also ex officio members of the CB.
- The ATLAS management consisting of Spokesperson, two Deputy Spokespersons, Technical Coordinator and Resources Coordinator is in charge of the overall execution of ATLAS. The Spokesperson is on the top of the organization, acting as the representative of the Collaboration outside it. (S)he is elected for two (previously for three) years by the Collaboration Board, after the nomination of candidates by the Collaboration. The spokesperson is important not only as transmitting information to and from the collaboration but also as the ultimate mediator between the collaboration members.

The ATLAS experiment is divided into subprojects according to the detector structure. There are four major components or subsystems of the detector. The subprojects have been more or less independent organizations within ATLAS, having internal structures very similar to that of the Collaboration. The subprojects are comparable to the vertical divisions or units of a company. Beside the subprojects there are Coordination groups, consisting of people coming from several subprojects in order to coordinate shared interests and common activities among them. These can also be seen as the horizontal operations or processes of the project. During the construction phase a lot of cooperation and coordination was needed as changing a parameter in one component might have consequences in another. In the operation phase the challenges and need for cooperation are somehow different which also affects the organization structure and overall coordination. In the present study the organization is studied as it was at the end of the construction phase.

METHODS

The approach used in this study is theory bound. Evidence based or grounded approach theory is built up on the research material whereas the theory-based approach has a certain theory as the starting point and the material is analyzed in relation to it. The theory bound approach is situated in between these two approaches combining both theory and evidence based on empirical material (Eskola 2001).

The logic of reasoning based on the theory bound analysis is often abductive. Abductive reasoning is based on inductive logic but it also exploits the concept of deductive logic (Cohen & Manion 1994). Abductive logic can thus be seen as situated in between the inductive and deductive reasoning. It is assumed that there must be a guiding principle such as an intuitive insight, hypothesis or theoretical assumption in the study (Grönfors 1982). Theory bound analysis can be seen as an attempt to overcome the problems of grounded analysis, namely the effect of the conceptual and methodological choices made during the research process (Tuomi and Sarajärvi 2002). The role of the previous theory is not to restrict but rather to spur new ideas and offer alternative paths of thinking (ibid.).

For the purpose of the present study, seven semi-structured interviews were conducted with the ATLAS management and project leaders. A semi-structured interview poses more or less the same questions to all interviewees but not necessarily always in the same order (Eskola and Suoranta 1998). It is a method that takes into account that interpretations are subjective and they emerge in the interaction between people (Hirsjärvi and Hurme 2006).

The interviewees were chosen using elite sampling, taking into account their position in the organization. In elite sampling or elite interviewing the size of target population is not significant but only the persons evaluated as the best informants concerning the issue in question are selected as research subjects (Tuomi and Sarajärvi 2002, Marshall and Rossman 1995). To ensure the representation of the different levels of the ATLAS organization, people on the executive level, policy-making level and operational level were chosen for interviews as following:

- Spokesman (management, executive level)
- Current and previous Technical Coordinators (management, executive level)
- CB Spokesperson (Collaboration Board, policy-making level)
- Two Project Leaders (operational level)
- Senior Project Engineer and Planning Officer (executive level)

The method used to analyze the interview material was the theory bound content analysis. The content analysis aims at analyzing research material systematically and objectively (Tuomi and Sarajärvi 2002). Two types of content analysis can be distinguished: content analysis and content itemization (Kyngäs and Vanhanen 1999). The former aims at a verbal description of the material whereas the latter is a more quantitative approach (ibid.). The analysis aims at creating an explicit verbal description of the research subject that enhances information i.e. is a reasonable and coherent entity. By the content analysis material can be organized without losing information included in it (Tuomi and Sarajärvi 2002). It may be seen as a process having three different phases: reducing, clustering and abstracting i.e. creating theoretical concepts (ibid).

This describes how the material was classified after transcription. The material was first categorized in two categories, namely "organization" and "people". Within these categories common themes, expressions and key words were searched in order top both get detailed information and form a general view and new perspectives on the issue. Results to be presented in the following section were formed in this process.

The present study was made within the ATLAS organization at CERN. The author had the access to internal documents as well as a possibility to discuss with researchers informally in many occasions. Ethnographic observations gained in these ways were also exploited in the study.

RESULTS

Motivation And Commitment

People working for ATLAS are not only experts of their field but also characterized by the working environment, the science and namely the ATLAS experiment. In general, people working in ATLAS were described to be "nice human beings", intelligent, some being even geniuses; open minded as well as highly motivated and committed to their work. They are driven by the curiosity, motivated by the scientific results and have all in common the will to get the experiment work.

Basic research is the basis for new knowledge, which fosters civilization. Curiosity and willingness to know have pushed scientists throughout the centuries to explore the world and the human being, to discover the secrets of the Nature and the Universe and to invent and build technical machines. Being a little link in the chain of this development or providing new knowledge as a common good is an intriguing idea and a motivating factor at least for some scientists.

