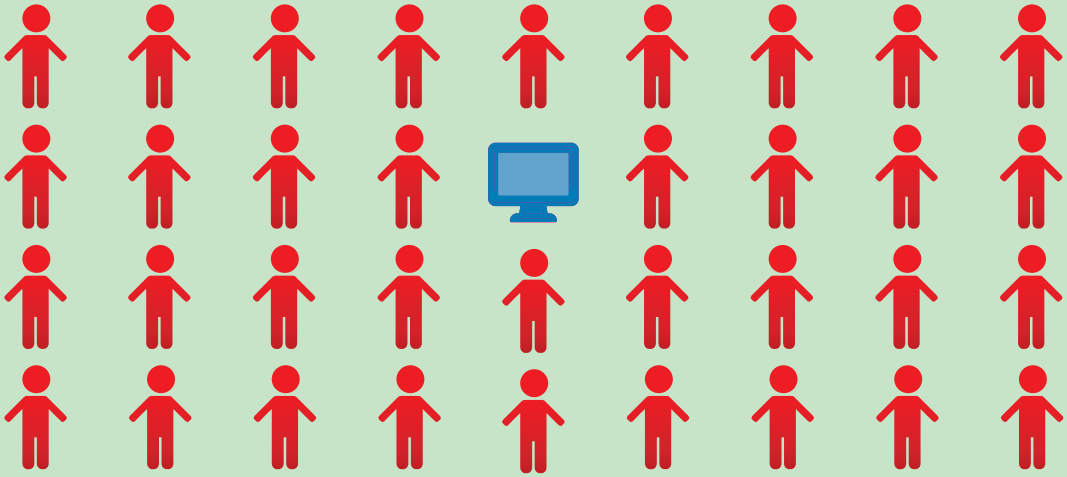
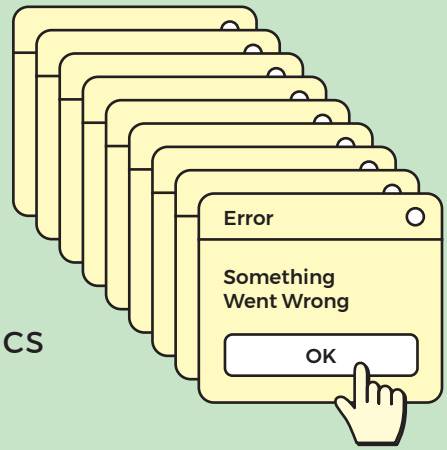


Markku I. Nurminen

Whose Work Does the Computer Do?

Foundations of Work Informatics



Whose Work Does the Computer Do?

Foundations of Work Informatics

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Printed by: Libri Plureos GmbH, Friedensallee 273, 22763 Hamburg, Germany

ISBN: 978-952-80-9489-0

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Starters

This book has one objective that is more important than the others. It seeks a clear-headed understanding of how information technology integrates with work performed by people. In other words what happens when a computer executes a programme stored in its memory without anyone needing to direct its operation in detail? Does this create added value and who receives it? Our hope is that through this reflective examination, information technology and its development might, at least to some extent, be brought under control.

Preface to the Finnish Original

Background and the Concept of Work

In the summer of 2023 I celebrated my 60-year career anniversary as a computing professional. It would mark six decades since I was first paid for my expertise in the field. As a young man in my twenties, freshly graduated with a bachelor's degree in natural sciences, I secured a summer job at the IBM regional office in Tampere. The most significant task that I undertook that summer was to develop a quality control programme for the J.W. Enkvist pulp mill. My job and salary were well-deserved. While there were colleagues at the local *Service Bureau* with more experience in programming, I was the only one who possessed two crucial skills: using subroutines in the IBM 1401 *Assembler* language and calculating square roots within the same environment. Without the square root, quality control would have been impossible, since one of its key concepts —standard deviation—requires square root calculations. This was no big feat for me, as I had already become familiar with the basics of numerical analysis during my mathematics studies. The strength of the subroutine structure became evident when certain tasks such as square root calculation had to be performed in multiple parts of the main programme. Without subroutines the same code would have had to be copied into each usage point. Although subroutines were described in the manuals, none of my colleagues had read or understood them—until I explained everything to them.

The application I built had two life-cycle phases, as was typical: development and a series of production runs. In the first phase, I needed to familiarise myself with the task, design the necessary data sets, and outline the programme structure and operational steps—such as sorting punched card files into a certain order. Programming was followed by numerous test runs until I could be confident the programmes were sufficiently free from errors. The Service Bureau's business model was based on the idea that the application would be run repeatedly so that the development costs could gradually be recouped. This approach is sometimes called the "salami model": one slice at a time. The rest of the staff had typically gained their expertise before recruitment, but my learning continued during my internship, as I had only taken a private programming course of a few weeks organised by IBM the previous winter. At that time, universities had neither computers nor computer science instruction.

Who Benefited from the Application?

