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Sustainability in knowledge-based companies

Abstract

Highly skilled knowledge work is on the rise and frequently produces strain and high risks of stress disorders. Although characterized by comprehensive working tasks, wide action scope, or ample opportunities to learn regarded as favorable conditions for sustainable work by the socio-technical design tradition, stress disorders are becoming widespread among knowledge workers. Resolving this obvious contradiction, a resource-based perspective on work has been developed that can explain stress reactions as caused by misfits between work demands, available resources, and established rules. Empirical findings from a case-based scrutiny of software development and consulting project teams in the German software and telecommunication industries demonstrate the explanatory value of this approach. Lessons learned for designing more sustainable work systems are finally presented.

Introduction: The particularities of knowledge work

Knowledge-based companies are key actors in advanced economies. They can be characterized by sharing knowledge rather than dividing labor. Wealth increasingly depends on the knowledge and competence of human agents, on their creative dealing with knowledge, i.e. on what companies are *able to do*, rather than on the capital employed, i.e. on what they *own*. The way knowledge is created and used in complex interaction processes of dividing and sharing knowledge is becoming the most powerful productive force and is crucial for performance or competitiveness.

Explicit or codified knowledge is generated by observation, in processes of reflection and concept formation, and can be expressed in the form of linguistic terms or technical artifacts. Its meaningful application for problem solving, however, always requires, due to its abstract conceptual nature, some implicit practical knowledge, some specific skills or competencies that enable experts to adopt and make sense of relevant codified knowledge, to recontextualize and enact it for specific purposes and situations. This implicit, practical and actionable knowledge itself grows through experience and by appropriating explicit knowledge for effective acting; it is embodied and cannot be expropriated from the knowledgeable actors owning it. Based on this dialectics of partially explicating experience in knowledge and of expanding experience through adopting knowledge, the use of knowledge creates new knowledge, in contrast to material products that wear out in use. “Intellectual capital is not a stock of knowledge, but a capacity to innovate” (Stewart 1997). Knowledge grows, like a tree, through branching, by differentiation, specialization and segmentation into specific knowledge domains, disciplines, and areas of expertise. Hence, its use for problem solving requires, as most problems are complex and cross borders of specialization, that relevant knowledge from different domains is identified and integrated or synthesized through sharing expertise and collaboration (Brödner et al. 1999, Helmstädter 2003, Nonaka & Takeuchi 1995).

These basic characteristics of dealing with knowledge have a number of far reaching consequences with respect to the work of “knowledge workers” (Drucker 1993) or “symbol analysts” (Reich 1991): First, as knowledge grows through use, innovation, i.e. the successful creation of new products, new processes or new institutional settings, becomes the dominant form of competition. Hence, companies as well as

workers have to permanently cope with new situations, surprise and uncertainty. Second, this requires continuous problem solving activities, which in turn call for the implicit embodied sense-making skills of human actors, in particular expert knowledge workers. Hence, in knowledge-based companies human competences are most important and indispensable resources to be continuously developed in quality and quantity. Third, innovative and problem solving activities require knowledge sharing and collaboration among experts from different domains. That is why project work in multidisciplinary teams to accomplish a unique and common task is becoming a widespread form of work organization in knowledge-based companies. Fourth, due to the fact that knowledge work is always subject to uncertainty and surprise, the course and outcome of projects is context-dependent and unforeseeable and can, therefore, neither be planned in advance nor governed by command and control. In this sense knowledge work is “deconfined” (Hatchuel 2002) with respect to course, outcome, and effort and therefore requires new forms of indirect or contextual control.

Deconfinement of knowledge work proves to be the root of its intensity indicated by long working hours and persistent stress reactions. Due to challenging tasks, wide action scope and ample opportunity to learn, knowledge workers on one hand typically are highly motivated to do a good job, they always face, however, due to context-dependent and unforeseeable courses of events, a high risk of lacking resources to accomplish their task on the other. As compared to Tayloristic forms of work organization, their work appears to be privileged, while actually it is likely to be intensive and subjected to high risks of excessive demands that may even lead to stress disorders if lasting for long time. These health risks tend to wear out the human resources on which knowledge-based companies are depending so much. According to the resource-centered perspective presented here, sustainable work is being achieved in contrast, if necessary resources are maintained or developed rather than consumed. This paper focuses on personal and social resources in an organizational context that are generative in nature and may grow in use, if sufficient working conditions are provided (Docherty et al. 2002). In this perspective, knowledge work frequently turns out not to be socially sustainable.

