EUROPEAN WORK AND ORGANIZATIONAL PSYCHOLOGIST, 1993, 3 (2) 85–100

Stress-oriented Analysis of Computerized Office Work[1]

Dieter Zapf
Faculty of Social Sciences, University of Konstanz, Germany

The stress-oriented job analysis instrument ISTA was applied to a sample of 232 office jobs to analyse the impact of new technologies on the stressor–strain relationship. Scales measuring work content (complexity of work, variety), stressors (time pressure, organizational problems, interruptions, concentration necessities, social stressors), and resources (control at work, control over time) were developed and demonstrated desirable scale characteristics. The results showed *positive correlations between stressors and* psychological dysfunctioning (psychosomatic complaints, irritation). Computer work was associated with a decrease of work stressors, but also with decreased job content. Work places using different software systems (word processing, specialist, spreadsheet, and graphic programs) manifested different characteristics regarding work content, stressors, and resources. For example, when working with word processors, most stressors occurred at a medium daily computer work time. This indicates that strategies of work design which involve computer and non-computer work have to be used carefully.

INTRODUCTION

There have been several studies analysing stress in computerized work, however they have not provided clear results. Some studies report an increase of stress with the introduction of computers (e.g. Johannson & Aronsson, 1984), while others report a decrease (e.g. Kalimo & Läppänen, 1985) and some studies find essentially the same amount of stress at work before and after the introduction of computers (e.g. Frese & Zapf, 1987a; and see Briner & Hockey, 1988; Frese, 1987b). Therefore, an interesting question remains as to how aspects of new technology are related to stress at work. After describing a theoretical framework of job characteristics, the following research questions will be investigated in this study: (1) What is the stressor–strain relationship like in computerized office work? (2) How are work content, work stressors, and resources affected by the amount of

Requests for reprints should be addressed to Dieter Zapf, University of Konstanz, Faculty of Social Sciences, Postbox 5560, D44, D-78434 Konstanz, Germany.

[1] This paper is a revised version of an article published previously in German (Zapf, 1991). Thanks are due to J. Lewter for helpful comments on an earlier draft of this paper.

daily computer work? (3) Are work content and work stressor variables related to work places with special software systems?

AN ACTION THEORY FRAMEWORK OF JOB CHARACTERISTICS

Stress-related job analysis questionnaires are often an atheoretical collection of stressful events. In order to overcome this problem, action theory was used to develop a theoretical framework for job characteristics. The core element of action theory is the hierarchical-sequential model of action regulation (Hacker, 1986; Volpert, 1982; an English overview in Frese & Zapf, 1994; cf. Miller, Galanter & Pribram's (1960) nested TOTE-units). The model describes how actions are regulated by a hierarchy of goals and plans (see Figure 1). According to this model, three groups of work characteristics can be differentiated: regulation requirements, regulation possibilities, and regulation problems (Frese & Zapf, 1994; Leitner, Volpert, Greiner, Weber, & Hennes, 1987; Semmer, 1984).

Regulation Requirements

High complexity at work corresponds to the hierarchical aspect of the regulation requirements necessary to do a particular task. That is, a very complex pyramid of goals and plans is necessary to carry out a complex task. An example of low complexity work is assembly line work, which can be almost completely regulated by simple cognitive structures (sensorimotor schemata). Thus, the altitude of the

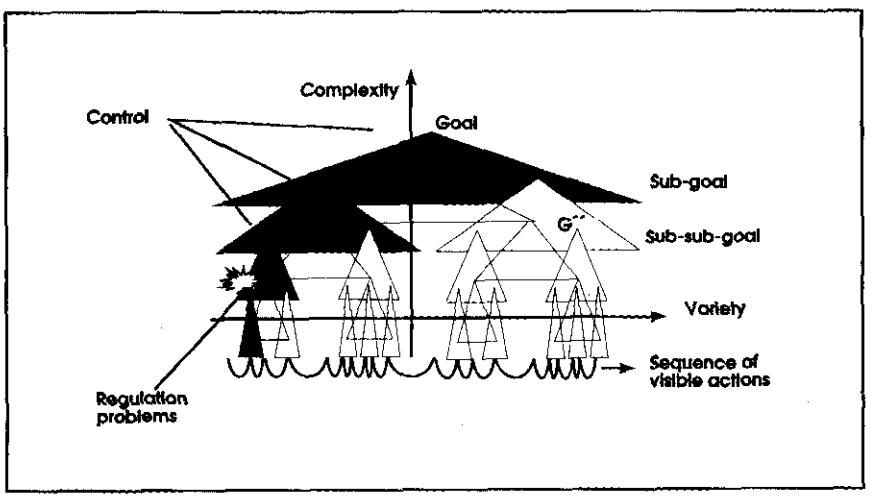

FIG. 1. Job characteristics within the model of hierarchic-sequential action regulation.

hierarchy of goals and plans is an approximation of complexity (scale: complexity). Variety has been used as an indicator of job content before (Hackman & Oldham, 1975). According to action theory, variety can be interpreted as the number of *different actions required by the tasks, independent of task complexity.* Thus, variety refers to the latitude of the pyramid in the hierarchical-sequential model, the pyramid being either very narrow or very wide (scale: variety).

