A project management issue of new technology developments - A case study on lack of human factors attention in human-robot interaction

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Abstract

The complexity of today's sociotechnical systems has prompted researchers and practitioners to advocate new holistic approaches to safety. However, many engineering standards, methods and processes for addressing technical, human and organizational factors do not fully reflect this. This paper investigates known project management challenges and how they can explain the lack of attention to human factors issues in the design and development of new technology. As such, the work contributes to a research stream investigating why the human factors discipline is repeatedly marginalized in engineering projects. The paper reports on findings from a case study – a research and innovation project developing technology and concepts for human-robot collaboration. We conclude that a narrow focus in early project phases and insufficient information coordination contribute to marginalizing the role of human factors in the design and development of new technology.

Keywords: Projects, Management, human factors, Design, Robotics

Introduction

Today's sociotechnical systems are already complex and interrelated, and both researchers and practitioners are advocating new approaches to safety addressing the accompanying challenges.[1, 2] The realms of robotics and automation represent one area contributing to more complex sociotechnical systems. Projects preparing for space exploration missions include development of concepts for collaborations between robots and astronauts.[3-5] Closer to home, and in the near future, our streets will be filled by self-driving cars interacting with corresponding traffic control infrastructures, health care activities will be managed by intelligent information infrastructures and many physical work activities will be performed by robots.[6] The last 40 years of system safety engineering and safety research have offered strong evidence of the crucial role of human factors knowledge in the design and construction of new systems.[7] As such, research efforts have focused on advancing human factors methodology and its application in engineering projects.[8] Recent studies also investigate new perspectives that may help explain why human factors continue to be marginalized in the development of new technology and systems.[9]

In the same timeframe projects have become a dominant way to organize both research, development and construction efforts. The main focus of the project management research has been on challenges, failures and success of projects.[10-13] Project management is strongly rooted in scientific disciplines such as engineering and economics, and traditional methodology is dominated by technical risk analyses calculating expected benefits and monetary costs as part of engineering planning and design.[14] However, streams of project management research also investigate the role of social, organizational and institutional factors. Moreover, contemporary project management discourse recognizes the importance of managing lack of information, lack of knowledge, ambiguity, characteristics of different project parties, trade-offs between trust and control mechanisms, and diverging agendas in different stages of the project life cycle.[15, 16]

The indications we discovered in course of our research,[17-20] and what this paper addresses, is that in many cases the lack of attention to human factors is rationalized by referring to existing work package objectives, scope and agreed plans for the project. This paper reports on findings from a case study, a research and innovation project developing technology and concepts for human-robot collaboration, and addresses the question: "*to what extent is lack of attention to human factors issues linked to known project management challenges?"*

The outline of the article is as follows: *Firs*t, we introduce known challenges from the human factors discipline. *Second*, we address known challenges from the project management discipline. *Third*, we recapitulate the context of the study and the research approach. *Fourth*, we describe the main results. *Fifth*, we draw upon our findings in the literature and results from our study to discuss the link between lack of focus on human factors issues and known challenges from the project management discipline. *Finally*, we offer some conclusions and proposals for further work.

We do not claim to be exhaustive in our accounts. The literature and selection of references are based on the authors' expert knowledge of the human factors and project management disciplines.

The human factors discipline – known challenges

The human factors discipline is traditionally divided into three areas: physical ergonomics, cognitive ergonomics and organizational ergonomics.[21] Physical ergonomics is mainly concerned with human anatomical, physiological and biomechanical characteristics as they relate to physical activity.[22] Cognitive ergonomics focuses on perception, memory, information processing and reasoning relevant to, e.g. task analysis, human-machine interactions (HMI), workload, and alarm philosophies.[21, 23] Organizational ergonomics address issues relevant to organizational structures, policies, processes and operational philosophies.[22, 24] We acknowledge the different perspectives on the human factors discipline,[25] e.g. vs. human reliability[26] and human factors engineering.[2] For the purpose of this paper, we use the following definition: "*Human Factors is a body of knowledge about human abilities, human limitations, and other human characteristics that are relevant to design. Human factors engineering is the*

application of human factors information to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable, and effective human use".[27]