In fact, the share of work-related stress disorders increases with the total workforce’s share of knowledge workers. They are becoming epidemic: In Germany, for instance, cases of early retirement due to work-related stress disorders have over the past 20 years surpassed those due to cardiovascular diseases and reached a level of 14% of all cases for men and 32% for women (Brödner 2002). A study by ILO states that 5,9% of all sick days in Germany are caused by mental strain and that in the EU the costs of these sickness leaves sum up to 3 to 4% of GDP (Gabriel & Liimatainen 2000). In the UK, stress disorders account for 38% of all incapacity benefits recipients causing 12 billion GBP annual expenses (LSE 2006). This indicates the obviously low care with which management, contrary to its permanent mantra, is treating the knowledge workforce as its “most important capital”.

Although stress disorders such as sleep disturbance, depression, burnout or drug abuse indicating intensive and unsustainable work processes are rapidly spreading among knowledge workers, their work-related causes as well as possible remedies have been insufficiently investigated so far. The paper intends to fill this gap. The case-based scrutiny it presents focuses on highly qualified, computer-supported knowledge work in software development and consulting projects in the German

software and telecommunication industries. The type of project work investigated can be regarded as a typical manifestation of high skill knowledge work and thus represents work processes in the vast majority of other knowledge-based companies.

The paper starts with an outline of the conceptual framework for the resource-based perspective used to explain the causes of specific stress reactions and health risks inherent in highly qualified knowledge work. This theoretical perspective serves as background for the empirical investigation, the data basis, procedure and selected findings of which are then presented. The paper concludes with design-oriented considerations including some guidelines for designing more sustainable work systems in knowledge-based companies.

Conceptual framework: A resource-centered perspective

Paramount characteristics of industrial work have been a high degree of horizontal division of labor and the vertical separation of work conception from implementation thus creating “simple tasks in complex organizations” (Sitter et al. 1997) that could be performed on a rather low skill level. Although intended to allow for being performed over long periods of time without health impairment on the basis of scientifically determined harmless work demands, this type of industrial work actually produced a number of other detrimental effects such as health impairments through one-sided repetitive work loads or atrophied skills and demotivation restricting personal development (Brödner & Forslin 2002).

In order to reduce these motivational and health risks, enlarging and enriching work tasks, widening the action scope, and creating more opportunities to learn have been predominant measures of the socio-technical work design perspective striving for better and healthier jobs. It basically assumed that creating complete and meaningful tasks with more discretion over work processes in terms of means, methods, and procedures would enhance variation of work, reduce strain, specifically with the chance of compensating work load, and foster personal development (Emery & Trist 1960, Trist 1981, Ulich 1994). Accordingly, knowledge work – and in particular team-based project work – with its complex tasks and high degree of discretion has in this perspective for long time been regarded as privileged, since it owns high scores in all these dimensions. In contrast to what can be expected from this perspective, knowledge work, however, actually often appears to be subject to high workload and severe stress reactions (Gerlmaier 2004). This socio-technical design paradox indicates that there must be something wrong with underlying assumptions.

Similarly, the so-called „demand-control model“ (Karasek 1998, Karasek & Theorell 1990) widely accepted in stress research emphasizes the important function of autonomy for fostering the workers’ wellbeing and personal development. According to this model, the strain and stress relationship in work may basically be influenced by two factors: work demands such as challenging work tasks or time pressure on one hand and the extent to which work processes can be controlled on the other. Autonomy in this model has a primarily moderating effect on stress reactions: Increased work demands may cause less stress reactions, if a working person has control over the working process, i.e. the means, methods, and procedures to achieve the task. Moreover, a high degree of control in connection with high job demands may lead to wellbeing and personal development in as much as they initiate or foster learning processes.

By further developing the idea of balancing demand and control, Maslach and Leiter (1997) emphasize that stress is caused by a variety of imbalances or “mismatches” between work demands and available resources that, if they persist, may lead to burnout characterized by physical and emotional exhaustion and reserved indifference. In particular, they pay attention to mismatches between workload and resources, to lack of control, to insufficient rewards, to unfair treatment, to the loss of supporting social relations at work, and to conflicting individual and organizational values. They thus not only focus on workers’ needs and resources, but also recognize conditions of the working environment as well (Maslach & Leiter 1997; cf. Kira 2002, 2003). Their approach is closest to the stress generation model presented here, although it still lacks sufficient awareness of the relational nature of resources.

