Computers and Computer Networks as Catalysts of Intraorganizational Decentralization

HANS GESER

Institute of Sociology, University of Zurich
Andreasstrasse 15, 8050 Zürich (Schweiz)
e-mail: h@geser.net
URL: http://geser.net

Abstract

In this article the author propose a Study of the organizational implications of new communication technologies as a highly complex endeavour for three reasons: First of all, a wide and constantly enlarging range of different applications (like Email, teleconferencing, electronic bulletin boards, Internet/Intranet access, Internet relay chats, and group decision support systems) has to be considered. Secondly, similar technologies have very divergent impacts because they are applied in very different roles, departments and functional areas. Thus, they encompass the sphere of production where robotics and numerically controlled machinery has been implemented, as well as the office sector where commercial and administrative processes have been basically transformed (Kling 1996). And finally, contrasting with traditional machineries that are often determining social interactions and structures in highly, specific, predictable ways, computer-based technologies have rather to be considered as factors of indetermination: e. g. by loosening temporal and spatial restrictions and thus widening the range of possible forms of human cooperation.

Rezumat

Studiul propus asupra consecinţelor la nivel organizaţional al noilor tehnologii de comunicare este un efort complex din trei motive. În primul rând trebuie luată în considerare o varietate mare de aplicaţii (precum email-ul, teleconferinţele, accesul la Internet/Intranet, aplicaţiile de chat sau platformele de sprijin. În al doilea rând tehnologii asemănătoare pot avea un impact diferit deoarece pot juca roluri diferite, şi pot fi aplicate în domenii şi în scopuri diferite.

Articolul se referă şi la sfera de producţie unde s-au utilizat roboţi şi maşini controlate numeric, precum şi la acele sectoare în care procesele comerciale au fost automatizate. Şi, nu în ultimul rând, spre deosebire de maşinile tradiţionale care de cele mai multe ori determină interacţiunile şi structurile sociale în modalităţi specifice, previzibile, este dezbătuta starea tehnologiilor informaţionale ca factor de interdeterminare, relaxând constrângerile temporare şi spaţiale şi astfel diversificând formele posibile de cooperare umană.

În consecinţă, efectele structurale (precum schimbări în distribuţia de putere şi influenţă) nu se vor face simţite numai dacă un număr ridicat de angajaţi stau în faţa calculatoarelor, ci vor avea loc treptat pe măsură ce noile tehnologii devin instrumente pentru satisfacerea nevoilor sau atingerea obiectivelor ale unei anumite organizaţii.

Revista de Informatică Socială
vol. VII nr. 12 / Decembrie 2009
ISSN 1584-384X

1. Introduction

Studying the organizational implications of new communication technologies is a highly complex endeavour for three reasons:

1) A wide and constantly enlarging range of different applications (like Email, teleconferencing, electronic bulletin boards, Internet/Intranet access, Internet relay chats, and group decision support systems) has to be considered.
2) Similar technologies have very divergent impacts because they are applied in very different roles, departments and functional areas. Thus, they encompass the sphere of production where robotics and numerically controlled machinery has been implemented, as well as the office sector where commercial and administrative processes have been basically transformed (Kling 1996).
3) Contrasting with traditional machineries that are often *determining* social interactions and structures in highly, specific, predictable ways, computer-based technologies have rather to be considered as factors of *indetermination*: e. g. by loosening temporal and spatial restrictions and thus widening the range of possible forms of human cooperation.

Contrasting with mere "terminals" of mainframe computers as they existed in the seventies, personal computers are highly polyvalent tools potentially able to accomplish an unlimited variety of different tasks with an even larger variety of alternative procedures. When computers are internetted, the spectrum of options widens again immensely, because users get access to external information sources and can interact and cooperate in any possible ways.

Several studies support the contention that the implementation of IT-technologies is a conflictive ("micropolitical") process shaped by various individuals and groups that try to maximize their own preferences and goals (Newman and Noble 1990; Bloomfield and Daniel 1995; Sabherwal and King 1992).
Some authors see these antecedent organizational structures as the main or even sole determinants: so that the results of IT implementation processes are predetermined by the formal power structure existing at the time of inception (Franz and Robey 1986; Ang and Cummings 1997; Tractinsky and Jarvenpaa 1995). Others give more room to technological factors and unpredictable contingencies by maintaining that IT-implementations set into motion various adaptation processes from which new cooperation patterns and even power structures may finally emerge (Lee 1991; Tan et. al. 1995; William and Wilson 1997).

Rob Kling agrees with Bullen and Bennett (1990) that in contrast to classical machinery, installing computer hardware is not sufficient for making the technology running and reaping its fruits. Instead, long processes of software development (and learning how to use programs effectively) are necessary for exploiting the potentials of stand alone computers (Kling and Iacono, 1989), and even more encompassing processes of reorganization are indispensable for maximizing the returns of Intranets, Extranets, groupware programs and other systems of multilateral communication.

As a consequence, it is not to be expected that structural effects (like shifts in the distribution of power and influence) will actualize as soon as larger number of employees sit behind the computer. Instead, they may slowly become reality to the degree that managers and workers discover how the new technologies can be instrumentalized for fulfilling their needs and furthering the goals of their particular organization.

2. The issue of (de-)centralization

In the sphere of conventional industrial technology, it is evident that many centralizing effects stem from the basic fact that management controls its implementation. Thus, especially Neomarxist authors like Braverman (1974) have stressed that material technology functions as a medium for perfectionizing interclass domination, because capitalists can control worker behavior by developing and applying machineries that predetermine the bodily movement, the pace of work as well as the patterns of interpersonal cooperation.
It is argued that in the same way, management also controls the implementation of computer technologies by deciding about the hardware to be bought and the software to be implemented.
As in the classical epochs of industrialization, private enterprises have been the major innovators: by investing into huge new computerized technologies that have affected the single work roles and work teams as well as the functioning of larger organizational and interorganizational structures.

Consequently, it is the *work place* where individuals are most deeply affected by the new computer technologies, so that their roles and behavioral patterns have often been fundamentally transformed:

> *".....computerization has touched more people more visibly in their work than in any other kind of setting -- home, schools, churches, banking, and so on. Work places are good places to examine how the dreams and dilemmas of computerization really work out for large numbers of people under an immense variety of social and technical conditions." (Kling 1996)*

By increasing the visibility and measurability of individual performances, many of these applications evidently increase the range of centralized human control:

> *"IT increases the visibility of individual performance, both to superiors and to peers. Performance monitoring devices built into IT systems include measuring: the number of key strokes per minute in word processing, the number of calls answered per day by operators in call centres, throughput in manufacturing industry, number of lines of code written by computer programmers, number of inquiries answered by customer assistance personnel, sales, etc." (Martin 2002).*

Countering the optimistic visions of electronic democratization with a Neomarxist perspective, Rob Kling maintains that office automation follows the same logic of interclass domination as the classical industrial mechanization:

> *"Our principal point is that the lessons of the factory are the guiding principles of office automation. In large offices, clerical work has already been transformed into factory-like production systems. The latest technology -- office automation -- is simply being used to consolidate and further a well-established trend. For most clerical workers, this spells an intensification of factory discipline. For many professionals and managers, it signals a gradual loss of autonomy, task fragmentation and closer supervision -- courtesy of computerized monitoring." (Kling 1996)*

In a similar vein, Wresch argues that centralizing effects dominate because managers have the power of specifying the ways the new technologies are implemented: e. g. by choosing the type of network administration software to be used. In accordance with their basic control interests, they tend to use it for installing a perfectionized "panopticon": a device of surveillance that allows them to track remotely all movements and activities of their employees (Wresch 1996).

However, it is doubtful whether similar centralization effects can be achieved as in the case of classical machinery, because information and communication technologies are so polyvalent that they lend themselves also to highly informalized and even "subversive" uses.

First of all, even stand-alone computers may empower individuals in many different ways: by extending their range for competent individual actions and decisions, even when their level of formal qualification is quite low.