Regulation Possibilities: Control

A central variable for work design is control. Many different terms are used in this area: Control, "Handlungsspielraum" (room for action), degrees of freedom, decision latitude or autonomy (see the discussion in Frese, 1989) There is high conceptual overlap between them, enabling them to be subsumed under the term "control". In the present case, control refers to the impact one has on working conditions and on one's activities in correspondence with some goal (Frese, 1977). Decision possibilities exist with regard to the sequence of the action steps, the content of goals and plans, and the time frame. Decision points regarding sequence include which tasks are carried out first, in which sequence plans are performed, and in which sequence feedback information is processed. Content refers to the *substance of the decisions: What particular task is done, what plan is performed,* etc. A high degree of control might allow the definition of the general goal of the work itself. A lower degree of control might only allow a choice between goals and plans at lower levels of action regulation (scale: control). The control of time frame refers to both when and for how long a certain task is performed (scale: control of time). Control is low if there is only one way to translate a higher order goal into a sequence of actions, i.e. there is just one pyramid related to the goal. If control is high then there may be different ways to carry out an action related to the higher

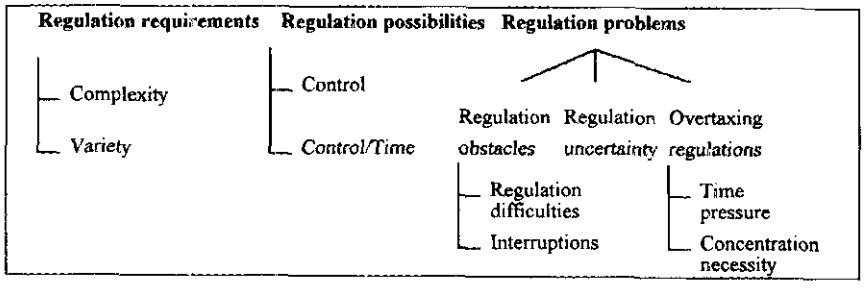

FIG. 2. Classification of task characteristics.

order goal, i.e. there are many possible pyramids representing the regulatory structure of actions for a particular task. It should be noted that some approaches confound complexity and control (Karasek, 1979; Volpert, Oesterreich, Gablenz-Kolakovic, Krogoll, & Resch, 1983). This is understandable from an empirical perspective, because complexity and control are usually highly correlated (Semmer & Zapf, 1989). Theoretically, however, control and complexity can be differentiated. Whereas control can be considered to be the degree of decision possibilities or regulation possibilities, complexity represents the degree of decision necessities or regulation necessities (Frese, 1987a). In other words a complex task requires complex decisions, regardless of whether or not the person wishes to make them. In a sense, complexity is a prerequisite of control: If there is no complexity then little substantial control is possible. Moreover, even if a task is very complex, there may be little room for individual decisions regarding how to perform it.

Regulation Problems: Stressors at Work

Stressors can be considered as regulation problems. They can be differentiated according to how severely they disturb the regulation of actions (Frese & Zapf, 1994; Greiner & Leitner, 1989; Semmer, 1984; Semmer, Zapf, & Dunckel, in press). These regulation problems can be differentiated into the following groups (see Figure 2).

Regulation Obstacles. Regulation obstacles are directly related to the task at hand. They make it harder or even impossible to pursue a goal and to regulate an action. The actor has to expend additional effort or has to engage in riskier actions (Leitner et al., 1987, p. 21). Obstacles have a negative influence on an otherwise intact action and they can be conceptualized as "daily hassles" (Kanner, Coyne, Schaefer, & Lazarus, 1981) in the work place. One subcategory of regulation obstacles is *regulation difficulties*, wherein it is, in principle, possible to do a task, but the task is made harder than it need be. Examples are lack of information, bad tools, etc. (scale: organisational problems). Another subcategory refers to the *interruption* of actions by unpredictable outside events. Interruptions can appear because of other people (colleagues, supervisors, customers; scale: interruptions), technical (machine breakdown), or organizational problems (lack of supplies).

Regulation uncertainty. In the case of regulation uncertainty, one does not know how to achieve a certain goal, which kinds of plans are useful, or what feedback is to be trusted (Semmer, 1984). Qualitative overload is a related category. Another issue is uncertainty because of insufficient or delayed feedback.

Overtaxing regulations. With overtaxing regulations, it is not impossible to develop adequate goals, plans, and feedback, as was the case with regulation uncertainty. However, the present problem is the speed and intensity of regulation.

For example, time pressure taxes the person's capabilities because of the high speed required to regulate the actions. One answer is a higher expenditure of energy by the person.

Speed of processing (scale: time pressure) produces problems because action regulation cannot occur as planned within a given time frame. An additional problem is the information overload of the short-term working memory during action execution within a specified time period (scale: concentration necessities). In this case, too much concurrent information is required in working memory in order to accomplish the task.

STUDY

Method

Stressor questionnaires often target the perception of stressors. This follows, for example, from the cognitive stress model of Lazarus and co-workers (Lazarus, 1966; Lazarus & Folkman, 1984; Lazarus & Launier, 1978), in which subjective appraisal processes played the major role in the evaluation of stressful situations. Stress depends mainly on the individual's appraisal of whether or not an event is stressful (see the discussion between Lazarus and co-workers and Dohrenwend and co-workers; Delongis, Folkman, & Lazarus, 1988; Dohrenwend, Dohrenwend, Dodson, & Shrout, 1984; Dohrenwend & Shrout, 1985; Lazarus, Delongis, Folkman, & Gruen, 1985). It is assumed that stress reactions can determine (future) stress perceptions. Stress perception is, therefore, intertwined with stress "reactions". These cognitive stress theories underline the importance of stress perceptions and do not take objective stressors into consideration.