The problem with these approaches is that they consider resources, in particular the degree of the worker’s control or autonomy, as resources *per se* without paying attention to contextual or situational circumstances. Knowledge work differs, however, in several respects from industrial manual work: It demands complex problem-solving capability operating with mostly unknown solutions that require changing collaboration with other experts and even customers. Hence, it strongly depends on the knowledge worker’s individual working capacity. And as deconfined work, it further requires new forms of contextual control. Consequently, an appropriate conceptual approach needs to put a relational perspective on work demands and resources at its center. Resources can no longer be determined as such, but in relation to the context conditions only, under which workers attempt to make them effective.

The conception of “contradictory work demands” (Moldaschl 2005) is a theoretical perspective based on this relational view on resources that has been adopted for the research presented here. According to this approach, work related strain is an effect of contradictions or misfits between actual work requirements, established rules, and available resources. Stress reactions are generated, if workers have to cope with contradicting demands, rules, and resources that constrain efforts to achieve their work objectives and lead to negative consequences for health and motivation. Based on this perspective, the study focuses on organizational aspects of knowledge-based project work, i.e. on work design and frame conditions rather than personal traits or individual prerequisites such as qualification.

In this relational view, resources are defined as effective means that can be activated and used by workers for attaining their goals. Whether something can serve as a resource or not, depends on context and frame conditions under which work is performed. Resources can only be determined in use: Some means may be applied as resources to resolve contradictory work demands; the same means may also turn out to generate stress under different circumstances. Social support, for instance, can be a resource for achieving the task, if talking with colleagues helps to solve a design problem; but this talk may be very disturbing and stressful for the workers involved, if they act under time pressure. Equally, autonomy may be a resource for optimizing work procedures, it is ineffective though, if frame conditions do not allow for using it. Or an IT system may be used as a resource for performing operations more efficiently, it may, however, also be a hindrance, if it lacks task conformity.

Most human resources are generative in nature, i.e. they develop and grow in use due to experience. They comprise of, for instance, personal capabilities and

competencies or social relationships such as trust or commitment. They will, however, be destroyed over time, if abilities and opportunities to recover from stress or to further develop competences are restricted. The resource-centered perspective thus is consistent with the concept of “sustainable work systems” (Docherty et al. 2002), according to which these systems generate and regenerate at least as much resources as they consume, while intensive work systems reduce or erode the resources in use (Kira 2003, Moldaschl 2005).

In a more operational view, mental strain is indicated by additional work and self-regulation needs to cope with misfits between demands and resources, by extensive time pressure, and by work interruptions that even further contribute to the time pressure experienced. When adopting the conception of “contradictory work demands” for this investigation in a heuristic model of strain generation, stress reactions are assumed to emerge, if the knowledge workers neither can resolve nor compensate or “buffer” contradictions or misfits they are exposed to (e.g. by mobilizing social support). Negotiating about constraining factors with management or with the customer (e.g. with respect to delivery dates or additional product functions) can be another way of coping in order to resolve such contradictions. If the knowledge workers’ activities are restricted in a way that none of these solutions is possible, stress reactions are likely in case the misfits would continue (Gerlmaier 2006, Latniak & Gerlmaier 2005; see fig. 1).