> *"IT facilitates decentralising responsibility to lower levels in the organisation, both within management and amongst employees. Middle managers may be given greater autonomy and responsibility when supported by decision support and expert systems. Skilled machinists may be given more discretion with machine tools that provide greater scope for flexible working than traditional machining centres, with their time consuming set up arrangements. Telephone operators in call centres may give advice to callers based on information available on line, instead of routing calls to specialist staff. Travel shop assistants may offer meaningful advice to holidaymakers, based on information accessed via corporate systems." (Martin 2002).*

Secondly, the installation of computer networks goes along with many risks because they provide a multitude of additional communication channels that make more unpredictable who communicates with whom about what - and therefore also: who is in possession of what kind of information at a specific point of time. To make such specifics predictable and controllable would be equivalent of closing the system down. A fortiori, opening the access to the Internet amplifies the spectrum of possible usage patterns: e. g. by facilitating the rapid switching between intra- and extraorganizational roles. (Geser 2002)[1]
All these potentials can only be exploited to the degree that no codified rules and no centralized controls predetermine who has to use the computer at moment in what precise way: so that employees are free to choose optimal procedures in the light of given goals, needs, and circumstances. As a consequence, it becomes more difficult to prescribe exact procedures and to base work coordination on behavioral control. Instead, management has to shift to output control: by assessing only work results, regardless of the way by which they have been achieved Baloh/Trkman 2003). This again implies that the main motivation of employees is to solve tasks and to reach goals, not to conform to bureaucratic norms and procedures.[2] (Baloh/Trkman 2003)

More than that: a certain degree of ex ante decentralization and informality may even be necessary for effective IT exploitation: an environment where employees have enough

[1] Given this pervasiveness and flexibility, it is evident that computer technologies are used for a wide range of purposes far transcending narrow work concerns and purely economic goals. Thus, a 1998 survey has shown that employees spend only 75% of their online hours in work related activities, while the remaining time was dedicated to news and entertainment searches and other private concerns. (Preciado 1998).
[2] For instance: controlling the observation of "office hours" becomes pointless when computers allow continuing working at home or on travel.

autonomy and leeway to learn on the job, and to try out many risky things without pressure to be effective and without fear of sanctions.
All these arguments accord with the finding of Hitt and Brynjolfsson 1997 that high levels of IT investment and IT use were related to work system with decentralized authority.
Among the earliest proponents of this optimistic view, Lee Sproull and Sara Kiesler (1991) asserted that computer-mediated communication promotes more equalized power structures by allowing peripheral employees to circumvent hierarchical barriers and to participate more actively in the processes of intraorganizational communication. Additional equalization effects may stem from the fact that receivers are often not informed about the sender's status characteristics (gender, education or formal position).

Similarly, Jasperson argues that

> *"….while IT does not bring about change in formal authority structures, it can be used by the less powerful to increase their visibility and enhance informal bases of power such as expertise and network centrality." (Jasperson 2002)*

Eric Lee has found that such empowerment of lower levels takes place for different reasons in various parts of the organizations. In the administrative sector, it is mainly stemming from increased centrality in communication networks, while in the technical sector; it is predominantly associated with increased resource provision (Lee 1991).

On a most general level, computer mediated communication (CMC) reduces the role of hierarchical structures because it increases the capacity of horizontal interaction networks to exchange information, to coordinate work processes and to reach various decisions (Bishop/ Levine 1999). In particular, CMC has the advantage that such processes can be started informally by anybody without much costs and efforts, so that the initiating or catalyzing function of formal authorities may be reduced. (Bishop/Levine 1999)

Given their capacity to support any kind of decentralized communication, *Intranets* have an intrinsic capacity to facilitate the emergence of grassroot Networks of workers and to promote processes of widespread horizontal coordination and collectivization (Levine 1999). While almost unknown in 1993, Intranets expanded in following years so quickly that in 1996, 64% of the Fortune 1000 companies had them already installed (Sinton 1996). By providing bilateral and multilateral communication channels across the organization irrespective of IT-specificities at different locations, Intranets are highly polyvalent technologies promoting the downward flow of information, facilitating the universal access to central documents as well as supporting any kind of horizontal interactions and group activities on all organizational levels (Marchand et. al 2001).[3]

In fact, by strengthening the action potentials of horizontal networks, IT is threatening the traditional hierarchical structures that are primarily based on vertical interactions. For instance, the interaction barriers between different departments may collapse in a way that the authority of middle managers is effectively undermined (Martin 2002). In addition, online interaction may well function as a breeding ground for a new corporate culture that is primarily based on interpersonal goodwill and trust (Nandhakumar, 1999; Martin 2002). In

[3] In his case study about the ESCO Reisen AG, Christian Tanner found that the top managers had sceptical attitude toward the Intranet because they feared that its internal dynamic would lead to a loss of centralized control (Tanner 2000).

turn, it can increase the company's cohesion by binding the employees tighter into the organization (Finholt, Sproull, and Kiesler 1990).

"For example, having groups of black, female professional, or gay and lesbian employees promotes social integration and may reduce turnover, which is in the interest of both the company and its employees. Having employees discuss science fiction over the computer network is not directly useful, but may enhance worker commitment. The presence of such interest groups is consistent with the traditions of welfare capitalism, playing much the same role as a company softball team." (Bishop/ Levine 1999)

In addition, Intranets may also promote corporate democracy by catalyzing vertical upward communication. Employees may feel more encouraged to articulate their views directly to top managers because they can avoid the tensions usually associated with face-to-face communication (Martin 2002). In his case study on a large high technology enterprise, Bishop and Levine found that CMC facilitated upward communication, thus enhancing the employee's ability to express their views and to participate in decision-making processes (Bishop/Levine 1999).

On the one hand, increased upward flows of communication may enhance productivity by accelerating decision making and providing managers with better information (Ichniowski et al. 1996), on the other hand, they can also improve the worker's job satisfaction and their overall evaluation of the firm (Lawler et al. 1995). However, such direct vertical connections may also have countervailing centralizing effects because peak managers have more chances to make their influence felt on the lower organizational levels by simply circumventing all intermediate ranks.

Thus, some more sophisticated studies have led to the paradoxical conclusion that IT technologies may foster centralization and decentralization at the same time.
On the one hand, centralization on the encompassing level of the whole organization is increased because top management uses the new technologies for reinforcing overall formalization and control. On the other hand, this same overall centralization opens the way for delegating more authority to lower levels, because even supervisors with very high discretion can now still be effectively controlled. (Dawson/McLoughlin 1986; Dean et al. 1992; Zeffane 1989)

3. The crucial role of intervening variables

All the straightforward bivariate hypotheses mentioned above collide with the evident fact that technology-structure relationships are mediated by powerful intervening variables.

Thus, Susan Herring has concluded that the technology itself had no intrinsic democratizing potential because personal status factors like gender were decisive whether electronic upward communication was effective or not:

> *"...although the medium theoretically allows for everyone with access to a network to take part and to express their concerns and desires equally, a very large community of potential participants is effectively prevented by censorship, both overt and covert." (Herring 1992)*

Likewise, Mantovani (1994) concluded that while CMC may overcome *geographic* obstacles, it does not eliminate *social* barriers: so that the effects of new Net technologies vary according to the culture, goals and structural conditions of the particular organization where they are applied.

One of the most encompassing research projects was the ten year study conducted by Symons who examined virtual departments in various organizational settings of firms with 3,000 to 5,000 full-time employees. He came to the conclusion that under certain conditions, new communication technologies can even enhance the power of managers by increasing their capacity to monitor employees. (Symons 1997)

On the basis of such arguments, Nerissa Nelson concludes that

> *".....studies supporting the democratizing impact of CMC are flawed. From the very outset, they fail to consider how the power structure in organizations controls how CMC is implemented and to what extent it is used or what restrictions are placed on it. Although technology provides us with a new method to transmit messages as senders and receivers, it does not ensure that these messages are heard or even considered. The reality is that technology, for the most part, has not changed behavior. In most companies, traditional power structures are still in place; messages can be ignored, and electronic activity is monitored." (Nelson 2000)*

Because IT technologies are so polyvalent, any organization can use them to realize its preferred structures to a higher degree. Thus, voluntary associations may use them to reach better approximation to their democratic power profile, while authoritarian bureaucracies may implement them for expanding the scope of hierarchical control (Geser 2001).

In line with this argumentation, Carter has found that IT contributes to *decentralization* in "organic" organizations that face unstandardized tasks and dynamic environmental change, while it reinforces *centralization* in the case of "mechanical" systems confronted with more stable conditions (Carter 1984). In addition, it has been observed that the type of work decides whether and to what degree IT is used for individual control. In administrative work flows, optimal conditions exist for applying behavioral and output control at the same time. In the realm of sales however, only output controls are usually applied, and in knowledge work, no control procedures seem viable at all (Frenkel et al. 1999).