Conversely, the tradition of work design emphasizes the objective characteristics of work instead (Frese & Zapf, 1988; Hacker, 1985, 1986; Hackman & Oldham, 1976, 1980; Oesterreich & Volpert, 1987; Ulich, 1991). Objective in this context means independent of a certain individual (Frese & Zapf, 1988). One of the primary reasons for this emphasis on objectivity is the theoretical tradition of action theory, and the empirical evidence that objective characteristics of work can have an impact on worker's health and personality development (e.g. Algera, 1983; Frese, 1985; Gardell, 1971; Hacker, Iwanowa, & Richter, 1983; Leitner et al., 1987, 1993; Semmer, 1982, 1984). Another practically important reason for emphasizing the objective nature of work is that work design is usually accomplished without taking individual factors into consideration. This is so because in many cases several individuals share the same work place, e.g. under shift work conditions. There are also important arguments for the inclusion of objective job characteristics in prospective work design (Ulich, 1984, 1991) meaning that criteria have to be developed to design jobs that do not yet exist and therefore have no known job incumbents. Clearly, from this perspective the analysis of objective stressors is central. The concept of objective stressors is often

dismissed on the grounds that something can only be regarded as a stressor if every individual experiences stress when it occurs. However, objective stressors can be defined in terms of risk, implying an increased probability of stress reactions in a given population (Semmer, 1991).

Based on these considerations an Instrument for STress-oriented job Analysis ISTA was developed, originally for industrial work (Semmer, 1984, Semmer & Dunckel, 1991). Scales were developed to cover regulation requirements, control, and several types of work stressors. The wording of the items was designed to keep individual appraisal processes to a minimum. For example, items such as "How much do you feel disturbed by interruptions of your work? Very much ... not at all" were avoided and wordings such as "How often is your work interrupted by colleagues? Several times per hour ... less than once a day" were preferred. A revised version of the instrument was developed for the analysis of office work. Not all aspects of theoretical stressors could be operationalized in this study. The original version of Semmer comprised a questionnaire for job incumbents and a rating instrument for experts, who needed to observe a certain work place for about two hours. The instrument could then be combined in order to deal with the advantages and disadvantages of both methodological approaches (Frese & Zapf, 1988; Semmer, 1984; Zapf, 1989). In this study, for organizational reasons complexity and control were part of an expert rating instrument, and the other job characteristics were part of a questionnaire for job incumbents.

In addition, the following variables were included in this study: (1) a scale of social stressors (Frese & Zapf, 1987b), comprising items referring to the social climate in the work group and conflicts with colleagues and supervisors; (2) a scale of "irritation", which included items such as "being irritated", "nervous", "aggressive", and "cannot stop thinking about work"; and (3) a scale of psychosomatic complaints, which included items such as "how often do you suffer from headaches, high blood pressure, insomnia", etc. (Mohr, 1986). An additional variable was daily computer work time, which was measured by asking the participants: "How much of your daily work time to you work with computers?" (0–100%).

Sample

The ISTA instrument was applied in a study on user errors (Zapf, Brodbeck, Frese, Peters, & Prümper, 1992). The present sample included 259 users of office software from 15 departments in 11 different public and private companies and 7 small firms in the southern part of the Federal Republic of Germany (former West Germany). For organizational reasons not all of the 259 subjects took part in every step of the study. We obtained questionnaire data from 232 participants. The mean age of the sample was 31.1 years, 73% women and 27% men. The work tasks included typing; secretarial work; work with office communication systems for several administrative purposes; specialized tasks in insurance and public administrations,

with integrated systems including large databases and word processing; and lower management tasks, such as working with spreadsheet programs to document the employment and absenteeism of workers.

RESULTS

Table 1 gives an overview of the scale characteristics. With the exception of the variety scale, satisfactory reliabilities were found for all the scales.

The intercorrelation of job characteristics, the two measures of psychological dysfunctioning, and daily computer work time can be seen in Table 2. There was a very high correlation between complexity and control, positive correlations between the stressors, and significant positive correlations between complexity and most of the stressors. Control was correlated with two of the stressors and with complexity.

The Stressor–Strain Relationship in Computerized Work

A first question was how the stressors were related to strain in computerized work. Three of the four stressors are slightly correlated with psychosomatic complaints. In general the correlations were somewhat lower than those found in the metal industry, where the instrument was applied originally (Frese & Zapf, 1987a; Semmer, 1984; Zapf & Frese, 1991). However the general pattern was the same. Several explanations can be given for the somewhat lower correlations: First, from

TABLE 1
Scale and Scale Characteristics

Scales	*Mean*	*Standard deviation*	*Cronbach's alpha*	*Range*	*Number of Items*
Observer's version					
Complexity	2.98	0.85	0.85	1–5	4
Control	2.85	0.94	0.92	1–5	6
Job incumbent's version					
Variety	3.08	0.93	0.18[a]	1–5	2
Control of time	3.92	0.86	0.63	1–5, 1–7	4
Interruptions	3.18	0.68	0.63	1–5	4
Organizational problems	2.51	0.71	0.53	1–5	3
Concentration necessity	3.28	0.78	0.58	1–5	4
Time pressure	2.78	0.79	0.73	1–5	4
Psychosomatic complaints	2.10	0.55	0.86	1–5	20
Irritation	2.71	1.02	0.85	1–7	8

N = 202–232.
[a] Correlation coefficient (two items only).