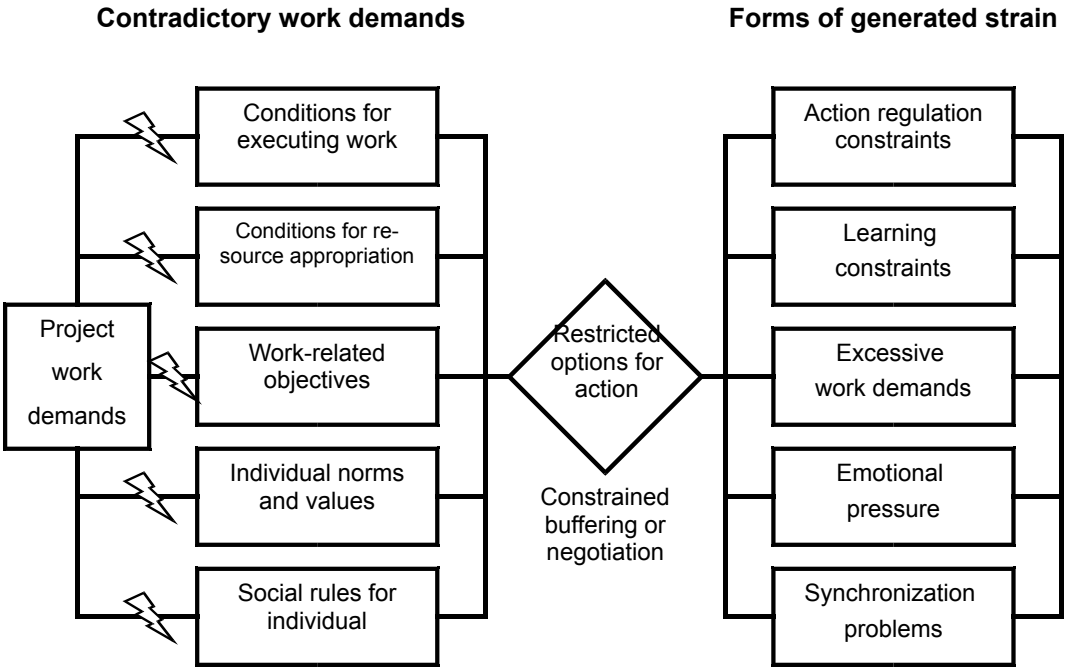

Figure 1: An operational model of mental stress generation

The model distinguishes five different types of misfits or contradictions (cf. flashes in fig. 1) as causes for the generation of mental strain if there is no chance to negotiate work constraints and conditions or to generate time or capacity buffers (examples in brackets below are taken from the cases investigated):

(1) Contradictions between tasks and executing conditions: These are action regulation constraints due to inadequate tools that cause additional efforts (e.g. a

software development framework unable to generate software functions as intended or a server at the customer not being available as needed for testing).

(2) Misfits between task and learning conditions: They hinder workers to appropriate necessary knowledge or technical artifacts (e.g. insufficient experience of the customer's IT system environment in which the software is applied, so they do not exactly know how it is used).

(3) Contradicting project objectives: They put workers in 'double loyalty' conflicts between different but equally important expectations to act, for instance, to obey their company rules by keeping the budget and time frame and to be 'loyal' to the customer simultaneously by meeting his demands (e.g. the obligation to fulfill additional software functionality for a customer while, at the same time, the core functionality has still to be finished within existing time and budget constraints).

(4) Contradictions between work-related and individual objectives or values: They put workers in conflict between project objectives and professional behavior or standards (this happens e.g., if, due to time pressure, the documentation of the software source code is neglected in order to keep the milestones and delivery time for the software).

(*5) Contradictions between work demand and rules of the social context:* They put workers in conflict between meeting project objectives and maintaining social relationships (e.g. in the final stage of a software development project, workers may have difficulties to integrate family roles and work demand that leads to extended working time and inability to recreate).

The model is based on a dynamic understanding of strain generation and specifically allows to analyze main impacts and rules of the work situation and context on one hand together with internal values and goals of the employees (e.g. values of professional behavior) on the other. While contradictory work demands can be clearly identified, indicated forms of strain generation normally result in combination and cannot be separated, however. Moreover, the model is emphasizing an active role of employees in resolving strain and stressing situations. By finding a "workaround" for emerging problems, by mobilizing social support or other substantial resources, employees can take an active part in changing the misfit situation. This is even more important, as coping with difficulties is a specific kind of success experience providing motivation, self-esteem, and "fun" at work.

Finally, the model provides categories to classify strain and stressing situations such that causes are precisely described and starting points for work design become visible. By reducing work constraints, work can, as guiding principle, simultaneously be made more efficient and more healthy or sustainable for the workers. The range of possible remedies covered by the model stretches from individual competencies and values (training), to organizational measures and rules (strategic agreements, process definitions), up to work environment (working time regulations).