We may hypothesize that all occupational role incumbents wish to instrumentalize the new information technologies for furthering their personal and role-related needs - but that they succeed very unevenly according to their highly divergent autonomy, power and material resources. Thus, architects or designers use computers to rationalize the elaboration of new constructions, journalists need the Internet for a quicker scanning of relevant information; and professional scientists make use of mail lists for improving their worldwide communication:

> *"Many professionals became hooked on the relative ease and speed of their computer tools, and dreaded any return to manual ways of working. They often adopted and adapted computers to their work in ways that enhanced their control over their work products (Kling 1996).*

While professionals may thus enhance the scope and variety of their work, lower occupations may find themselves more constrained because they have to tolerate the infringements caused by the expansion of higher occupations. Thus, secretaries lose classical spheres of competence because their bosses use their own computer for mailing messages and their own cell phone for answering calls (Geser/Bürgisser 1998), and workers face perfectionized systems of surveillance because managers seek their self-realization mainly in the implementation of electronic systems of control.

As a consequence, we may expect that when most employees are highly qualified professionals, computers and computer networks contribute to *decentralization*: because members are eager as well as capable of using the new potentials for empowering purposes.

On the other hand, organizations staffed with highly unqualified personnel may experience *centralizing* impacts, because average workers are not able to resist the implementation of managerial systems of Taylorist standardization, surveillance and control. In turn, computerization may reinforce deskilling because roles are simplified to a degree that highly unqualified personnel can be hired:

> *"Some organizations computerize some jobs so as to make them as simple as possible. An extreme example is the way that fast food chains have computerized cash registers with special buttons for menu items like cheeseburgers and malts so that they can hire clerks with little math skill. (Kling 1996)*

In a similar vein, it was found that the impact of information technologies on hierarchical structure was conditioned by the antecedent degree of centralization. In highly centralized firms, top managers used the new technologies for reducing the middle management levels, in decentralized settings; they instrumentalized them for increasing these middle layers (Pinsonneault and Kraemer, 1997)

The technological impacts may also vary according to *organizational size*. In his early comparative study of newspaper organizations, Carter concludes that the organizational power structure is more affected by IT in smaller than in larger firms (Carter 1984). This may be explained by the higher structural formalization and inertia of larger enterprises or vice versa: by the higher structural informality and "malleability" of many (especially newer) small firms.

On the other hand, Zeffane has found in Australia that in medium to large firms, computer use was significantly related to decentralization (Zeffane 1989). Evidently, the advantages stemming from the loosening of spatial restrictions accrue to mainly larger organization where members with common interests have no chance to meet face-to-face (Bishop/Levine 1999).

Apart from the many conditioning factors on the organizational levels, the microsocial impacts of information technologies may also be co-determined by macrocultural, political and legal-institutional conditions.

In his broad survey of European countries, Eric Lee has found that most Nations have provisions to protect the private sphere of employees at the workplace, so that employers have

only a limited permission to supervise and control the Email traffic and the Internet surfing activities of their staff (Lee 2000).

In addition, Art. 28 of the "European Social Charta" implies that Labour Unions must be given access to the intrafirm computer networks to the degree that such access is necessary for them to gather important information and to contact and organize their members (Lee 2000).
In Switzerland, Art. 179 of the penal code disallows employers to supervise private employee activities at the work place, except in cases where such controls are necessary for reasons of security or for assessing the work performance. In addition to such legal provisions, the federal deputy for data security has enacted a guideline ("Leitfaden") which regulates neatly the conditions under which such supervisions are permitted.[4]

In the United States, however, privacy claims at the work place have usually not been protected by the courts (Mansfield/Gabel 2003). Generally, employers are allowed to supervise any online activities of their workers as long as the electronic equipment used is owned by the firm. Therefore, tendencies toward centralized surveillance have become very widespread, especially among larger corporations:

> *"For the most part, the introduction of IT into the workplaces of the new capitalism resulted in an intensified surveillance of employees. In 2001, the American Management Association reported that 77.7 percent of companies acknowledged routine electronic monitoring of their employees activities, a figure that has doubled since 1997"*
> *"Software to regulate the speed of workstation users and to time the length of toilet breaks had become a standards feature of information work. Video typing and revieing of personal email and Web-surfing are becoming more prevalent" (Ross 2004:12)*

However, such surveillance efforts are often self-defeating because morale is lowered and trust relations are impaired (Schwartz 2000; Mansfield/Gabel 2003).

4. Aims of the study

Based on a comprehensive comparative survey of enterprises from the industrial and the service sector in Switzerland, the following empirical study tries to clarify whether and how computer usage is affecting various organizational conditions at the workplace level, especially the role and status of lower-level operative employees. Given the extensive sample as well as the large variety of measured variables, we are able to address several questions that have remained open by the rather sketchy and inconclusive research results available at this present time.

First of all, we acknowledge that the terms "computer technology" and "information technology" are highly synthetic concepts including many facets that deserve to be distinguished on the analytical as well as on the empirical plane.

In a sociological perspective, it is particularly crucial to make a difference between

- stand alone computers not connected among each others;
- closed intraorganizational PC networks (e. g. "Intranets") that allow for mutual online communication within the boundaries of the firm;

[4] http://www.edsb.ch/d/themen/internet/index.htm

- limited access to external networks: allowing the flow of email traffic beyond organizational borders;
- full access to the Internet (especially the WWW).

There are good reasons to assume that each higher level of network integration is associated with additional pushes for decentralization, because the spectrum of alternative actions available to any users (even on lowest hierarchical levels) is immensely increased.

Secondly, we take into account that terms like "centralization" or "decentralization" are also multidimensional concepts encompassing very different aspects that may not covary highly among each other.

Of course, a full picture would have to include the whole profile of power and influence over all hierarchical levels. so that basic relationships between workers and superiors are considered as well as the distribution of competences branch managers and the CEO.

It is a major limitation of our study that only the lowest level (affecting the singular workplace of nonsupervisory employees) is taken into consideration. As a consequence, no countervailing effects on different hierarchical levels can be detected.

On the other hand, the multidimensionality of the centralization concept is respected by taking into account that supervisory authority (or its mirror: employee empowerment) may be different in various aspects of the work process.

In particular, we ask separately about the decisions made

1) to allocate work tasks to specific employees,
2) to specify the concrete working procedures,
3) to determine the pace of work,
4) how interactions with customers are handled.

Third, we consider that technological impacts on social structures (if such causalities exist at all) are likely to need time, so that they may not easily be discovered in simultaneous cross-sectional correlations. As a consequence, we add some additional empirical evidence based on processes of recent change, not on the current state of conditions.

Fourth, we take into consideration that that computer technology impacts may not be all pervasive, because so many intervening variables determine whether centralizing are decentralizing consequences prevail. Given that our data set extend to almost 2000 cases, we have ample opportunities to test such assumptions by applying multivariate statistical procedures. In particular, it will be checked whether effects vary across economic branches or according to firm size and the skill level of employees.

And *fifth*, finally, we hypothesize that decentralization effects on the organizational level go along with correlates on the level of individual roles. In particular, the assumption is tested that technologically induced worker empowerment is associated with a broader range of work tasks and with an increased emphasis on personal self-direction.

5. Data and Methodology

The following empirical findings are based on two comprehensive survey studies conducted 1998 and 2000 in Switzerland. In both studies, a questionnaire was mailed out to about 6000 Swiss Firms of all major branches in the industrial and service sector, out of which about 1500-1800 were finally returned. The sample was constituted by the KOF (Konjunkturforschungsstelle der ETH Zürich) with the explicit aim to mirror the Swiss private economy as whole: excluding the educational health and social welfare sector. For approaching this goal, a stratified selection was made for generating an equilibrated sample of different branches on the one hand and different size categories on the other. Special efforts were made to receive a positive response from the small group of largest enterprises.

In the survey of 1998, the main focus was laid on staff composition and the demand for occupational skills as well as on strategies of firm reorganization and ongoing processes of organizational change. In 2000, the questionnaire addressed usage patterns of computers and computer network technologies as well as various aspects of organizational structure. In both survey, the main focus was directed to the work places of average non-supervisory employees.