Incident investigations have revealed that cognitive ergonomics and organizational ergonomics are seldom mentioned or explored sufficiently. It is suggested that insufficient knowledge and misconception of human factors engineering have resulted in poor HMI design and latent errors. It is also known that risk analysis seldom includes human and organizational factors.[28] Investigations of serious accidents in the petroleum sector such as Piper Alpha and Macondo have shown that triggering causes include the little understood interaction of factors at various system levels, such as technical, human, social, organizational, managerial, and environmental.[29-35] Key examples from the space industry include the investigation reports from the two fatal space shuttle accidents that point towards human, organizational and political aspects as root causes[36, 37] and clearly state that the accidents were a product of long term organizational problems.[38] Such major accidents are highly relevant and interesting. However, we also take great interest in studying the more daily consequences of lack of focus on human factors issues: those that do not generate accidents but result in expensive re-designs, cause minor human errors, breed inefficiency in operations and, most likely, result in some form of dormant, aggregated risk in the organization. After studying the development of new automated drilling technology for offshore oil and gas production Sætren *et.al.* [9] concluded that homogenous competence involving technical aspects contributed to developers' lack of understanding of the need for sufficient analyses of end-user requirements and of the human tasks that would be affected by the new technology. Consequently, they argued that technological development could benefit from including human factors experts from the project's outset. Sætren *et.al.* [9] also found narrow focus in different project phases to be one of two main categories that contribute to insufficient human factors analyses in the development phase, the second category being insufficient information coordination in the development phase. As part of preparations for future space exploration missions, a need to address the significant human factors challenges related to human-automation integration is acknowledged.[39, 40] We list a few of these challenges here:

1. Human factors standards are very high-level and not tailored for specific systems.
2. Human factors knowledge and expertise are lacking in the teams specifying, designing and engineering systems – leading to poor requirements and poorly designed systems.
3. There is a need for methods that support evaluation and development of human-automation-robotic collaboration for long duration, long distance missions.
4. There is a need for design guidelines for effective human-automation-robotic systems in diverse operational environments and conditions.

Leva *et.al.* [2] provide a good overview of current industrial practices and standards promoting inclusion of human factors knowledge in structured system design processes. They contribute to a stream of researchers advocating the need for new approaches to fully address the challenges of increasingly complex and interrelated sociotechnical structures. [1, 6, 8, 41] We maintain that such challenges require novel holistic approaches to safety and reliability and need the participation of experts from a wide range of fields, especially human factors. New technologies instrumental to continued improvement of robotic systems working in proximity to humans and other dynamic obstacles are developing at a fast pace. An example is the advances with Dynamic Road Map (DRM) approach[42] and new methods like Parallel DRM (PDRM)[43] designed to allow robots to react to changes to their surrounding in a fast and concise manner. These are technologies

which clearly improve the safety of robotic operations. However, it is not clear how such technologies affect the role and requirements for the human counterpart, such as new tasks, need for situational awareness, need for new training and new performance requirements.

The project management discipline – known challenges

Projects have become a dominant way to organize development and construction efforts.[44-47] Project management plays a central role in the process of research and innovation and impacts the way firms organize their design of new products.[47] Project management constitutes the accomplishment of a clearly defined goal within a specified period of time and consistent with budget and quality requirements. Project management as a discipline devotes significant attention to techniques and models that are designed to identify, assess and ultimately manage the risks and uncertainties associated with the project.[48-50] In his investigation into different explanations for known project performance problems' Sanderson [51] examines different assumptions about decision makers' cognition and views on the future (risky or uncertain). He revisits the work of Simon [52] and highlights the proposition that "decision makers are intendedly rational, but only limitedly so".

A major part of project management literature focuses on challenges, failures and success of projects. For an introduction to known challenges of project management we propose Samset and Volden [10], Morris [11] and Brady *et.al.* [12], from which most of our insights are drawn. In the following we introduce seven aspects of project management known to create challenges. We present them in two groups: challenges related to narrow focus in different project phases and challenges related to insufficient information coordination.

First, we introduce four aspects of project management that are known to contribute to narrow focus in different project phases. Such a narrow focus makes it challenging to take the right decisions at the right time, especially in early phases of projects.

Front end management refers to analyses and decisions made before a project actually starts, i.e. at the front end phase of projects. It is the process that defines the major characteristics of a project e.g. budget, timeframe, objectives and core concepts.[11, 48] Samset and Volden [10] advocate that the potential to reduce uncertainty and risk is largest in the project front end phase and decreases substantially during the project implementation. They further point out that most projects' planning resources are spent on detailed planning and engineering while too little are spent on getting the core concept right from the start, i.e. many sub-optimal project deliveries can be traced to a lack of knowledge or erroneous focus in the project front end.