Empirical investigation: Methodology and major findings

Data and methodology

Due to the novelty of the underlying conceptual model, the study was designed as an explorative, longitudinal investigation based on in-depth case studies in seven software development and IT consulting project teams (N = 34 employees) in four

different German companies. The intention was to observe each project team from the beginning to the end in order to capture the dynamics of knowledge-based project work and identify the impact of contradictory demands and misfits at work (in one case the customer cancelled the project earlier, however).

The IT projects ranged from consulting and implementation of standardized IT products up to software development and programming. Five projects were located in large IT service companies with more than 3000 employees; two projects were done in a small multi-media start-up company. The projects T1 and T2 were sub-projects in large composite projects for the telecom industry providing integration tests for customers respectively the development and implementation of a software application for coordinating customer related data on different servers. The project teams E1 and E2 were located in an IT service company primarily offering outsourcing services. Both teams closely co-operated with their customers in public administration for which they developed software applications. Ti1 and Ti2 were projects in a small 'new economy' start-up with 14 employees focusing on the development and hosting of interactive web design applications (Ti1) and the development of a mobile online booking system (Ti2). Project H in a large company with ca. 3000 employees for consulting and implementing IT services, focused on implementing an adapted solution based on a SAP R/3 system for a car supplier.

The study was based on a mix of different methods: In order to identify the background of the project work, semi-standardized interviews with management and project managers focused on the competitive situation, on the company structure, on work organization and working time, and on HR strategies (N = 15). Additionally, group interviews were used to investigate into the project related work constraints asking all team members to describe their specific work demands, encumbering situations and the ways they were coping with them. They were further asked to specify favorable and supportive conditions for doing their work. Finally, the encumbering situations were categorized according to the five different forms of contradictory demands generating strain (cf. fig. 1).

According to the significance of affecting work experience, also the forms of project regulation and control were analyzed with a modified questionnaire (the so-called "self regulation pattern", cf. Ulich 1994): Two members of each project team were asked who is responsible for certain decisions and who else in the team is taking part (concerning e.g. working times, planning of HR allocation, project acquisition; N = 14 respondents). Moreover, in order to identify changes in strain during project duration, a monthly diary about wellbeing and critical incidents was applied based on an adapted screening questionnaire sent to all team members every month for about one year (with a recall after one week if no answer arrived). One month after each project's end, a standardized questionnaire was sent to all team members for a final evaluation of project outcomes asking for economic success, waste or generation of resources, and personal development issues, e.g. vocational training opportunities, recreation opportunities, development of social relations and support at work. The research findings are presented below (Gerlmaier 2006, Latniak & Gerlmaier 2005).

Misfits and contradictions: Encumbering situations and strain

As surveyed by group interviews, 92 different strain situations in seven projects have been identified and 83 of them (90%) could be clearly assigned to one of the five different categories of contradictions or misfits.

Contradictions between tasks and their executing conditions (*type 1*) were an every day problem in the projects investigated. Five of seven teams were struggling regularly with functionally inadequate software and hardware equipment hindering and restricting them to accomplish their tasks due to management's restrictive budgeting; this caused additional work and reduced performance. Also, missing or delayed management or customer decisions led to stress reactions: They affected project schedules (or could even stop a project), while the workers, although not responsible, had to compensate for the delays and work overtime as delivery dates remained unchanged.

Misfits between tasks and learning conditions (*type 2*) were identified in T1 and T2 and in the multimedia projects Ti1 and Ti2, while customer-driven projects hardly exhibited this type of misfit. Difficulties arose from the dilemma that workers missed sufficient experiences with the customer's system environment and had no time for adequate training. Resolving the dilemma again caused extra work and strain to the workers' expense in order to get their work right.

Contradicting objectives were the prevalent misfits (*type 3*) leading to intensified work and increased workload. Typically, the definition of the intended software functionality remained relatively vague during project specification. In the course of development, customers often generated additional ideas and wishes to be integrated in the software that caused additional workload, as schedules were not modified ("planning dilemma"). Most of the teams passively accepted that kind of extra burden associated with extended working time ("close your eyes and pass through it"). Only in two projects efforts have been taken to avoid this by providing "checks and balances" in the contracts. Four of the projects reported that they received instructions from customers conflicting with defined work packages in the project plans. The teams tried to fulfill most of these extra wishes, while, at the same time, they tried to keep the schedule – by increasing work pace or by extending working times. With this strategy, they tried to avoid long lasting negotiations between management and customers. An active coping strategy was found, in contrast, in only one project, where the team asked the project manager to negotiate with the customer.