Money is not a reason why one chooses a scientific or academic career but economic reasons should not be underestimated either. The CERN staff positions are limited but wanted, as many universities cannot offer such salaries and other benefits as CERN does. Still, working at CERN includes tempting factors as such. It is an intriguing environment for a person who is interested in solving challenging problems with other experts of many fields in a very multinational community. The work itself may be rewarding even if it does not always offer career prospects. However, combining the passion in science with family engagements is not always easy as the contracts are often temporary and only for a short term.

Cooperation And Competition

In business organizations, the competition is often hard. Helping a colleague may be profitable to some extent but not always as it may turn against oneself. It is easy to compromise the common goal for a personal benefit. In ATLAS there is not such an immediate risk as there is little competition in that sense as most people are employed by different institutes. The cooperation and the lack of competition are also probably due to the close personal relations and mutual trust,

Even though there is not that much competition between individuals there is some competition between institutes. This competition does not preclude the members of different institutes to cooperate or discuss the problem in question. This ensures the multiplicity of the points of view that makes it more probable that all the relevant questions will be taken into account.

Cooperation among people and between institutes is quite safe and thus profitable in ATLAS. Helping others is worthwhile because it progresses the whole project and because by offering help to others, one can rely on their help if needed. As the success of the entire project is dependent on functioning of all the areas, uncooperative people would fall outside the supporting network. The situation may change in the operating phase as the data the detector provides can be analyzed by small teams of only few people which may create more competition.

There is some friendly competition with the sister experiment CMS as both run for finding the Higgs boson and consequently, highly possible the Nobel Prize (Santalainen & al. 2007). Still, the success of both experiments is beneficial for all, as the other must validate the results of the one. Having a competing experiment aside may give an additional spur to people, enhance the collaboration cohesion and community spirit. The competition in ATLAS in general can, however, be seen as a positive phenomenon that exhorts the experiments, institute groups and individuals to do their best and ensure that the chosen solutions are the best possible ones. The positive competition is not a destructive but an encouraging force that enhances the quality.

Communication And Decision-Making

The effective information sharing is essential for the project progressing especially as the members of the collaboration are dispersed all over the world. The progress is made by collective decision making and informing each other, as well as documentation and accessibility of information via computer networks, regardless of time and physical location.

ATLAS is known for being democratic and an effort is made to get people involved in the decision-making process (see also Knorr-Cetina 1999). Numerous boards, committees and meetings of every kind support self-orientation of the people and ad-hoc problem solving. There are meetings on every level of the organization, to the extent that some may question whether they are all needed. This definitely takes time but it is also effective and important for problem-solution. Everybody gets the same information at the same time and open questions can be discussed collectively to find the best solutions. The problems are solved, sometimes instantly, by a heuristic method hard to explain even by the participants. One of the interviewees compared the problem solution in ATLAS with brains and neuron networks as the problems are not handled hierarchically but there are always several parallel possibilities and entries.

Ad hoc problem solving teams get mainly organized based on the personal relations and researchers' knowledge about expertise areas and experiences of the colleagues. Trust is an essential element in forming these groups. Ad-hoc problems are often situated into "no man's land", concerning issues such as the consolidation of different parts of the detector.

The democratic decision-making process also serves other functions than the formal acts of taking decisions (Knorr-Cetina 1999). The decisions are not as important as the process preceding them: reviewing, discussing, justifying and convincing the colleagues (Tuertscher 2008).

DISCUSSION

If a technical project of the size of the ATLAS detector was realized in the private sector, i.e. by commercial companies, the project would highly possibly emerge and be organized in a different way. Compared with ordinary organizations ATLAS is an oddball in many ways.

First, the results a scientific organization delivers define its success (Géles & al. 2000). The success of the ATLAS experiment is due to the performance of the detector and the results it will provide. On the one hand, it is a question of "all or nothing". Either the detector works as designed or it does not do so. Achieving the set aims is seldom as critical as it is for ATLAS where every subsystem and machine simply must work. The components and devices must often meet high standards in terms of temperatures, pressure and radiation. Repairing systems is not evident as most systems are not always accessible during the operation period. In most organizations, the need for meeting requirements and goals is not that definitive. Somehow comparable examples where compromises are intolerable include airplanes and medical devices, to name a few.

Another definition of success is not as evident. A main goal during the operating phase is to discover the Higgs boson but failing in that would not necessarily imply a failure at the project. Theories may be proved to be wrong or someone else may discover the boson first. In every case, the experiment will provide new information since the LHC enables the highest energy level ever obtained.

Second, a peculiar thing in ATLAS and in other HEP collaborations is a high degree of democracy involved in the decision-making and low hierarchy. Democracy and one vote per institute are especially interesting when taking into account the amount of money involved in the project and the diversification of shares members can devote. It is notable that even the national funding agencies accept this and do not claim for sharing the power in the function of allocated resources.