For measuring the independent variables, informants of the second survey (= general firm managers) were asked about the percentage of work places which had access to a computers or to various forms of online communication.

On the level of the total sample, the following frequency distribution has been achieved:

Table 1: Distribution of firms according to the percentage of work places having access to computers and online communication: total sample (percentage values)

	Percentage of work places						*Total*	*(N =)*
Access to:	**0**	**1-20**	**21-40**	**41-60**	**61-80**	**81+**		
Personal Computer	4.1	25.4	23.1	13.5	11.8	22.1	100%	*(1668)*
Internal Email	12.4	38.7	17.7	9.7	7.9	13.6	100%	*(1500)*
External Email	12.6	45.6	17.0	8.5	7.0	9.4	100%	*(1473)*
WWW	5.7	55.5	20.0	8.0	5.3	5.5	100%	*(1482)*

Inspecting Table 1, it is evident that only tiny fractions of enterprises do still not make use of personal computers at all (ca 4%), and that seven out of eight have at least some few of their work places hooked up to (internal or external) Nets.

However, more than half of them limit access to about thirty percent of their staff, and less than ten percent can be considered as fully "wired organizations".
From a methodological angle, this wide dispersion opens attractive opportunities for multivariate analyses of variance, because sub-samples with highly divergent usage patterns can be contrasted.

While no full interval measurements are available, the graded ordinal variables provide at least limited opportunities for discovering non-linear relationships as they have to be expected in the three network variables according to Metcalfe's law.[5]

6. Empirical Results

6.1 The variety of work

In contrast to "systemic" industrial technologies which have heavy impacts on encompassing *organizational structures* in the moment of their implementation, personal computers (and computer networks) primarily change the behaviour of working *individuals* and the microsocial conditions of *interindividual cooperation*. Because of their extreme functional polyvalence and rapid evolution, such effects are highly variable and divergent: depending on the selective usage patterns and learning processes of individual users of the one hand and the development of performance capacities (on the hardware and software level) on the other.

Even when information technologies are installed by management with very strong aims to change market strategies or internal organizational structures, such systemic effects can only be realized indirectly by modifying the microscopic working conditions of many individual employees. And in many cases, we see the paradoxical effect that such centralized implementation processes lead to a loss of centralized control: e. g. because employees hooked up to computer networks have more leeway to choose their own interaction channels and to engage in all sorts of unpredictable behaviour.

As shown in Table 2, the extended usage of Personal Computers goes along with more challenging work roles that contain a richer variety of different tasks, especially among smaller firms with 100 or less employees. It might be hypothesized that the labour division within smaller enterprises is fluid enough to be easily affected by technological conditions, while in larger firms; role specialization is sufficiently fixed by formalized norms and procedures.

Table 2: Variety of work tasks* of a typical employee and the percentage of work places having access to PC: according to size of firm

Size of firm	Percentage of work places with PC						Corr	Sign.	*(N =)*
	0	1-20	21-40	41-60	61-80	71+			
15-40	338	336	348	364	372	383	+.20	.041	*(279)*
41-100	325	322	333	356	344	384	+.26	.000	*(339)*
101-200	-	343	326	340	333	350	+.11	.658	*(210)*
201-500	-	346	297	322	354	343	+.28	.024	*(144)*
501+	-	322	310	316	336	358	+.17	.165	*(92)*
All firms	330	333	329	344	350	370	+.16	.000	*(1069)*

**Five point scale between 100 (very low) to 500 (very high)*

[5] Metcalfe's law states that the value of any network equals the square of the absolute number of participants, because every new user also increases its utility for the already existing users (Metcalfe 1995).

From Table 3, it can be seen that task variety is only marginally increased when computers are also internetted. Only in the category of smaller enterprises (between 41 and 100 employees), a significant relationship with access to intraorganizational mail networks can be observed.

Table 3: Correlations between variety of work tasks and percentage of work places with access to various information technologies: according to the size of firm

Size of firm	(N =)	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
15-40	*(280)*	+.20**	+.16*	+.19**	+.16*	+.10	+.10	+.17
41-100	*(340)*	+.24**	+.23**	+.24**	+.22**	+.19**	+.15	+.14
101-200	*(211)*	+.03	+.12	+.10	+.16**	+.05	+.09	+.15
201-500	*(145)*	+.12	+.07	+.10	-.02	-.05	+.00	-.06
501+	*(237)*	+.24*	+.27**	+.30**	+.27**	+.10	+.15	+.12

** p < .05* *** p < .01*

It might be assumed that such job enrichment effects only occur in enterprises where employees are skilled enough to make use of the new facilities, while in branches with unskilled personnel, information technologies may even contrarily be used to increase the degree of specialization.

This hypothesis is neatly borne out by Table 4 where we can see that positive correlations only appear when the percentage of unskilled staff is extremely low. Interestingly, the effects emanating from access to the WWW are stronger than those associated with internal or external electronic mail.

Table 4: Correlations between variety of work tasks and percentage of work places with access to various information technologies: according to the percentage of unskilled employees

Percentage unskilled	(N =)	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
0-6%	*(140)*	+.14	+.14	+.17*	.21**	+.10	+.06	+.20*
6-25%	*(195)*	+.11	+.07	+.10	+.07	-.00	+.08	+.07
25-50%	*(172)*	+.01	-.09	-.02	+.04	-.11	+.01	+.07
50%+	*(154)*	+.07	+.04	+.03	+.05	+.00	+.11	+.00

** p < .05* *** p < .01*

Thus, we may conclude that full Internet access is contributing significantly to the richness of work roles, but only when a certain skill level (implying a sufficient "Net literacy") is given.

6.2 Distribution of power between workers and supervisors

In a second step, we ask how the intraorganizational usage of information technology is related to the centralization of authority on lower (operative) levels of organizations. This balance was assessed by asking informants to characterize the relative influence of workers and first-level supervisors on various work aspects by using a five point scale ranging between 100 (complete autonomy of the worker) to 500 (complete determination by the supervisor).

As shown in Table 5, supervisory jurisdiction is consistently highest in the small minority of firms that still don't make any use of computers, and consistently at the lowest level in the most progressive firms where more than 80% of all workplaces have digital equipment. Even more impressive is the faultless monotonic relationship between the percentage of PC-equipped collaborators and all aspects of supervisory power. Interestingly, the most pronounced gain in worker empowerment takes place in the external interaction with clients, while internal task distribution is least affected by technological conditions.
It could be argued that such correlations are spurious because they conceal underlying branch-specific factors. For instance, they may be explained by the regularity that older mass production industries are centralized as well as "computer-resistant", while modern high-tech branches have implemented more progressive organizational styles characterized by extended computer usage on the one hand and participative employee relations on the other.

Table 5: Authority of supervisors in different domains of work organization*: according to percentage of work places with PC (all firms)

Aspect of work organization	**Percentage of work places with PC**						**Corr**	***Sign.***
	0	**1-20**	**21-40**	**41-60**	**61-80**	**81%**		
Distribution of tasks*	435	427	414	409	383	376	-.22	*.000*
Specification of work*	416	375	353	336	321	305	-.25	*.000*
Pace of work*	405	362	338	317	308	292	-.24	*.000*
Contacts with clients*	425	399	379	338	313	308	-.30	*.000*
Total authority**	420	390	371	349	332	321	-.36	*.000*
(N =)	*(20)*	*(235)*	*(286)*	*(173)*	*(131)*	*(199)*	*(1032)*	

**Five point scale between 100 (total autonomy of the subordinate) to 500 (total determination by supervisor)*
** Summative average value of the four preceding variables.

The large sample size evidently provides the opportunity for detailed breakdowns in order to assess whether such decentralization effects are particular to specific industries, or whether they occur as generalized effects across all economic branches.

Table 6 demonstrates convincingly that the second alternative holds. Out of 95 correlation coefficients, only 11 show a positive sign and none of them on as significant level. On the other hand, 22 of the remaining 84 coefficients reach significance, most of them on the level of one percent.

Nevertheless, industry seems to be more affected than the service sector, where only firms specialized on wholesale trade show consistently high correlations.

Of course, these findings provide no information whether decentralization results simply from work stations as stand alone units, from computer networks within the firm (e. g. intranets) or from the integration of computers into the worldwide Email system and the WWW.