Similarly, increasing quality demands of central departments were reported by three teams raising the dilemma that higher quality standards should be applied, while necessary time buffers to perform the tests were reduced in order to cut costs. Moreover, during project acquisition, project managers often had to calculate time and cost budgets under high time pressure causing miscalculations workers then had to compensate for. Three teams further had problems with increasing documentation needs while no additional time was given. This aggravated a more general problem: Managers tended to deploy project staff in different projects at the same time in order to achieve, as they thought, maximum efficiency. As a consequence, team members had to coordinate different project time schedules and priorities individually and they had to shift their attention and focus on different projects in short terms. This led to an increasing number of mistakes, especially when phases of intensive work in different projects overlapped. Team members tried to cope with the overload by possibly mobilizing social support of colleagues no matter how limited it was.

Contradictions between work-related and individual objectives and values (*type 4*) showed up when team members missed management's appreciation of their work

and performance, while a high degree of commitment and personal flexibility were simply presumed. A further dilemma was the misfit between individual and project-related quality standards: Many knowledge workers saw their professional ethics violated by delivering software incompletely tested, as sufficient testing was skipped in order to keep the delivery dates.

Finally, due to the emphasis on work-related aspects, contradictions between work demand and values or rules of the social context (*type 5*) tended to be underestimated. The teams mentioned difficulties to co-ordinate work on weekends with family duties. Furthermore, the need to travel to (remote) customers and the extended traveling times often reduced the chance to spend time with the family. Concerning solutions, workers were quite passive in this respect – these difficulties being regarded as an unchangeable part of work.

Looking at resources available to the teams, co-operation within the teams, opportunities to individually plan working times, and intellectual challenges of development tasks were primarily mentioned as resources to cope with contradictions. However, the projects' context conditions, first of all time pressure and underestimated budgets, often impaired their effects, particularly in case of social relationships. Self-determined working times and the chance to recover at weekends, therefore, need to be defended against management and customer demands.

In sum, the study reveals that the underlying conceptual model and the different types of contradictions can well explain strain generation in project work. Most common stress situations mentioned were those caused by simultaneous work in several projects and by additional work due to inadequate equipment and delayed management or customer decisions. In order to overcome the problems, a majority of knowledge workers tends to extend their working times which causes other difficulties and misfits, however, for instance with family roles; consequently, solutions of one strain aspect often lead to new contradictions on a different level. These rather passive modes of coping were predominant, while more active attempts to negotiate on the project context conditions were less common. From a work design perspective, it is decisive that knowledge workers get influence on the definition of the overall working conditions as they affect strain generation.

Autonomy: Self-control versus management control of project work

Hence, the influence of project teams on work organization, on planning and scheduling, and on work design was a prevailing research aspect. This was surveyed by a 'self regulation pattern' to find out which tasks and decisions were self-regulated by the teams or individuals and which aspects were controlled and co-coordinated by management. Fig. 2 shows that these decisions exhibit no consistent pattern.

Co-ordination of projects T1 and T2 – as sub-projects of large composite projects – is comparatively hierarchic: In both teams, project managers were responsible for the acquisition of new projects, project planning and budgeting, definition of tasks, and staff allocation, while equipment, tools and methods applied were determined by the customer. After fixing the contract, further interaction between customers and project team was not intended. The responsibilities of the project teams were limited to working time regulations and to the control of working progress.

Working tasks	Teams in large integrated projects		Customer-oriented project teams			Teams in a ”new economy” context	
	T1	T2	E1	E2	H	Ti1	Ti2
Planning of working times							
Choice of working methods							
Choice of working tools							
Training of new employees							
Output control						n. a.	n. a.
Sequencing of work							
Staff allocation							
Planning of new projects							
Acquisition of new projects							
Project budgeting							

Project team (with or without team leader)
Individual team member (with or without team leader)
Team leader (with or without management)
Experts outside teams
Customer

Fig. 2: Findings: Operational autonomy under management control of projects

Teams in projects E1, E2, and H, in contrast, had considerably more space for self-regulation. Work planning and design was made in close co-operation with the team members. Furthermore, all teams had a comparatively high scope for team-based regulation: The individual workers decided on working times and holidays, while the team was in charge of selecting tools, methods, and equipment as well as the training of new staff. Except for one team, however, the team members were excluded from budgeting and staff allocation. In two of these teams, team members with specific knowledge were also involved in the acquisition of new projects.