TABLE 2
Correlation of Job Characteristics and Variables of Psychological Dysfunctioning

	Variety	*Comp*[a]	*Control*[a]	*Control/ T*	*Interrup.*	*Org. pr*	*Concen*	*Time pr*
Variety	1.00							
Complexity [a]	0.34**	1.00						
Control [a]	0.37**	0.72**	1.00					
Control/Time	0.13*	0.26**	0.41**	1.00				
Interruptions	0.22**	0.07	0.21**	–0.02	1.00			
Organizational problems	0.17**	0.35**	0.40**	0.20**	0.20**	1.00		
Concentration necessity	0.19**	0.32**	0.31**	0.07	0.27**	0.24**	1.00	
Time pressure	0.24**	0.26**	0.26**	–0.17**	0.41**	0.17**	0.45**	1.00
Psychosomatic complaints	–0.06	0.03	0.04	0.00	0.16**	0.19**	0.13	0.16**
Irritation	–0.07	0.17**	0.28**	0.12**	0.09	0.27**	0.07	0.17**
Computer work time	–0.31**	–0.23**	–0.39**	–0.25**	–0.20**	–0.26**	–0.18**	–0.02

Minimum N: > 160; * $P < 0.05$; ** $P < 0.01$.

[a] Scale scores obtained by observer rating

Comp, complexity; Concen, concentration necessity; Control/T, control/time; Interrup, interruptions; Org. pr, organizational problems; Time pr, time pressure.

a methodological point of view, the scales comprised fewer items than was the case in their original form, and their reliability was lower. This could have led to the lower correlations. Second, as discussed, in the office version of the questionnaire the items were worded more objectively, which should reduce artificial correlations. Third, the intensity of the stressors was lower in the office. Fourth, the office sample was younger than the industrial workers, therefore there was a reduced exposure to the stressors. This could also attenuate the correlations (Frese & Zapf, 1988).

Stressors and Daily Computer Work Time

The last row of Table 2 shows correlations of job characteristics with computer work time. The job analysis measures were related to the job as a whole. Therefore, this variable provides an answer to the question of whether it is computer or non-computer work that is more responsible for the job characteristic measurements obtained. All of the correlations were negative, indicating that regulation requirements, control, and stressors decreased with increased computer work time. This result is in line with theories suggesting that the introduction of computers leads to a reduction of qualification requirements and job control (Sauter, 1989); however it contradicts hypotheses suggesting that computer work is necessarily related to more stress (Johannson & Aronsson, 1984).

Stressors and Computer Applications

For some years there has been an increasing demand to consider the organizational context in software design (e.g. Hacker, 1987; Ulich, 1989). Some interesting information was available from the present data regarding possible differences between jobs with different types of computer programs. Jobs that included word processing (usually done by secretaries and typists), specialist programs (usually mainframe programs consisting of menus and on-line forms, e.g. insurance), spreadsheet programs like Symphony or Lotus, and jobs with graphics programs like GEM or EMS from Siemens were investigated. Table 3 shows the results of variance analyses with program type as the independent variable and job characteristics and stress reactions as the dependent variables. As can be seen in the table, jobs with spreadsheet programs showed the highest degree of variety and complexity, and jobs with word processors showed the lowest degree of complexity. Jobs with graphics and spreadsheet programs were associated with high control and control of time. Control was lowest at work places with specialist programs. This is interesting because these jobs had medium complexity and there was a very high correlation between complexity and control (see Table 2).

There were also differences with regard to the individual stressors. For example, jobs with word processing had the most time pressure and interruptions, which seems to be typical of secretarial work, but also had the lowest degree of organizational problems. Conversely, graphics and spreadsheet jobs had the greatest degree of organizational problems. No differences between software applications appeared pertaining to psychosomatic complaints or irritation. This can be explained by the fact that there were no jobs with a program type where all

TABLE 3
Differences of Job Characteristics with Regard to Different Software Programs

Job Characteristic	*Word processing (n=114)* Mean	*Specialist program (n=69)* Mean	*Spreadsheet (n=35)* Mean	*Graphics (n=7)* Mean	*F-value*
Variety	3.19	2.77	3.28	3.07	3.78**
Complexity [a]	2.81	3.03	3.33	3.18	3.48*
Control [a]	2.85	2.49	3.47	3.43	9.87***
Control of time	3.73	3.84	4.46	4.82	10.53***
Interruptions	3.35	2.92	3.18	2.96	6.56***
Organizational problems	2.41	2.42	2.92	2.95	6.51***
Concentration necessary	3.16	3.43	3.35	3.57	2.19
Time pressure	2.91	2.68	2.65	2.32	2.58*
Psychosomatic complaints	2.16	2.10	1.90	1.99	1.87
Irritation	2.71	2.59	2.97	2.46	1.15

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
[a] Scale scores obtained by observer rating.

of the stressors were high or low. Rather, the stressors were balancing each other out, which led to the appearance of having no effects on the dependent variables.

The last issue to be addressed was whether or not there was an interaction between computer work time, program type, and job characteristics. Such information would provide an answer to the question of whether it was more the computer work or the non-computer work that was responsible for the degree of the job characteristics obtained. For the following analyses the variable of computer work time was trichotomized, resulting in the categories 0–40%, 40–70%, and more than 70% of daily computer work time. The results are shown in Table 4. Very few work places applied either graphics programs or spreadsheet programs individually, and we know from Table 3 that these groups of jobs were rather similar. They were therefore subsumed under one category in the following analyses.