In order to disentangle these different effects, the partialized impacts stemming from access to intrafirm email, external Email and to the WWW have also been empirically assessed.

Surprisingly, the results of Table 7 indicate again that most effects are originating from stand-alone computers, not from computer networks, because most negative bivariate correlations with the extensity of Email and WWW access are reduced to zero when the total number of PC's is controlled. Only the control over work specification becomes somewhat more decentralized when widespread online communication (especially intrafirm email traffic) exists.

Table 6: Correlations between total authority of supervisors in different domains of work organization and the percentage of work places with access to PC in 19 branches of industry and the service sector

Category:	*(N =)*	**Distrib. of tasks**	**Specific. of work**	**Pace of work**	**Client contact**	**Total authority**
Food and Beverage	*(50)*	-.45**	-.37**	-.22	-.28*	-.46**
Textile and Apparel	*(33)*	-.19	-.23	-.50**	*+.11*	-.28
Paper and Packaging	*(22)*	-.15	*+.03*	-.01	-.25	-.16
Print and Publishing	*(38)*	-.13	-.27	-.13	-.16	-.26
Chemicals	*(39)*	-.16	-.11	-.11	-.23	-.14
Plastics	*(31)*	-.13	-.16	*+.03*	-.30	-.21
Minerals	*(30)*	-.17	-.19	-.18	-.34	-.26
Metals	*(83)*	*+.03*	-.20	-.11	-.11	-.14
Machinery and Vehicles	*(78)*	-.27*	-.32*	-.22	-.38**	-.42**
Electrical	*(36)*	*+.00*	-.25	-.23	-.32	-.29
Electronics	*(55)*	-.32*	-.30*	-.13*	-.21	-.35**
Energy	*(13)*	-.23	-.41	-.11	-.72**	-.78**
Construction	*(115)*	-.11	-.14	-.24*	-.15	-.21*

Category:	(N =)	Distrib. of tasks	Specific. of work	Pace of work	Client contact	Total authority
Wholesale trade	*(96)*	-.34**	-.27**	-.20	-.39**	-.44**
Retail trade	*(54)*	-.26	-.13	-.19	-.25	-.27
Tourism / personal Services	*(34)*	*+.24*	*+.09*	-.20	-.19	-.07
Transport/Communication	*(50)*	-.05	*+.07*	-.01	*+.05*	*+.05*
Banking / Insurance	*(49)*	-.27	*+.17*	-.07	-.34*	-.21
Business Services	*(63)*	-.11	-.15	-.40	*+.18*	-.21

Table 7: Correlations between total authority of supervisors in different aspects of work organization and percentage of work places with access to various information technologies: bivariate and partial correlations

Aspect of work organization:	Bivariate correlations				Partial correlations (PC controlled)		
	PC	Int. Email	Ext. Email	WWW	Int. Email	Ext. Email	WWW
Distribution of tasks	-.22**	-.18**	-.16**	-.13**	-.04	-.02	+.02
Specification of work	-.25**	-.26**	-.22**	-.20**	-.16**	-.10**	-.06
Pace of work	-.25**	-.22**	-.23**	-.19**	-.02	*+.09**	*+.04*
Contacts with clients	-.30**	-.26**	-.23**	-.15**	-.08*	-.00	*+.07*
Total authority	-.36**	-.33**	-.30**	-.23**	-.11**	-.08*	+.00

** p < .05 ** p< .01*

Considering the conflicting theorizing and empirical evidence about the relationship between technological decentralization effects and organizational size, the correlations of Table 8 indicate that both sides may be right because a curvilinear relationship stands out. While effects in very small firms are considerable, they are lowest in middle-sized establishments with 101 to 200 employees, and they rise above this level to reach maximum values in firms larger than 500. Especially the control of workers over task distribution and client relations is considerably increased in larger computerized plants.

Table 8: Correlations between the authority of supervisors in different domains of work organization and the percentage of work places with PC: according to the size of firm

Domain of decision:	Size of firm (number of employees)				
	15-40	**41-100**	**101-200**	**201-500**	**501+**
Distribution of tasks	-.32**	-.14**	-.18**	-.13	-.42**
Specification of work	-.21**	-.27**	-.10**	-.32**	-.38**
Pace of work	-.28**	-.21**	-.17**	-.26**	-.34**
Contacts with clients	-.31**	-.28**	-.20**	-.24**	-.45**
Total authority	-.38**	-.32**	-.24**	-.45**	-.54**
(N =)	*(271)*	*(332)*	*(202)*	*(144)*	*(90)*

** p < .05 ** p< .01*

More detailed analyses (not presented here) support the conclusion that in all size categories, all major decentralization effects are exerted by the mere presence of computers, not by their integration into intrafirm networks or the global Internet.

Given the regularity that computers are significantly more widespread in firms with highly qualified staff, it might be argued that it is the skill level rather than the technology that is causally related to the lower level of centralization. Of course, also mutual contingencies between the two potential determinants could be envisaged. Thus, it could be hypothesized that decentralization effects of digital technologies cannot be realized on low skill levels, because employees lack the qualification for using them effectively for enhancing their own discretion. This would imply that computers have a "prismatic" effect: by amplifying the polar difference between rather centralized low-skill and highly decentralized high-skill organizations.

In order to get insight into such complexities, we analyze how the correlations vary across different levels of skill.

From Table 9, at least two major conclusions can be drawn. *First,* it is evident that the correlations with computer usage are not spurious, because while reduced, they remain highly significant when the percentage of unskilled personnel is controlled. *Secondly,* slight confirmation is found for the contention that decentralization effects are lower when large percentages of unskilled workers are employed. Especially the empowerment in client contacts is much higher when 75% or more have at least a basic vocational education.

Again, more extended analyses (including all communication technologies) show that regardless of skill levels, almost no additional decentralization effects are realized when computers are internetted.

Table 9: Correlations between the authority of supervisors in different domains of work organization and the percentage of work places with PC: according to the percentage of unskilled personnel

Domain of decision	Percentage of unskilled personnel			
	-6%	**7-25%**	**26-50%**	**51%+**
Distribution of tasks	-.15*	-.19**	-.16**	-.14*
Specification of work	-.23**	-.18**	-.15**	-.18**
Pace of work	-.20**	-.18**	-.22**	-.17**
Contacts with clients	-.26**	-.35**	-.19**	-.18**
Total authority	-.31**	-.32**	-.26**	-.25**
(N =)	*(201)*	*(256)*	*(265)*	*(168)*

** p < .05 ** p< .01*

6.3 Participation in reorganization processes

In order to tap more extensive organizational empowerment effects transcending the microlevel interaction with immediate supervisors, it was asked whether management was formally consulting the nonsupervisory employees when reorganization measures were planned and implemented. It was found that in exactly 50% of all cases, some mode of formal consultation was observed: ranging from simply informing workers about ongoing reorganization processes to giving them a substantive say in the respective decisions.

As seen in Table 10, percentages rise consistently with the frequency of computerized workplaces: achieving maximum values in larger firms with a penetration rate of more than 80%. Again, we observe that correlation coefficients covary with firm size in a curvilinear fashion: reaching (nonsignificant) minimal values within the range between 100 and 500 employees.

Further statistical procedures (not presented here) lead once more to the conclusion that the major empowerment effects stem from work stations as stand alone devices, because no additional empowerment effects are observed when computers are wired to intraorganizational networks or to the WWW.

Table 10: Percentage of firms where nonsupervisory employees are consulted in processes of reorganization: according to the percentage of work places having access to a PC: by size of firm

Firm size	*(N =)*	Percentage of work places with PC						Corr	*Sign. Chi-2*
		0	**1-20**	**21-40**	**41-60**	**61-80**	**81+**		
15-40	*(239)*	0	25	40	54	61	64	+.31	*.000*
41-100	*(319)*	25	22	51	47	49	64	+.26	*.000*
101-200	*195)*	--	36	61	66	61	63	+.15	*.036*
201-500	*(140)*	--	50	53	67	56	61	+.07	*.433*
501+	*(90)*	--	30	57	72	64	87	+. 35	*.001*
Total sample	*(983)*	18	29	52	59	57	67	+.25	*.000*

Again, we may hypothesize that only more educated workers may profit from such effects, because they are better able to use computers for amplifying their level of information and judgment. However, the results do not allow such a conclusion To the contrary, highest percentages of worker participation are found in fully computerized enterprises with a very large percentage of unskilled employees (Table 11).