Similarly, there was a close and rather informal co-operation between project teams and customers in both multi-media projects. The chief manager, charged with planning, budgeting, and acquisition alone, partially involved technical experts in discussing these aspects. Similar to all other teams, workers decided on their working times. The project manager discussed work-related decisions on equipment or tools with team members individually in a rather informal way as compared to a formalized project management found in the other companies. This ‘short way’ communication reduced co-ordination efforts, but obviously led to a lack of structure and clear responsibilities.

The study thus reveals a broad range of self-regulation and autonomy among the IT projects investigated. But except for one project, the influence on project planning and decision-making is evidently restricted to working time regulation, to the selection of equipment and methods, and to vocational adjustment of new staff – i.e. on *job control*. The majority of project staff remains excluded from *management control*, i.e. the design of contextual frame conditions for their work and from influencing substantial resources to be negotiated. There is a remarkable impact of the team members on operational aspects of work, while the influence on the work environment is very limited in most projects investigated; teams or team members are not allowed to influence the basic and most significant strain generating factors.

The deviant case of project E2 is indicating however that an option exists to act differently with two respects: First, the individual management style of the project manager in E2 is very participatory by involving the team in most decisions. Second, he is not avoiding conflicts with upper management or risky decisions (i.e. acting against the company internal regulations) to keep his projects going.

Mental stress and increasing burnout risks

Findings on the degree of experienced stress in the projects' contradictory working situations reveal that approximately 41% of the workers complain about difficulties to "come to an end with work" and to relax at the end of the day, 50% feel being worn out or exhausted. About one third of the employees agreed to the question that they would not be able to bear the workload continuously. With respect to the risk of work-related stress disorders, the results of the monthly diaries on wellbeing and critical incidences show significant differences as compared to those of a recent representative employee survey in Germany (Bauer et al 2004). In our sample, much more employees suffer from tiredness or fatigue, nervousness, and sleep disorders (cf. fig. 3).

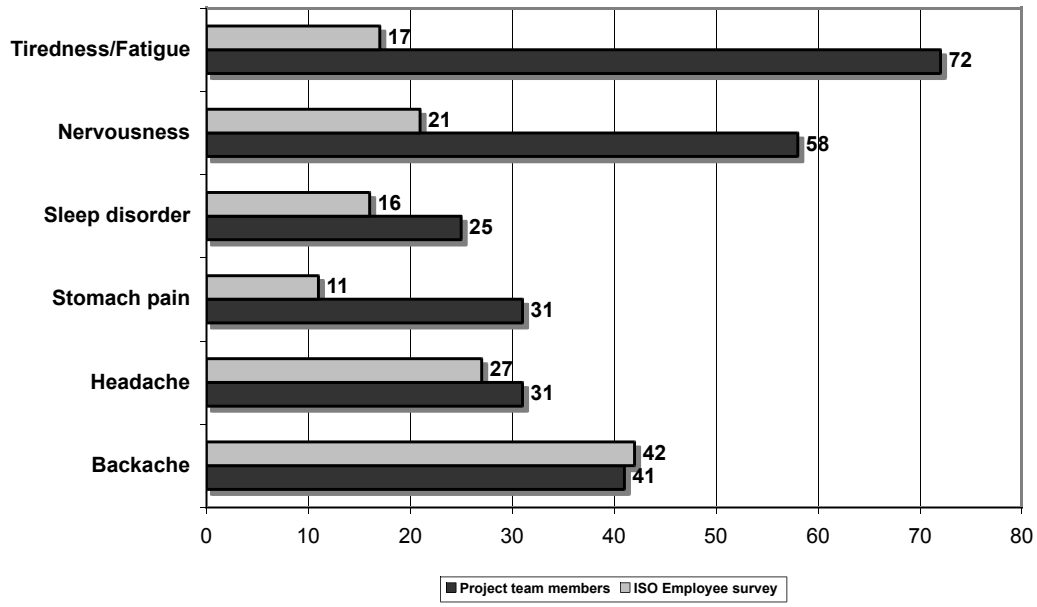

Fig. 3: Stress reactions of project team members as compared to average workers

The analysis of the monthly diaries provided further insight into the course of individual stress generation. By comparing the mean values of mental exhaustion between different groups of employees, it turned out that project team members reporting on high values of stress for more than eight weeks significantly suffer more

often from mental exhaustion than comparable groups with lower degrees of stress or with the ability to relax earlier. There was no similar effect for employees with high values for less than two months. This indicates that a period of stress lasting longer than two months is drastically increasing the risk of burnout – a relevant finding for work design.