Predict-and-provide approaches most often create challenges when the project needs and benefit assessments get decoupled from overriding goals and priorities. An example of a predict-and-provide approach would be to solve any capacity problems with an increased capacity, usually based on trend predictions of future demand. However, needs should not be defined narrowly as a need to increase capacity, but rather as a need to solve a congestion problem. The latter allows for a variety of measures regulating demand, including legal and informative measures.[10] Thus, emphasis on predict-and-provide strategy in individual projects should be avoided, unless a development driven by trend extrapolation is clearly defined and desired.

Neglecting the opportunity space is most often caused by path dependency.[53] Projects are initiated to solve some problem or fulfil some needs and much evidence suggests that discipline experts often have an inherent tendency to emphasize some aspects and downplay others when selecting solutions. The same is expected to apply to organizations planning their rules, processes, procedures, etc. In practice, path dependence means we act as we did before, making the same choices, even if these narrow our focus, conflict with rational choices and ignore new opportunities.[54, 55]

Myopic decisions often result in sub-optimal choices because planning horizons are too short, e.g. short term challenges and benefits are emphasized at the expense of long term viability.[10]

The following three aspects of project management are known to contribute to insufficient information coordination. Such insufficient information coordination often results in sub-optimal or erroneous decisions.

Early information overflow confronts decision makers with an abundance of detailed information at an early point in the project and may result in "analysis paralysis".[56] This abundance of information often consists of quantitative and historic data that has a complex relevance to a specific project context, e.g. needs, priorities, stakeholders, etc. For example, exact information about failure rates in existing systems may have limited relevance with the introduction of new technology or concepts. Exact information about the demand in a fast-developing market is another example. This suggests that the major problem may not be the quantity of available information, but rather the capability to carefully select facts and judgmental information relevant to the essential issues of a specific project.

Erroneous logic of causalities and probabilities is usually most noticeable when project objectives misalign with the fundamental need, or problem, that motivates the initiation of a project. Alignment of objectives is the exercise of defining the basic logical structure outlining the project by following the causal link from the basic needs of users, through defined goals to the delivery of project results (outputs), their outcome (effects) and long term benefits.[10] Failure to establish such logical cause and effect structures will usually result in erroneous assumptions about the probabilities of realization and can result in significant underperformance compared to expectations.

The measurement of success may be in absolute or in relative terms, but it is usually calibrated against our expectations. Thus, without clear and realistic expectations the term "success" becomes a highly complex and aggregated measure. The project management discourse related to the definition of success and success factors is comprehensive.[57-62] Insufficient information on how different stakeholders define the success of a project often leaves room for varying definitions on success to exist throughout a project. A classic struggle in projects is between stakeholders that emphasize the importance of the project's tactical success, i.e. on time, on budget and to scope, and those with a key interest in the strategic success, i.e. long term viability and efficient operation of the project product.[48, 63]

As part of the result section we address the link between the human factor and project management challenges in more depth.

Research approach and context of the study

We first describe the background of the case study and the role of this paper in its context. We then outline the approach used to investigate links between known project management challenges and the lack of attention to human factors.

The foundation for the work presented was laid during a study performed for the European Space Agency (ESA).[17] The study focused on shortcomings of human factors standards in the space industry.[39, 40] The ESA study included a review of human dependability methods from aviation, the nuclear industry, the petroleum industry and railways. Although there is little systematic research on the applicability of different safety management methods across different industries[64] it was deemed interesting to investigate if safety methods and processes developed for the petroleum sector [65] could be useful in the space industry. The decision to focus on the space and petroleum sector was one based on opportunity. Also two of the authors have detailed knowledge of the Norwegian petroleum sector, from both safety and project management perspective, while the two other authors have their background from the space sector. Standards developed for petroleum industry on the Norwegian continental shelf [66] (NORSOK) recommends CRIOP (Crisis intervention and operability analysis) as the preferred methodology for "validation of the design, manning and procedures, and the ability to control process disturbances and emergencies" of a control centre in all modes of operation. The findings from the ESA study were subsequently used to tailor the CRIOP method[67] to support the development of collaborative human-robot systems.[18] The modified CRIOP method was tested in the case study.[19] The case study was a 3-year cooperative research and innovation project funded by the space calls from the European Commission. Thus, the investigation presented in this paper was not initially included in the case study. However, based on initial findings it was included towards the end of the study.