The spreadsheet/graphics group had the highest degree of complexity; the lowest degree of complexity appeared in word processing jobs. In addition, complexity decreased with increased computer work time, but this effect was apparent mainly in the word processing jobs. This pattern may reflect the difference between typists, who use their word processing systems throughout the day, but whose tasks are not very complex, and secretaries, who perform many different tasks having at least medium complexity. A similar pattern appeared with regard to control and control/time.

As for the stressors, the specialist program jobs required the highest concentration necessities when the job involved medium computer work time, and required the lowest concentration necessities for jobs involving higher computer work time. Organizational problems occurred most often in the spreadsheet/graphics jobs. They decreased considerably for word processing jobs, but not for the others. For all program types interruptions occurred most often when job required medium computer work time.

DISCUSSION

This last section will discuss the main results of this study. Then, in conclusion, implications of work design and suggestions for software development will be presented.

Relationships Between Job Characteristics and Psychological Ill Health

There were mostly positive correlations between job characteristics and irritation and psychosomatic complaints. This was expected for the stressors, but not for complexity and control. One could argue that the relations, although significant, were not substantial. However, it can hardly be expected that one single variable determines psychological well-being, and it can be shown that even small correlations can be highly relevant. In an analysis by Frese (1985), based on a

TABLE 4
Differences of Job Characteristics Depending on Program Type and Computer Work Time

Job Characteristics		*Word Processing* *Mean* 0–40% 40–70% 70–100%	*Specialist Programs* *Mean* 0–40% 40–70% 70–100%	*Spreadsheet/ Graphics* *Mean* 0–40% 40–70% 70–100%	*F-value*[b] Program Work time Interaction
Variety	0–40%	3.48	3.33	3.23	0.96
	40–70%	3.30	3.23	3.36	9.48 ***
	70–100%	2.70	2.42	3.30	1.00
Complexity [a]	0–40%	3.26	2.85	3.43	3.29 *
	40–70%	2.86	3.41	3.25	4.48 **
	70–100%	2.36	2.94	3.15	2.15[c]
Control [a]	0–40%	3.29	2.64	3.64	6.71 **
	40–70%	3.03	2.83	3.45	9.27 ***
	70–100%	2.38	2.25	2.97	0.52
Control/Time	0–40%	3.98	3.67	4.55	7.62 ***
	40–70%	3.69	4.18	4.64	2.74[d]
	70–100%	3.49	3.69	3.90	1.29
Interruptions	0–40%	3.46	3.14	3.06	4.51 **
	40–70%	3.52	3.35	3.50	12.39 ***
	70–100%	3.02	2.71	3.10	0.77
Organizational problems	0–40%	2.59	2.48	3.00	5.88 **
	40–70%	2.44	2.90	2.83	5.55 **
	70–100%	2.19	2.25	2.87	1.24
Concentration necessities	0–40%	3.25	3.43	3.30	6.34 **
	40–70%	3.37	3.85	3.31	8.65 ***
	70–100%	2.76	3.29	3.05	0.55
Time pressure	0–40%	2.87	2.64	2.78	2.20
	40–70%	3.08	2.96	2.34	1.50
	70–100%	2.79	2.56	2.70	0.99

N = 177; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

[a] Scales of the observer rating.

[b] In this column the *F*-values for the main effects program (1st row), computer work time (2nd row) and the interaction effect (3rd row) are listed.

[c] $P = 0.08$.

[d] $P = 0.07$.

correlation of $r = 0.19$ high stressors led to a threefold increase of the probability of having high psychosomatic problems as compared to a low level of stressors. Comparatively, the current results are within the realm of expectation. Nevertheless, the working conditions investigated in the office were obviously less stressful than the working conditions investigated in the metal industry (Frese & Zapf, 1987a; Semmer, 1982, 1984; Zapf, & Frese, 1991). These results fit with other findings in the literature, i.e. that the jobs of unskilled workers are more

stressful than the jobs of skilled workers or managerial work (Caplan, Cobb, French, Harrison, & Pinneau, 1975; Cooper & Smith, 1985).

Job Characteristics and Computer Applications

The results of this study should not be understood as supporting the idea of technological determinism. The introduction of information technology (IT) is a result of managerial decision-making (e.g. Bjørn-Anderson, 1985; Kern & Schumann, 1984; Ulich, 1991). The introduction of IT usually provides room for user-oriented job design. However, in many cases these opportunities were not utilized. That is, managerial decisions regarding the introduction of computers are constrained on hardware and software decisions, whereas job design criteria are not taken into consideration. The present results showed that computers are neither "good" nor "bad". In terms of regulation requirements (complexity) and control, computer work showed a negative effect (which was bad), whereas in terms of stressors, work places with a high degree of computer work time showed moderate stressors in many cases (which was good).

With regard to complexity and control, for word processing jobs the two-factorial variance analyses showed that an increase of complexity and control appeared with decreasing daily computer work time. These results were in line with findings of, for example, Schardt and Knepel (1981) or Stellman, Klitzman, Gordon, and Snow (1985). However, this was not the case for jobs with calculation or graphic applications. Jobs with specialist programs showed an inverted U-shaped relationship: complexity, variety, and control were highest in the middle group.