Table 11: Percentage of firms where nonsupervisory employees are consulted in processes of reorganization: according to the percentage of work places having access to a PC: by percentage of unskilled employees

Percentage of unskilled employees	*(N =)*	Percentage of work places with PC						Corr	*Sign. Chi-2*
		0	**1-20**	**21-40**	**41-60**	**61-80**	**81+**		
-6	*(198)*	--	29	52	60	11	71	+.18	*.015*
7-25	*(256)*	--	40	58	50	68	68	+.21	*.001*
26-50	*(359)*	--	33	47	55	57	42	+.13	*.048*
51+	*(245)*	--	24	50	61	33	88	+.28	*.000*

6.4 Recent trends of decentralization

Cross sectional comparative studies provide only limited insight into causalities because organizational effects of computer technology need much time to realize. In contrast to most industrial machineries which enforce specific roles and cooperative patterns at the very moment they are set into motion, computers are just universal tools that display their consequences to the degree their potentialities are discovered and exploited. Such developments imply cumbersome and time-consuming learning processes on all scales: on the organizational level where strategies of computerization and informatization have to be

designed and implemented in accordance with the firm's specific needs and conditions; and on the level of individual employees who have to become acquainted with software systems and to develop usage patterns in the course of daily work experience.
While longitudinal studies would be necessary to scan such developments, we try to grasp part of the indirectly by asking whether computer usage has gone along with correlative changes in organizational structure. Thus, while full-blown traditional bureaucracies may still not have transformed into informal "adhocracies" even when everybody works with digital equipment, they may still be show moderate recent trends toward less centralization. For assessing such tendencies, informants were asked whether in the preceding years, reorganization measures aiming at

- devolution of responsibility
- increasing worker autonomy
- increasing voice for employees
- enlarging the scope of group work

have been enacted.

While it is well known that under the concepts of "lean production", "management reengineering" or various other headings, such reorganizations have started in the eighties well without being conditioned by computers or any other technological factors (see Kling 1996), they may well be reinforced by computers and computer-supported networks, insofar as capacities for individual discretion as well as for horizontal interindividual coordination are increased.

In accordance with such argumentations, it is found that the inclination to implement decentralizing measures is consistently at a minimum in firms where almost no computers are used, and they reach a peak level when more than 40% of workers use digital equipment. Interestingly, the impact on interindividual cooperation patterns (=group works) is stronger than the effects on than the autonomy or voice of individual employees.

Table 12: Percentage of firms that have experienced recently various changes toward organizational decentralization: according to the percentage of work places having access to a PC

Recent changes:	**Percent of workplaces with PC**						**Corr**	***Sign. Chi-2***
	0	**1-20**	**21-40**	**41-60**	**61-80**	**81%**		
Devolution of responsibility	40	71	82	82	77	78	.18	*.000*
More autonomy at the workplace	30	50	60	72	57	62	.17	*.009*
More voice for employees	48	53	58	67	57	65	.11	*.065*
More group work	04	27	38	40	42	49	.19	*.000*

Given the semantic similarity of the four items as well as their parallel covariation with technology, it seems justified to aggregate them to a summative index that measures the firm's general tendency toward structural decentralization. As shown in Table 13, only smaller and middle-sized firms seem to be affected, because all correlations vanish above a threshold of 200 employees. This certainly disaccords with the strong correlations between computer usage and *current* decentralization levels found in larger firms (see Table 8 and

Table 10). However, this inconsistency should not induce too much speculation, because the sample for which decentralization indices are available is rather reduced.

Table 13: Correlations between the index of recent decentralization[1)] and percentage of work places with access to various information technologies: according to the size of firms

Size of firm	*(N =)*	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
15-40	*(381)*	+.20**	+.17**	+.20**	+.15*	+.05	+.12	-.04
41-100	*(154)*	+.15	+.11	+.08	+.05	+.04	-.03	-.02
101-200	*(77)*	+.30**	+.22**	+.24*	+.12	+.09	+.05	-.09
201-500	*(45)*	-.04	-.11	-.12	+.01	+.07	-.27	+.05
501+	*(33)*	-.07	+.11	-.12	+.18	+.08	+.22	+.25
All firms	*(690)*	+.17**	+.16**	+.16**	+.09*	+.06	+.03	-.02

[1)] *Sum of the four recent changes mentioned in table 9: ranging between -4 centralization on all aspects) to +4 (decentralization on all aspects)*

Table 14: Correlations between the index of recent decentralization[1)] and percentage of work places with access to various information technologies: according to the percentage of unskilled personnel

Percentage of unskilled personnel	*(N =)*	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
1-6	*(206)*	+.08	+.02	+.07	+.03	-.03	-.02	-.04
7-25	*(167)*	+.25**	+.18*	+.14	+.16	+.13	+.05	+.06
26-50	*(143)*	+.08	+.26**	+.31**	+.12	+.29*	+.26*	+.06
51+	*(136)*	+.21*	+.16	+.17	+.13	+.13	-.05	-.06

[1)] *Sum of the four recent changes mentioned in table 9: ranging between -4 centralization on all aspects) to +4 (decentralization on all aspects)*

In addition, Table 13 makes again evident that all correlations with the Net variables are spurious, because they are reduced to insignificance when the number of PC's is controlled. This result is certainly surprising in the light of all arguments that see the computer *networks,* not stand alone computers, as the major agent of organizational change.

Once again, no clear corroboration is found for the contention that higher levels of vocational education are preconditions for technological effects of decentralization, because significant correlations are found on various levels of skill (Table 14).

6.5 Patterns of Individual learning and personal skills

While the general formal skill level of organizational staff has hitherto been treated as an intervening (conditioning) variable that may potentially moderate technological impacts on roles and organizational structure, certain more informal skill aspects are also a potential dependent variables that may be influenced by technology directly or by technology-induced organizational change.
Considering the empowerment effects demonstrated above, we may hypothesize that computers induce higher needs for personal competencies related to advanced training, self-directed learning, independent problem-solving and autonomous decision (Baloh/Trkman 2003). As these informal skills are evidently correlated positively with the level of formal education, it is paramount to keep these formal skill variables under statistical control.

6.5.1 Advanced training

First of all, it is evident that in all size categories, extensive computer use goes along with more extensive enrolment in advanced training courses. Once again, almost no additional effects are observed when computers are netted, because the respective correlations- while keeping mostly a positive sign - vanish to insignificance when the PC density is controlled (Table 15). Thus, we may conclude that the major new skill demands associated with Information technologies have arisen in the early phases where basic knowledge about computer handling and the mastering of software programs had to be transmitted. On the basis of these primary computer skills, employees may then easily learn the technicalities of Net related activities like data bank searching and online communication.

Table 15: Correlations between percentage of employees enrolled in formalized advanced training in 1999 and percentage of work places with access to various information technologies: by size of firm

Size of firm	(N =)	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
15-40	*(280)*	+.31**	+.27**	+.25**	+.26**	+.02	-.03	+.11
41-100	*(340)*	+.30**	+.28**	+.29**	+.28**	+.12	+.15*	+.12
101-200	*(211)*	+.27**	+.24**	+.21**	+.15*	+.06	+.06	+.04
201-500	*(145)*	+.44**	+.44**	+.35**	+.30**	+.11	+.08	-.03
501+	*(93)*	+.36**	+.35**	+.33**	+.23**	+.06	+.13	+.03

** p < .05* *** p < .01*

While the absolute levels of training involvement are certainly lower when the percentage of unskilled personnel is very high, the correlative relationships between enrollment and computer usage are remarkable similar over all categories of firms. (Table 16). There is only a slight tendency of Network skill effects to decrease (or even turn to the negative) when skill levels are very low.

Table 16: Correlations between enrolment in formalized advanced training in 1999 and percentage of work places with access to various information technologies: by the percentage of unskilled employees

Percentage unskilled	(N =)	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
0-6%	*(407)*	+.23**	+.24**	+.23**	+.20**	+.08	+.10	+.10
6-25%	*(370)*	+.19**	+.20**	+.13**	+.16**	+.07	-.04	+.02
25-50%	*(340)*	+.28**	+.24**	+.25**	+.24**	+.01	+.09	+.11
50%+	*(308)*	+.25**	+.18**	+.08	+.05	-.07	-.11	-.06

** p < .05* *** p < .01*

6.5.2 Self-directed learning

More than any tool from preindustrial ages or any machine originating in classical industrial eras, the computer is a "responsive" technology that engages its user in a looped diadic interaction process that can usually not be observed (end even less controlled) by any outsiders (e. g. colleagues or supervisors) (Geser 1989).