Participants in the study included key project members from six out of seven organizations involved in the project, including the project manager. Ten persons participated, three women and seven men, aged 30–60. All participating organizations were represented by senior managers and engineers with 10+ years of experience from their representative field of expertise. The research team was composed of two CRIOP and human factors experts and one person dedicated to reporting and documentation. There was no participation from the client/project owner.

Both preliminary and final results from the case study identified a lack of attention to human factors in the project. Furthermore, we found that in many cases the lack of attention to human factors was rationalized, i.e. explaining why it was not a priority, by referring to existing work packages and task descriptions, project objectives, scope and agreed plans for the project. These findings initiated discussions and further investigation along these lines: *So the lack of focus on human factors is not design (process) oversight but a project management error?*

The main purpose of this paper is to describe this investigation. As such, the main contribution in this paper is the discussion on how lack of attention to human factors

issues[9, 29, 68] can be linked to known project management challenges.[10, 11, 63] These investigations constitute an exploratory research approach aimed at gathering information that will help define problems and suggest hypotheses.[69, 70] We investigated the research streams of the two knowledge areas, human factors and project management. In the following, we present our findings and provide propositions for how known project management challenges are linked to lack of attention to human factors issues in design and development of new technology.

Results

The results are provided in two parts. The first part recapitulates the main findings from the human factors study.[19] The second part reports from the exploratory investigations addressing links between known project management challenges and lack of attention to human factors discipline when developing new technology and concepts.

From a human factors perspective, the results from the case study identified a lack of attention to the operation phase, and a unclear allocation of responsibility and authority of the operation organization was identified as the main concern.[19] Below we list the top seven items that were identified and agreed by the project team. The actions are sorted in the prioritized order as decided by the project team. The numbers in parenthesis reference the corresponding item from the modified CRIOP checklist. The complete action item list including proposed responsibilities was included in the final report to the project management team.

(O1) *Operations organization:* There is a need to appoint/name responsible persons and mandate them as the core team (for) planning simulations (and operations).
(O2.2) *Allocation of clear, complete, known and accepted responsibility and authority* should be the goal when addressing the action in O1.
(P3) *A verification and validation scheme for the procedures* should be defined and documented.
(O3.1) *Procedures for communication* ensuring operators and supervisors are continuously aware of all critical and hazardous tasks in progress. Need to be considered during the system development and definition of operational organization and products.
(P1.1) *Approach to developing, using and maintaining procedures and work descriptions:* Who authors what procedures must be identified as well as who, how and where to verify and approve them.
(C2) *Guidelines for communications operations and support*: A communication plan needs to be developed, i.e. who can talk to whom about what and when.
(A4) *A clear policy for the assignment of autonomy levels of the automated agents*: Need to investigate if this is an objective of the project.

The action (A4) shows clearly how the project team believed the development of such policies was outside the project scope. Although no project objective, work package, task description included the development of such policy, it is hard to argue why assignment of autonomy levels in collaborative human-robot systems should not have a clear policy, especially in the early technology development phase. In the case of (O1) and (O2.2) there was full agreement in the project team that this was of high importance, especially

for planned field testing and simulation of the system. During the field test campaigns, clear roles and responsibilities were assigned for technical and site safety. Further, health and medical safety of the test subjects working with the system was addressed. Also, the technical teams compiled valuable technical data and experience from different components of the systems. However, it was argued that the tests and simulation had little relevance for any existing or planned operational organization. Although the need to (de)scope technology development projects has clear merits, there are also clear and known risks generated by limiting any realistic involvement of end users and their organizations.

Linking the human factor and project management challenges

The results in this section constitute a summary of the information gathered and the investigation of how these findings link the lack of attention to human factors to known challenges of project management. The results are structured based on the seven challenges from project management literature addressed earlier.