As for the stressors, it should be noted that hardware-related stressors, causing eye strain or musculoskeletal diseases, were not included in this study. Because of this, the picture available from the data is incomplete. However, several findings were interesting. First, a high amount of daily computer work was not related to an increased number of stressors. On the contrary, the opposite effect was found for jobs with word processing applications. In many cases, the greatest number of stressors occurred on jobs requiring medium computer work time. This leads to the conclusion that the often-recommended combination of different tasks and tools (computer tools and non-computer tools) is actually related to higher degrees of stressors. This may be caused by the organization of the work itself rather than by the actual computer systems, because computer systems are often introduced without taking the general work context into account (Hacker, 1987). Consequently, the design and introduction of computer systems should be considered as part of job design and should be put into an organizational context (Frese, 1987b; Hacker, 1987; Ulich, 1991). Computer-supported tasks should provide adequate complexity and sufficient control. This was not so for jobs involving specialist programs in the present study. Such jobs were of medium complexity, but they clearly provided less control than jobs with other applications. This result can be explained by the fact

that specialist programs clearly provided more system guidance and, thus, prescribed how tasks had to be performed. This was good for beginners because it made the system easier to learn but it was definitely annoying for the more experienced users, who could not develop their own work strategies.

As mentioned previously, the combination of computer and non-computer work is often recommended. However, this recommendation does not automatically prove useful. It is true that regulation requirements and control were best for medium daily computer work time, but this was also true for some of the stressors. Therefore, combining computer and non-computer work should be done with special care to prevent the increase of stressors, such as interruption or organizational problems.

Even if the introduction of new technology is recognized as a chance to improve working conditions, it may not always be possible to reduce the work stressors themselves. In such cases computer systems can be designed to work as technical resources in the stress process. Internal and external resources are means that support coping activities in the stress process (Schönpflug, 1985; Udris & Frese, 1988). For example, some studies have shown that errors are related to stress (Brodbeck, Zapf, Prümper, & Frese, 1993; Schulz & Schönpflug, 1982; Zapf, 1993). Therefore, tools supporting error handling will also contribute to coping with stress. Backup files, undo functions, or context-sensitive help are some examples (Zapf, Frese, Irmer, & Brodbeck, 1991). Tools for information search are helpful to overcome organizational problems, which usually consist of missing, incomplete or obsolete information. Interruptions at work sometimes require the use of another system and then a return to the first. A person could more easily cope with interruptions if it is always possible to interrupt the current action, if they can save the actual results, if they can move easily to another program to work on another task, and if it is easy to go back to the first program. These requirements are met by windows applications. History functions for recapitulating parts of a task are also helpful in such situations. Thus, software design can support coping with stress effects by providing technical resources. This perspective should also be taken into consideration when new software systems are introduced.

REFERENCES

Algera, J.A. (1983). "Objective" and perceived task characteristics as a determinant of reactions by task performers. *Journal of Occupational Psychology, 56,* 95–107.

Bjørn-Andersen, N. (1985). Are 'human factors' human? In N. Bevan & D. Murray (Eds.), *Man–machine interaction: State of the art report.* Maidenhead: Pergamon Infotech.

Briner, B., & Hockey, G.R.J. (1988). Operator stress and computer-based work. In C.L. Cooper & R. Payne (Eds.), *Causes, coping, and consequences of stress at work* (pp. 115–140). Chichester: Wiley.

Brodbeck, F.C., Zapf, D., Prümper, J., & Frese, M. (1993). Error handling in office work with computers: A field study. *Journal of Occupational and Organizational Psychology, 66,* 303–317.

Caplan, R.D., Cobb, S., French, J.R.P., Harrison, R. van, & Pinneau, S.R. (1975). *Job demands and worker health.* Washington: National Institute for Occupational Safety and Health (NIOSH).

Cooper, C.L., & Smith, M.J. (1985). Introduction: Blue collar workers are 'at risk'. In C.L. Cooper & M.J. Smith (Eds.), *Job stress and blue collar work.* Chichester: Wiley.

DeLongis, A., Folkman, S., & Lazarus, R.S. (1988). The impact of daily stress on health and mood: Psychological and social ressources as mediators. *Journal of Personality and Social Psychology, 54,* 486–495.

Dohrenwend, B.P., & Shrout, P.E. (1985). "Hassles" in the conzeptualization and measurement of life stress variables. *American Psychologist, 40,* 780–785.

Dohrenwend, B.S., Dohrenwend, B.P., Dodson, M., & Shrout, P.E. (1984). Symptoms, hassles, social supports, and life events: Problems of confounded measures. *Journal of Abnormal Psychology, 93,* 222–230.

Frese, M. (1977). *Psychische Störungen bei Arbeitern.* Salzburg: Otto Müller Verlag.

Frese, M. (1985). Stress at work and psychosomatic complaints: A causal interpretation. *Journal of Applied Psychology, 70,* 314–328.

Frese, M. (1987a) A theory of control and complexity: Implications for software design and integration of the computer system into the work place. In M. Frese, E. Ulich, & W. Dzida (Eds.), *Psychological issues of human computer interaction in the work place* (pp. 313–338). Amsterdam: North-Holland.

Frese, M. (1987b). The industrial and organizational psychology of human-computer-interaction in the office. In C.L. Cooper & I.T. Robertson (Eds.), *International Review of Industrial and Organizational Psychology* (pp. 117–165). Chichester: Wiley.

Frese, M. (1989). Theoretical models of control and health. In S.L. Sauter, J.J. Hurrel, & C.L. Cooper (Eds.), *Job control and worker health* (pp. 108–128). New York: Wiley.