Conclusion: Lessons learned for sustainable work design

Expanding dissemination of stress disorders due to intensive work – especially in knowledge-based project work –, the distress it effects for the knowledge workers' health, and the high costs and economic damages it causes for companies and societies call for immediate and effective action. To this end, the research findings deliver a number of promising approaches for designing sustainable work systems. First of all, it is obviously not sufficient, frequently even not possible, to constrain or reduce single strain factors. Rather, as this type of work is essentially deconfined, it requires efforts of process design instead of structural design (as in industrial work), i.e. to create working conditions and rules, under which given work demands and available resources can continuously and dynamically be balanced for the sake of mental health and business performance alike. As deconfined work is characterized both by process-dependent work demands not being determinable *ex ante* and by context-dependent resources only relationally effective, methods of *reflexive work design* (Moldaschl & Brödner 2002) are required for maintaining this balance.

Effective approaches for creating sustainable work systems need to attack work intensity and contradicting work demands at two levels: at the externally given objective working situation as well as at the internally developed personal coping capabilities. On company level, this requires the establishment of new strategic regulations and rules for an appropriate management of process-dependent workloads and, on individual level, the creation of favorable conditions for the workers to (re-)generate sufficient resources for coping. In particular, as management control excludes employees from influencing the framework underlying their work and this turns out to be a significant cause of stress, sustainability can be enhanced by letting employees participate in the design of frame conditions under which they do their work. Moreover, reflexivity in work design can be realized by a cyclic and evolutionary procedure of continuous reflection and work re-design during which improvements are regularly being explored, reflected, and evaluated. In this respect, the resource-centered perspective with its contradictory work demands approach and the lessons learned from this research go considerably beyond the socio-technical design tradition. The first step for achievements would be to raise management's awareness for the new challenges and risks of mental health as significant resource and to direct employees' awareness on their responsibility for developing both coping capabilities and work design capacities for controlling frame conditions.

Specifically, with respect to management's responsibility for sustainable work design, new specific *regulations and procedural rules* on project contract level should be introduced by which frequent *ad hoc* or "quick fix" reactions to customer requests can be avoided. This would contribute to harmonize workloads, to alleviate time pressure and thus help to considerably reduce strain and increase product quality alike.

Further improvements can be achieved by organizational measures for restricting workload in cases where project team members are working in different projects in parallel and where they are compelled to individually co-ordinate their activities. In

order to avoid additional demands from this straining situation, the *role of a co-coordinator (*"assignment manager"*) for multi-project work* can be defined whose task is to continuously check for staffing demands of the projects on one hand and for actual individual capacities and workloads on the other.

Moreover, existing *schemes of continuous improvement* should be expanded to aspects of developing and using personal, organizational und social resources for coping with work demands. Similarly, the practices of *health circles* could be refocused on the reflection of work demands and coping capabilities, thus connecting working with learning activities, with particular focus on the reflection of workloads and available resources. Such practices might be further supplemented by specific *coaching* for highly demanded workers helping them to better understand causes and symptoms of stress reactions and to effectively develop coping capabilities.

Finally, rules for *systematic allowance of time for re-creation* for highly demanded workers should be developed. According to the findings, it is important to provide recovering periods close to stressful and intensive working periods, while it appears not being helpful to foster sabbaticals or long recovery times for this purpose, no matter how useful for other objectives they might be; they obviously do not help, however, to avoid burnout or reduce burnout risks.

This research was designed as an exploratory study to test the significance of the resource-centered perspective on work. Although its usefulness for better comprehending the causes and effects of mental strain in highly skilled project work has been demonstrated, its scope is still limited. More methodological and empirical research is needed for extending design-oriented knowledge by answering questions like: How far is mental strain disseminated in different industries and professions? What are practical conditions and modalities to create and maintain sustainable work systems? Which effects do they produce with respect to workers' health and economic benefits?

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