Sætren *et.al.* [9] found that homogeneous groups of engineers tend to have a strong focus on technology and what technical problems are the important ones to solve.[9] This supports the findings of Samset and Volden [10] suggesting that most projects' planning resources are spent on detailed technical engineering analyses. We suggest that this contributes to lack of focus on human factors in the *front end management* of technology research and development projects. That is, evaluating the merits of alternative technologies, the causalities between their strengths and weaknesses and the probabilities of realization within the project envelope take precedence over assessments of end-user needs, limitations as well as the operational environment. In our case study the project team responsible for writing the grant proposal, i.e. part of the front end phase of the project, was in most aspects a heterogeneous group and the topic of human factors was assigned to a dedicated task. However, the action items identified during the human factors analyses, i.e. the tailored CRIOP, indicate several key issues related to the operational organization and responsibilities were still not addressed at the project mid-point.[19] We suggest a twofold explanation for this. First, a misconception identified human factors as limited to physical ergonomics. Second, the selection of technologies as a key part of the project concept was strongly driven by the interests of the participating organizations. The development of certain technologies was the main motivation, not the fundamental needs and long term viability of the end result from the project.

We suggest a link between lack of focus on human factors and project management *neglecting the opportunity space*, in both front end and implementation phase of projects. That is, the existence of *predict-and-provide* approaches and path dependency are amplified in technology development projects with homogenous engineer development teams.[9] Discipline experts often have an inherent tendency to emphasize some aspects and downplay others when selecting solutions, e.g. a focus on technical safety and risk analyses of technical systems. We suggest this as a cause contributing to lack of attention to human factors knowledge.

Sætren *et.al.* [9] found that developers had a general comprehension that automation leads only to less human error. However, several studies show that when new automated technology is introduced human errors tend to move to other areas, such as those described by Lee [71]. We propose this as an example of e*rroneous logic of causalities and probabilities* that may result in a lack of focus on human factors. Given the large number of accidents where the triggering causes have shown to include the interaction of factors at various system levels, such as technical, human, social and organizational, any development project with a lack of focus on human factors displays a general erroneous logic of causalities and probabilities as a basis for their safety strategies and risk assessment.

In most cases, we have a substantial amount of technical data and empirical information collected from past and present systems and situations that can be used as a basis for our probabilities. However, for the case of developing and/or implementing new technology and novel concepts we suggest that this more often results in an *early information overflow*, or "analysis paralysis", i.e. decision makers are confronted with an abundance of detailed information at an early point in the project decision-making process. We propose that such "paralysis" contributes to lack of attention to the human factors discipline, i.e. losing sight of the need to analyse how alternative technology solutions and concepts impact the organizations and individuals in the larger sociotechnical system.

We suggest that known challenges from project management related to *the measurement of success* and *myopic decisions* can contribute to explain the lack of focus on human factors in technology developments. A variety of project management literature acknowledges the challenges of balancing the inward-focused, task-oriented and "single delivery" view of projects and the strategy-focused and wider organizational and society views.[11, 72, 73] We believe that due to the nature of stakeholders involved in technology development projects there will be a key focus on the technical and project tactical success. In most cases, any negative consequences resulting from lack of or insufficient focus on human factors will exist as latent errors (or confusion), stay dormant and not materialize before operational phases, or at best, during rigorous testing phases involving user testing. In other words, the short term success of the project tends to divert attention away from the long term success of the system.

Discussions

Sætren *et.al.* [9] found that homogenous development team contributed to a lack of understanding of the need for sufficient analyses of end-user requirements of the tasks that would be affected by the new technology. In our case study the project group was heterogeneous in age, gender and disciplines, and lack of attention to human factors was also identified in this project. Thus, such findings indicate a need for more elaborative explanations. Spurred by the findings in our case study, we postulated connections between known project management challenges and lack of attention to human factors when developing new technology. We investigated the research streams of the two knowledge areas – human factors and project management – and in what follows we discuss to what degree lack of attention to human factors is a project management issue.

In modern project management, "a project" is defined as a temporary endeavour undertaken to create a unique product, service or result.[74] However, the word *project* comes from the Latin verb *proicere*, meaning "before an action". The term *design* refers to the creation of a plan for the construction of an object, system or measurable human interaction, e.g. engineering design. Our main point is that any contemporary engineering efforts are projected before they start. We also know that many known challenges of project management are rooted in the *front end management* of projects, i.e. referring to analyses and decisions made before a project actually starts. This has resulted in a large research stream known as management of projects. The management of projects and project management collectively refer to management of portfolios, programmes and individual projects, all which coexist within a corporate management framework.[75] Corporate management is the system by which business corporations are directed and controlled.[76, 77] Project management refers to the management of individual projects while management of projects refers to the management of a group of projects, e.g. within a programme or portfolio of projects. It is important to emphasize the importance of coordinated decisions on different management levels in the project front end phase. Insufficient information coordination in this phase, where projects are chartered and filled with "purpose", often seeds e*rroneous logic of causalities and probabilities*, *predict-and-provide* approaches or *neglecting opportunity space*, which results in lack of attention to the role of human factors in development of new technology and concepts.