The organization can be very self-organizing and thus flexible as long as some prerequisites have been taken into account. First, the organization must support effective problem solving. This includes the possibility to come back to any issue or parameter if needed. Second, to ensure the effective problem solving, the information must be available for every member of the organization all over the world at any time. Third, the people must be willing and capable to work efficiently both in teams and on their own initiative. This enables also a low hierarchy.

This is possible as the people working for ATLAS are highly motivated and committed to their work as a result of their passion in science and willingness to know more, create new knowledge and be part of a unique scientific project. Many common problems related to organization and management are implicitly solved because of the high motivation and commitment of the people in ATLAS. The risk of losing the focus is not relevant to ATLAS as the whole organization is working for achieving the unchanging aim. For ATLAS, the challenges are often endogenous and of technical nature, not due to the external factors. The problems are solved as soon as possible and as close to the subject as possible.

Control can be understood either as a positive or as a negative phenomenon. The positive control is to keep the superiors and coworkers aware of the progress of the project, possible problems and adequate resource allocation. Negative control can be understood as encumbering employees and adhering to rules, regulations, hierarchies or formal processes despite even negative consequences. In ATLAS, the control is understood in its positive form. The freedom on every level of the organization is crucial for the project success as the decisions must be made as close to their subjects and the problems must be solved where they appear. If ATLAS had a hierarchical decision making structure of several levels, the organization would soon be paralyzed. Thus, the organization is kept as flat as possible without any hierarchy that might complicate the work. The formal and informal structures are to facilitate coordination and information flow and not to control people.

Application Gap

The classic strategy theories state that the strategy shapes the structure: the organization structure is arranged in a certain way to realize the organization's goals and to optimize the effectiveness and efficacy (Chandler 1962). According to Fayol (1949) and his successors, the structure defines the hierarchy, the areas of responsibility of people and the lines of command among others. In ATLAS these classical strategy theories emphasizing the causality between strategy and organization structure do not seem to apply. In this occasion, this phenomenon is called as an application gap of strategy theories. There is no need for a codified strategy in ATLAS as all the members of the organization have the common subordinate goal in their mind and they search for all possible means to achieve it. As the goal can only be achieved collectively, the close cooperation is indispensable.

The detector building process itself was devious but the aim has always been very clear to everybody working for ATLAS. It has been known *what* must be done and even though it has sometimes been less clear *how* to do it, but the means have emerged along the way. As the ultimate goal is obvious to everyone and the practicalities solved when needed, writing them down as a strategy document would almost look absurd. This is not to say that the big picture of the whole project has been clear long before the construction began, as well as the rough design of the detector.

When discussing with the ATLAS management one gets an impression that nobody really knows how ATLAS works. This has also been bewildering for people visiting ATLAS. Only a few "traditional" organizational characteristics apply well in ATLAS. It does not have a strategy document where the structure is defined. The organization structure is ambiguous. It is thus assumed that in ATLAS the strategy, the organization structure and the people are not in a linear relationship but interconnected. The strategy and the structure are interdependent and because of the people and their characteristics, the strategy and structure can be such as they are.

CONCLUSION

The absence of an outspoken strategy and a codified strategy document in ATLAS is due to the fact that the organization does not need such a document. ATLAS works "now and here" and the decisions are taken when needed. It is assumed that the functioning of the organization of this size without an outspoken strategy is due to the people working for ATLAS and especially two characteristics: motivation and personal capacities. The people are not driven by external factors but by their curiosity, interest in science and willingness to be involved in something no one has ever done or seen before. The factors that motivate the ATLAS people are both the easiest and the most complicate. As the people are working because they want to know more, the work is not a burden but a pleasure and they are willing to contribute as much as possible. On the other hand, this kind of inner motivation cannot be improved by money or any other promotional action. They may help to some point but not forever.

In the present study only managers and leaders from different levels of organization were interviewed. Therefore it is possible that the results may be somehow biased. To get a more comprehensive view it would be profitable to study ordinary researchers as well. However, the results of this study are similar to previous studies on ATLAS.

The problem of the present study as well as the case studies in general is limited generalizability. Because ATLAS and CMS highly resemble each other, comparing them might give more reliable results. Due to the special conditions regarding the environment and people, the HEP collaborations in general can be considered as somehow exceptional organizations. Therefore it is questionable whether they can be used as generalizations outside the field. The scientific organizations with their characteristics are in general little studied so instead of adapting models from business organizations they could provide new knowledge for organization and management studies and to be exploited also in other kinds of organizations. Universities, R&D companies or departments and other expert organizations might benefit from the experiences of ATLAS presented in this study whereas they hardly apply to organizations where the focus is not on human expertise but on the work to be done.

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