Frese, M., & Zapf, D. (1987a). Die Einführung von neuen Techniken verändert Qualifikationsanforderungen, Handlungsspielraum und Stressoren kaum. *Zeitschrift für Arbeitswissenschaft, 41,* 7–14.

Frese, M., & Zapf, D. (1987b). Eine Skala zur Erfassung von Sozialen Stressoren am Arbeitsplatz. *Zeitschrift für Arbeitswissenschaft, 41,* 134–141.

Frese, M., & Zapf, D. (1988). Methodological issues in the study of work stress: Objective vs. subjective measurement and the question of longitudinal studies. In C.L. Cooper & R. Payne (Eds.), *Causes, coping, and consequences of stress at work* (pp. 375–411). Chichester: Wiley.

Frese, M., & Zapf, D. (1994). Action as the core of work psychology; A German approach. In H.C. Triandis, M.D. Dunnette, & L.M. Hough (Eds.), *Handbook of industrial and organizational psychology* (Vol. 4, pp. 271–340). Palo Alto: Consulting Psychologists Press.

Gardell, B. (1971). Alienation and mental health in the modern industrial environment. In L. Levi (Ed.), *Society, stress, and disease. Vol. 1: The psychosocial environment and psychosomatic diseases* (pp. 148–180). London: Oxford University Press.

Greiner, B., & Leitner, K. (1989). Assessment of job stress: The RHIA-Instrument. In K. Landau & W. Rohmert (Eds.), *Recent developments in job analysis. Proceedings of the International Symposium on Job Analysis, University of Hohenheim* (pp. 53–66). London: Taylor & Francis.

Hacker, W. (1985). Activity: a fruitful concept in industrial psychology. In M. Frese & J. Sabini (Eds.), *Goal directed behavior: the concept of action in psychology* (pp. 262–284). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Hacker, W. (1986). *Arbeitspsychologie.* Bern: Huber.

Hacker, W. (1987). Software-Ergonomie: Gestaltung rechnergestützter geistiger Arbeit? In W. Schönpflug & M. Wittstock (Eds.), *Software-Ergonomie '87* (pp. 31–54). Stuttgart: Teubner.

Hacker, W., Iwanowa, A., & Richter, P. (1983). *Tätigkeits-Bewertungssystem.* Berlin (DDR): Diagnostisches Zentrum.

Hackman, J.R., & Oldham, G.R. (1975). Development of the job diagnostic survey. *Journal of Applied Psychology, 60,* 259–270.

Hackman, J.R., & Oldham, G.R. (1976). Motivation through the design of work: Test of a theory. *Organizational Behaviour and Human Performance, 16,* 250–279.

Hackman, J.R., & Oldham, G.R. (1980). *Work redesign.* Reading, MA: Addison Wesley.

Johansson, G., & Aronsson, G. (1984). Stress reactions in computerized administrative work. *Journal of Occupational Behaviour, 5,* 159–181.

Kalimo, R. & Leppänen, A. (1985). Feedback from VDT's, performance control, stress in text preparation in the printing industry. *Journal of Occupational Psychology, 58,* 27–38.

Kanner, A.D., Coyne, J.C., Schaefer, C., & Lazarus, R.S. (1981). Comparison of two modes of stress measurement: Daily hassles and uplifts versus major life events. *Journal of Behavioral Medicine, 4,* 1–39.

Karasek, R.A. (1979). Job demands, job decision latitude and mental strain: Implications for job redesign. *Administrative Science Quarterly, 24,* 385–408.

Kern, H., & Schumann, M. (1984). *Das Ende der Arbeitsteilung? Rationalisierung in der industriellen Produktion.* München: C.H. Beck.

Lazarus, R.S. (1966). *Psychological stress and the coping process.* New York: McGraw Hill.

Lazarus, R.S., DeLongis, A., Folkman, S., & Gruen, R. (1985). Stress and adaptational outcomes. The problem of confounded measures. *American Psychologist, 40,* 770–779.

Lazarus, R.S., & Folkman, S. (1984). *Stress, appraisal and coping.* New York: Springer.

Lazarus, R.S., & Launier, R. (1978). Stress-related transactions between person and environment. In L.A. Pervin & M. Lewis (Eds.), *Perspectives in international psychology.* New York: Plenum Press.

Leitner, K., Lüders, E., Greiner, B., Ducki, A., Niedermeier, R., & Volpert, W. (1993). *Analyse psychischer Anforderungen und Belastungen in der Büroarbeit. Das RHIA/VERA-Büro-Verfahren.* Göttingen: Hogrefe, Verlag für Psychologie.

Leitner, K., Volpert, W., Greiner, B., Weber, W.G., & Hennes, K. (1987). *Analyse psychischer Belastung in der Arbeit. Das RHIA-Verfahren.* Köln: TV Rheinland.

Miller, G.A., Galanter, E., & Pribram, K.H. (1960). *Plans and the structure of behavior.* London: Holt.

Mohr, G. (1986). *Die Erfassung psychischer Befindensbeeinträchtigungen bei Arbeitern.* Frankfurt a.M.: Peter Lang.

Oesterreich, R., & Volpert, W. (1987). Handlungstheoretisch orientierte Arbeitsanalyse. In U. Kleinbeck & J. Rutenfranz (Eds.), *Arbeitspsychologie. Enzyklopädie der Psychologie, Themenbereich D, Serie III, Band 1* (pp. 43–73). Göttingen: Hogrefe.