If those responsible for analyses and decisions made before a project starts do not recognize the important role of human factors knowledge, the project resources and objective will be defined accordingly. However, as our case study shows, even when human factors are recognized as important there is a need to be vigilant towards misconceptions and conflicting interests among different stakeholders. Similarly, if early project deliveries have no or little requirement or accountability towards the operational phase there is considerable risk that short term project goals, i.e. on time, on budget and to scope, take priority, often leaving the long term viability and efficient operation of the project product to suffer.

Leva *et.al.* [2] propose that educational programmes for engineers should include some basics human factors engineering (HFE) elements for system design and that HFE principles should be integrated in broader technical engineering and design standards. Such measures would indeed also contribute to better knowledge of human factors discipline among decision makers at corporate and project management level. In addition, we see the need for both human factors verification and validation activities to ensure that the human factors perspective is taken care of through all phases of the project from concept, design and finally implementation.

From a project management perspective, the concept of emergence could be useful to explore. Emerging risks are described by International Risk Governance Council [78] and are relevant risks that emerge as time passes, and should be evaluated in a project. Key emergent issues in project management are: A) *Scientific unknowns / technological advances*: The development of automatization and robotics introduces new technology

that may have unknown vulnerabilities that can be understood and mitigated by the field of human factors. Risks may emerge when technological change is not based on prior investigation or surveillance of results. Risks can also be exacerbated when policy or regulatory frameworks, e.g. in the front end definitions phase, are insufficient. B) *Loss of (safety) margins / increased connectivity and new interactions*: Project management of new integrated technology may pose a substantial challenge due to poor understanding of consequences such as couplings. Tight couplings may lead to loss of buffering or margins and emergent problems have been seen when automated systems resolve too many issues before the human enters the control-loop i.e. "human in the loop" challenges. This is also a challenge that may be related to scientific unknowns. C) *Conflicts about interests, values and science / social dynamics*: Public debates about emerging risks seldom show a clear separation between science, values and interests. Thus, there is a need to support open information sharing and trust between the different actors from technology area and human factors area, e.g. psychology.

Future work

The main focus of this paper is how project management decisions impact the role of human factors knowledge in development of new technology. However, an interesting avenue of research would be to investigate how human factors methodology in general, and a specific validation and verification (best practice) tool such as CRIOP, could support project organizations when planning new projects for development of novel technology and concepts. It would also be interesting to explore differences in social standing and dynamics between different stakeholders in academia depending on core values, i.e. technology vs. social sciences, and how such factors impact the role of human factors discipline in technology development projects.

Conclusions

The human factors discipline includes a vast set of methods and processes, and there is clear merit to and, to our knowledge, no major dispute about the recommendations of most human factors standards that technological developments could benefit from including human factors experts from the project outset. However, the literature is rich in examples and explanations of why relevant human factors analyses were excluded or inadequately performed, e.g. Sætren *et.al.* [9] and Johnsen and Liu [79]. We addressed the question "to what extent is lack of focus on human factors issues linked to known project management challenges?". We found that narrow focus in different project phases and insufficient information coordination contributes to marginalizing the role of human factors in design and development of new technology.

The work constitutes an interesting and novel case that warrants further investigations into how project processes can be tailored to address a lack of attention to human factors. We acknowledge that the limited amount of empirical research data limits our possibility to provide any systematic contribution to a specific body of knowledge. However, we do consider the research and our findings to encourage further studies into the nature of

projects and how their organizational context impact the role of the human factors discipline in development of new technology and novel concepts.

It may appear elementary rather than novel, but we conclude that the importance of including human factors knowledge in early (project) phases is just as much about "doing the right project", as it is about "doing the project right".[56] Thus, lack of attention to human factors primarily involves project management issues that need to be addressed on corporate management level.

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