While such engagements lead to a weaking or dissolution of interindividual interactions, they substitute them by man-machine relationships in which rather intensive and rapid processes of behavioural adaptation occur. In fact, it is hard to use a computer without learning something, because the user is constantly confronted with the causal effects of his immediately preceding actions.

As much of this self-learning occurs unsystematically and unintentionally, it is of course a major basis for more systematic processes of self-guided learning. (By the way, this explains why so many computer skills are acquired by informal "on the job training", not by any formalized educational procedures.) As a consequence, we hypothesize that firms with extensive computer usage give more weight to "self-guided on the job learning" (instead of formalized training) as a major method for upgrading skills.

As seem from Table 17, this hypothesis holds only for smaller firms with 100 or less employees, but not for any larger enterprises. This indicates that larger firms use their resources for supplementing informal learning with formalized educational courses, so that more speedy, systematic and homogeneous skill upgrades can be achieved.

Contrary to our expectations, Table 18 demonstrates that effects of computer usage on self-guided learning are highest when the general skill level of employees is rather low. From this, we may draw the double conclusion that computer-induced self-learning also extends to very low qualificational levels, and that highly qualified workers are disposed to rely on self-learning anyway, so that computers do not make any difference.

Table 17: Correlations between the importance of "self-guided on-the-job-learning" as a mode of securing individual skills[1]: and percentage of work places with access to various information technologies: by size of firm

Size of firm	(N =)	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
15-40	*(280)*	+.10**	+.15**	+.15**	+.10*	+.15**	+.19**	+.15**
41-100	*(340)*	+.24**	+.14**	+.15**	+.11*	-.13	-.04	-.04
101-200	*(211)*	+.02	+.03	+.03	-.01	+.07	+.05	-.05
201-500	*(145)*	+.12	+.13	+.17*	+.04	+.16	+.13	-.00
501+	*(93)*	+.08	+.07	-.02	-.02	-.04	-.14	-.09

[1]*Average value on a scale ranging from 100 (no importance) to 500 (highest importance)*

Table 18: Correlations between the importance of "self-guided on-the-job-learning" as a mode of securing individual skills and percentage of work places with access to various information technologies: by percentage of unskilled personnel

Percentage unskilled	(N =)	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
0-6%	*(432)*	+.09	+.16*	+.16**	+.09	+.10	+.11	+.06
6-25%	*(388)*	+.12*	+.10	+.10	+.02	-.02	+.04	-.05
25-50%	*(351)*	+.10*	+.09	+.12*	+.05	+.12	+.09	+.11
50%+	*(325)*	+.14*	+.14*	+.11	+.05	+.03	+.03	-.05

** p < .05* *** p < .01*

6.5.3 Autonomous judgment and decision

Given all these effects on autonomous learning and role empowerment, it is to be expected that computer usage goes along with an increased demand for employees with a high capacity to work on their own and to rely on their own judgment and decisions.

In fact, the salience ascribed to such skills (by personnel managers) correlates positively with the extensity of computer use, especially in middle-sized firms ranging between 100 and 500 employees (Table 19). In the largest size category, autonomy skills seem to depend critically on the access to transorganizational online communication and the Internet, while the impact of stand-alone computers is much reduced.

However, a breakdown by skill categories reveals that most of these correlations may be spurious artefacts originating from the positive intercorrelation between formal skill level and the importance ascribed to autonomy skills. Only in firms with almost no unskilled personnel, a slight significant correlation can still be observed (Table 20).

Table 19: Correlations between the importance of "independent judgment and decision making capacities"[1]: in the skill profile of average employees and percentage of work places with access to various information technologies: by size of firm

Size of firm	*(N =)*	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
-40	*(387)*	+.14**	+.11*	+.18**	+.14**	+.06	+.15*	+.08
41-100	*(178)*	+.10	+.17*	+.21**	+.16*	+.20*	+.25**	+.16
101-200	*(98)*	+.28**	+.33*	+.29**	+.10	+.18	+.16	-.09
201-500	*(61)*	+.28*	+.20	+.18	+.12	-.16	-.18	-.18
501+	*(37)*	+.10	+.16	+.25	+.30	+.14	+.36*	+.35*

[1]*Average value on a scale ranging from 0 (no importance) to 400 (highest importance)*

Table 20: Correlations between the importance of "independent judgment and decision making capacities" in the skill profile of average employees and percentage of work places with access to various information technologies:: by percentage of unskilled personnel

Percentage unskilled	*(N =)*	Bivariate Correlations				Partial correlations (PC controlled)		
		PC	Internal Email	External Email	WWW	Internal Email	External Email	WWW
0-6%	*(267)*	+.12*	+.16*	+.09	+.14*	+.06	+.15	+.10
6-25%	*(221)*	+.02	+.10	+.02	+.02	+.01	+.23**	-.00
25-50%	*(197)*	-.05	+.09	-.04	+.00	+.03	+.05	+.10
50%+	*(184)*	+.08	+.14*	+.02	-.02	-.03	+.01	-.06

** p < .05* *** p < .01*

7. Conclusions

While acknowledging that the social implications of computers vary according to the ways of their usage, we are nevertheless impressed to what extent the mere presence of IT equipment is associated with many correlates on the level of organizational structures and individual roles.

All these results may be summarized by stating that a broad availability of Personal Computers in a firm goes along with a certain empowerment of the rank-and file.
In more specific terms, the following impacts on lower level work incumbents can be observed

1) *Job Enrichment*. At least in higher skill environments, employees are typically confronted with a larger variety of tasks: This job enrichment may well give them the opportunity for acting out a broader range of interests and skills, for engaging on more learning processes and for exercising more discretion in the way they divide up their time.

2) *Decentralization.* Vis-à-vis their supervisors, rank and file workers exercise more influence on all major aspects of the work process: on the distribution of tasks as well as on the specification of work procedures, the pace of work and the interaction with external clients. And thin the larger work organization, lower-level ranks are more likely to be consulted (or even invited to participate actively) when processes of reorganization are enacted. These decentralization effects occur even in firms with highly unskilled staff and they are most pronounced in larger enterprises.

3) *Advanced training:* In firms of all size and skill categories, employees are more likely to become formally enrolled in courses of advanced training for upgrading heir work-related qualifications.

4) *Self-guidance:* There is somewhat more demand for workers able to engage in self-guided learning processes and to rely on autonomous judgment and decision.

Of course, these correlations cannot provide sufficient evidence for a technological determinism, because at least two alternative interpretations would have to be ruled out:

1) *The correlations are artefacts produced by underlying third factors*. In particular, it could be argued that the observed empowerment effects are generated by the regularity that firms who have many computers tend to have professional employees with higher skills - employees that would have large work variety and high influence even without any computers. While this contention cannot be fully refuted, it is still made improbable by the fact that empowerment effects are observed in almost all branches and that they do not vanish when the percentage of unskilled personnel is controlled.

2) *The reverse causality holds:* firms with highly empowered employees are in a better position to buy and apply computers. This would imply that empowerment has already been achieved ex ante. However, we have found that highly computerized firms are more likely to have undergone recent changes toward decentralization – what indicates that such changes are in fact a consequence, not an antecedent of technological innovation.

Finally, let's wonder about the highly consistent, contraintuitive finding that almost all empowerment effects are associated just with the mere availability of personal computers, while the access to computer networks (Intranets, Extranets or the WWW) does not seem to matter. Among many other speculations, it might be argued that in comparison with the PC that has been introduced since the eighties, such computer Networks are too recent to have had hitherto any deep impacts on organizational structures – or that they are even the source of countervailing centralizing impacts which may weaken or neutralize their empowerment effects (e. g. by facilitating more intensive managerial control).