Sauter, S.L. (1989). NIOSH studies of control and worker well-being. Moderating effects of job control on health complaints in office work. In S.L. Sauter, J.J. Hurrell, & C.L. Cooper (Eds.), *Job control and worker health* (pp. 91–96). Chichester: Wiley.

Schardt, L.P, & Knepel, W. (1981). Psychische Beanspruchungen kaufmännischer Angestellter bei computerunterstützter Sachbearbeitung. In M. Frese (Ed.), *Streß im Büro* (pp. 125–158). Bern: Huber.

Schönpflug, W. (1985). Goal directed behavior as a source of stress: Psychological origins and consequences of inefficiency. In M. Frese & J. Sabini (Eds.), *Goal directed behavior: The concept of action in psychology* (pp. 172–188). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Schulz, P, & Schönpflug, W. (1982). Regulatory activity during states of stress. In W. Krohne & L. Laux (Eds.), *Achievement, stress and anxiety* (pp. 51–73). Washington: Hemisphere.

Semmer, N. (1982). Stress at work, stress in private life, and psychological well-being. In W. Bachmann & I. Udris (Eds.). *Mental load and stress in activity* (pp. 42–55). Amsterdam: North Holland.

Semmer, N. (1984). *Stressbezogene Tätigkeitsanalyse.* Weinheim und Basel: Beltz.

Semmer, N. (1991). One man's meat, another man's poison? Stressors and their cultural background. In M. Cranach, G. Mugny, & W. Doise (Eds.), *Social representations and the social bases of knowledge. Proceedings of the 1st Congress of the Swiss Society of Psychology* (pp. 152–157). Bern: Huber.

Semmer, N., & Dunckel, H. (1991). Stressbezogene Arbeitsanalyse. In S. Greif, E. Bamberg, & N. Semmer (Eds.), *Psychischer Stress am Arbeitsplatz* (pp. 57–90). Göttingen: Hogrefe.

Semmer, N., & Zapf, D. (1989). Validity of various methods of measurement in job analysis. In K. Landau & W. Rohmert (Eds.), *Recent developments in job analysis* (pp. 67–78). London: Taylor & Francis.

Semmer, N., Zapf, D., & Dunckel, H. (in press). Stress oriented job analysis. A theoretical framework and the development of an instrument.

Stellman, J.M., Klitzman, S., Gordon, G.C., & Snow, B.R. (1985). Work environment and the well-being of clerical and VDT workers. *Journal of Occupational Behavior, 6,* 95–114.

Udris, I., & Frese, M. (1988). Belastung, Fehlbeanspruchung und ihre Folgen. In D. Frey, C. Graf Hoyos, & D. Stahlberg (Eds.), *Angewandte Psychologie: Ergebnisse und neue Perspektiven* (pp. 427–447). München: Urban & Schwarzenberg.

Ulich, E. (1984). Psychologie der Arbeit. Management-Enzyklopädie. Landsberg: *Moderne Industrie, 7,* 914–929.

Ulich, E. (1989). Arbeitspsychologische Konzepte der Aufgabengestaltung. In S. Maass & H. Oberquelle (Eds.), *Software-Ergonomie '89. Aufgabenorientierte Systemgestaltung* (pp. 51–65). Stuttgart: Teubner.

Ulich, E. (1991). *Arbeitspsychologie.* Stuttgart: Poeschel.

Volpert, W. (1982). The model of the hierarchical-sequential organization of action. In W. Hacker, W. Volpert, & M.V. Cranach (Eds.), *Cognitive and motivational aspects of action* (pp. 35–51). Berlin: Deutscher Verlag der Wissenschaften.

Volpert, W., Oesterreich, R., Gablenz-Kolakovic, S., Krogoll, T., & Resch, M. (1983). *Verfahren zur Ermittlung von Regulationserfordernissen in der Arbeitstätigkeit (VERA).* Köln: TÜV- Rheinland.

Zapf, D. (1989). *Selbst- und Fremdbeobachtung in der psychologischen Arbeitsanalyse. Methodische Probleme bei der Erfassung von Stress am Arbeitsplatz.* Göttingen: Hogrefe.

Zapf, D. (1991). Stressbezogene Arbeitsanalyse bei der Arbeit mit unterschiedlichen Bürosoftwaresystemen. *Zeitschrift für Arbeits- und Organisationspsychologie, 35,* 2–14.

Zapf, D. (1993). *Fehler in der Mensch-Computer Interaktion. Zum Einfluss von Komplexität, Handlungsspielraum und Stress auf Fehler und Fehlerbewältigung.* Unpublished habilitation thesis. University of Giessen: Department of Psychology.

Zapf, D., Brodbeck, F.C., Frese, M., Peters, H., & Prümper, J. (1992). Errors in working with computers: A first validation of a taxonomy for observed errors in a field setting. *International Journal of Human-Computer Interaction, 4,* 311–339.

Zapf, D., & Frese, M. (1991). Soziale Stressoren am Arbeitsplatz und psychische Gesundheit. In S. Greif, E. Bamberg, & N. Semmer (Eds.), *Psychischer Stress am Arbeitsplatz* (pp. 168–184). Göttingen: Hogrefe.

Zapf, D., Frese, M., Irmer, C., & Brodbeck, F.C. (1991). Konsequenzen von Fehleranalysen für die Softwaregestaltung. In M. Frese & D. Zapf (Eds.), *Fehler bei der Arbeit mit dem Computer: Ergebnisse von Beobachtungen und Befragungen im Bürobereich* (pp. 177–191). Bern: Huber.