References

1. Ang, S. & Cummings, L. L. (1997). Strategic Response to Institutional Influences on Information Systems Outsourcing, *Organization Science* (8:3), May-June 1997, 235-256.
2. Baloh, P. & Trkman, P. (2003). *Influence of Internet and Information Technology on Work and Human Resource Management*, Ljubliana.
3. Bishop, L. & David I. L. (1999). Computer-mediated communication as employee voice: a case study. *Industrial and Labor Relations Review*, 52(2), 213-233.
4. Bloomfield, B. P. & Daniel, A. (1995). The Role of Management Consultants in the Development of Information Technology: The Indissoluble Nature of Socio-Political and Technical Skills. *Journal of Management Studies* (32:1), January 1995, 23-46.
5. Braverman, H. (1974). *Labor and monopoly capital: The degradation of work in the Twentieth Century*, New York, Montly Review Press.
6. Bullen, C. V. & Bennett, J. (1990). Learning from User Experience with Groupware. In: Halasz, Frank (ed.): *Proceedings of the 1990 ACM conference on Computer-supported cooperative work*. October 07 - 10, 1990, Los Angeles, California, US. 291-302.
7. Carter, N. M. (1984). Computerization as a Predominate Technology, its Influence on the Structure of Newspaper Organizations. *Academy of Management Journal* (27:2), April, 247-270.
8. Dawson, P. & McLoughlin, I. (1986). Computer Technology and the Redefinition of Supervision: A Study of the Effects of Computerization on Railway Freight Supervisors, *Journal of Management Studies* (23:1), January 1986, 116-132.
9. Dean Jr., J.W., Yoon, S.J. & Susman, G. I. (1992). Advanced Manufacturing Technology and Organization Structure: Empowerment or Subordination?. *Organization Science* (3:2), May 1992, 203-229.
10. Finholt, T., Sproull, L. & Kiesler, S. (1990). Communication and Performance in Ad Hoc Task Groups. In J. Galegher, R. Kraut, and C. Egido, (eds.): *Intellectual Teamwork.* Hillsdale, N.J.: L. Erlbaum, 291-325.
11. Franz, C. R. & Robey, D. (1986). Organizational Context, User Involvement, and the Usefulness of Information Systems. *Decision Sciences* (17:3), Summer, 329-356.
12. Frenkel, S.J., Korczynski, M., Shire, K.A. & Tam, A. (1999). *On the Front Line: Organization of Work in the Information Economy.* (Ithaca, N.Y.: Cornell University Press).
13. Geser, H. (2002). *Toward a (Meta-)Sociology of the digital Sphere*. Online Publication, Zürich, http://socio.ch/intcom/t_hgeser13.htm.
14. Geser, H. (2001). *On the Functions and Consequences of the Internet for Social Movements and Voluntary Associations*. Online Publication, Zurich. http://socio.ch/movpar/t_hgeser3.htm.

15. Geser, H. (1989). *Der PC als Interaktionspartner; Schweizerische Zeitschrift für Soziologie*, Vol. 18, 1989, S.230-243.
16. Geser, H. & Bürgisser, M. (1998). Bald überflüssig - oder befreit für Neues? Sekretariatsarbeit im Wandel (In: *Unimagazin,* Heft 2, S. 40-44).
17. Herring, S. (1992). *Gender and Participation in Computer-Mediated Linguistic Discourse.* Paper presented at the Annual Meeting of the Linguistic Society of America (Philadelphia), Jan 9-12. 1992.
18. Hitt, L. M. & Brynjolfsson, E. (1997). Information Technology and Internal Firm Organization: An Exploratory Analysis, *Journal of Management Information Systems* (14:2), fall 1997, 81-101.
19. Ichniowski, C., Kochan, T., Levine, D. I., Olson, C. & Strauss, G. (1996). What Works at Work. *Industrial Relations*, Vol. 35, No. 3 (July), 299-333.
20. Jasperson J. (2002). Review: power and information technology research: A metatriangulation review. *MIS Quarterly* Vol. 26 No. 4, 397-459/December 2002. http://www.misq.org/archivist/bestpaper/Jasperson.pdf.
21. Kling, R. & Lacono, S. (1989). Desktop Computing and the Organization of Work. In Forester (Ed.): *Computers in the Human Context*. Cambridge, Massachusetts: MIT Press.
22. Kling, R. (1996). Computerization at Work. *Computer and Controversy: Value Conflicts and Social Choices*. San Diego, Academic Press.
23. Lawler, E.III, Albers, M.S. & Ledford, G.E. Jr. (1995). Creating High Performance Organizations: Practices and Results of Employee Involvement and Total Quality Management in *Fortune 1000 Companies*. San Francisco: Jossey-Bass.
24. Lee, E. (2000). *Online-Rechte für Online-Beschäftigte in den Mitgliedstaaten der Europäischen Union*. http://www.union-network.org/unisite/Sectors/IBITS/ICT/documents/OnlineLee_g.pdf.
25. Lee, S. (1991). The Impact of Office Information Systems on Potential Power and Influence, *Journal of Management Information Systems* (8:2), Fall 1991, 135-151.
26. Mansfield, N.R. & Gabel, J.T.A. (2003). The information revolution and its impact on the employment relationship: an analysis of the cyberspace workplace. *American Business Law Journal* 2: 301, Winter.
27. Mantovani, G. (1994). Is computer-mediated communication intrinsically apt to enhance democracy in organizations?. *Human Relations*, 47(1).
28. Marchand A.D., Kettinger J.W. & Rollins D.J. (2001). *Information orientation: the new business performance metric*. Oxford University Press Inc., New York.
29. Martin, R. (2002). Trust and Technology – the limits of technological control. Paper delivered at the *ANZAM / IFSAM 6th World Congress*, Gold Coast City, Queensland Australia, July.
30. Metcalfe, B. (1995). Metcalfe's Law: A network becomes more valuable as it reaches more users, *Infoworld*, Oct. 2.
31. Nandhakumar, J. (1999). Virtual Teams and Lost Proximity: consequences on trust relationships, in Jackson, P. (ed.) *Virtual Working: Social and Organisational Dynamics* (London: Routledge).
32. Nelson, M. (2000). Can Computer-Mediated Communication Democratize the Workplace? *Special libraries associations* (SLA).
33. Newman, M. & Noble, F. (1990). User Involvement as an Interaction Process: A Case Study. *Information Systems Research* (1:1), March 1990, 89-113.
34. Pinsonneault, A. & Kraemer, K. L. (1997). Middle Management Downsizing: An Empirical Investigation of the Impact of Information Technology. *Management Science* (43:5), May, 659-679.

35. Preciado, R.L. (1998). Mouses to the Grindstone, *Lycosnetwork Wired News*, Aug. 12, http://www.wired.com/news/culture/0,1284,14371,00.html.
36. Ross, A. (2004). *No-Collar. The Humane Workplace and its hidden costs.* Temple University Press.
37. Sabherwal, R. & King, W. R. (1992). Decision Processes for Developing Strategic Applications of Information Systems: A Contingency Approach. *Decision Sciences* (23:4), fall 1992, 91 7-943.
38. Schwartz, K. (2000). *Too Much Monitoring*.
39. Sinton, P. (1996). Businesses Wired on Intranets. *San Francisco Chronicle*. Sept. 26, B1.
40. Sproull, L. & Kiesler, S. (1991). *Connections: New Ways of Working in the Networked Organization*. MIT Press. Cambridge, Mass.
41. Symons, F. (1997). Virtual department, power, and location in different organizational settings. *Economic Geography*, 73(4), 427.
42. Tan, B. C. Y., Watson, R. T. & Wei, K. K. (1995). National Culture and Group Support Systems: Filtering Communication to Dampen Power Differentials. *European Journal of information Systems* (4:2), May 1995, 82-92.
43. Tractinsky, N. & Jarvenpaa, S. L. (1995). Information Systems Design Decisions in a Global versus Domestic Context. *MIS Quarterly* (19:4), December 1995, 507-534.
44. Wresch, W.C. (1996). *Disconnected: Have and Have Nots in the Information Age*. Rutgers University Press, New Brunswick, NJ.
45. http://www.cio.com/archive/091500_mail_sidebar1.html.
46. http://www.sla.org/content/Shop/Information/infoonline/2000/Jun00/nelson.cfm.
47. http://www.slis.indiana.edu/faculty/kling/cc/.
48. http://proceedings.informingscience.org/IS2003Proceedings/docs/071Baloh.pdf.