The Service Bureau was a service centre whose customers paid for the services they received—that is, the development and use of applications. The customer ultimately decided what the application should include. As with services in general (see Chapter 3 of this book), the added value created by the service was meant to benefit the customer. In this case, the customer received a series of quality control reports, possibly even weekly. Quality issues identified in the reports could lead, for example, to the cancellation of a cellulose trade agreement or a price reduction. If the product had been something more critical, such as a medicine or food, delivery would have been halted until the quality control cleared them for dispatch. Rejected products would probably have been destroyed or repurposed—for example, as biofuel. In any case, operating in the pulp market required a verifiable and credible level of quality. The value of this requirement can be assessed negatively: what would be lost if the quality level could not be verified or if it momentarily failed?

Back then, computers operated on a batch-processing basis. Batch-processing took place at fixed intervals, such as once or twice a month. Files were typically sequential files punched onto cards, which could only be updated during batch runs. A computer operator performed the runs. I mention these details because they help explain why information systems were commonly viewed as separate from the broader activities of people and organisations. The computer operator was not an active participant in pulp production. He had his own domain—the computer room—which was connected to the outside world through strict border protocols. Generally, only punched cards crossed this border in either direction; output might also include line-printer listings.

It is not difficult to imagine how quality control was carried out at the pulp mill before the computer system that I developed. The quality control manager had two teams: laboratory and calculation teams. The laboratory team defined sampling locations and schedules to ensure representativeness. This permitted credible inferences about the overall production quality based on statistics. They also collected and analysed the samples. These results were then passed to the calculation team, which performed the statistical calculations for interpretation. The computer programme was designed to handle these very calculations. The company estimated that a six-person calculation team could be reduced to one, and the cost of computer runs was only slightly higher than the salary of one or two people.

The first conclusion about the system that I developed is that it did essentially the same things that had previously been done manually: statistical calculations adapted to a specific environment. New tasks were not added. However, it was later realised that by retaining the data in a computer-readable format, it was possible—almost as a bonus—to compile time series longer than a single batch cycle. So while the content of the work remained unchanged, the method and the workers undoubtedly changed.

A responsible actor needs to be called upon, at least when goal-oriented activity is being undertaken. The realm of such activity in our culture can be considered the world of work: people generally go to work to produce some result. In this book, we therefore use the concept of ***work*** instead of the more complex concept of ***goal-oriented activity***. The title's question about work done by a computer raises the concept of knowledge work, and it also raises a new research area, namely ***Work Informatics***. Behind this is the idea that work cannot proceed without knowledge or expertise. The terms also direct interest towards those aspects of work that emerge when information technology is used in its performance.

However, the intention is not to completely turn our backs on activities outside the actual working life, since various information technology systems and devices also form an important tool within the framework of citizens' leisure time. The management of various matters in electronic markets and administrative interfaces, as well as the control of the immediate environment, are forms of activity of this kind. The focus of goal-oriented activity can also be the experience or change felt by the actor themselves, for example, skills that have been improved as a result of studying or the desired relaxation of one's state of mind by listening to one's favourite music. In this book we examine work in general, specifically as a goal-oriented activity. In this way we hope that the book will also provide understanding of other types of activity than work done in specific workplaces. Or looked at in reverse: if an activity has no goal at all, we do not call it work. Thus, we understand work very broadly; it also includes most household chores, hobbies and studying. Planning, management, and decision-making are also work, not to mention innovation. In this way, we hope to be able to counter the occasional disparaging or derogatory attitude towards work. Yes, work is still a source of well-being even today. We still believe that most people would rather be workers than unemployed.

Wanted: Performers of Computerised Work

In addition to human work, the quality control report used the computer's calculation capacity, but who was the performer of this work in the new situation? In the course of this study we want to reserve the role of actor for people and therefore adopt a cautious and even critical approach to ideas and also to language that may suggest that a computer or robot could be considered the actor for certain tasks. In the landscape of the 1960s, it was easy to find an ***actor***[1] for the cellulose factory's system: a physical person. The batch runs of the systems were performed by a computer operator, who, after preparing the run, started and carried it out. The activity was even physically impressive, since the often substantial punch card files had to be sorted, fed into the programme and then saved after punching and computer runs. But this operator didn't need to know anything about quality control or cellulose production. Hence, he could not be held responsible for the accuracy of the results, just as very little responsibility can be placed on the programme writer's shoulders, although in practice it may happen that the programme crashes before completing its task or gives an incorrect end result for some other reason. If the programmer's employer, in this case the service office, has approved the programme for production use, it has at the same time taken responsibility for its effects, although even today this kind of responsibility often seems quite thin. Wouldn't the overall management be much better with that remaining member of the calculation group at the factory whose tasks included gathering the data to be processed and ensuring that they would be punched onto punch cards (the service centre offered this as part of a comprehensive agreement)? Previously, he had acted as the supervisor of the calculation group and was therefore responsible for the calculations. At least he was able to interpret the quality control reports from the perspective of cellulose production.

Why are we so interested in responsibility issues in work situations where information technology is utilised right from the start? The answer is that it is in fact the main question posed in this entire book. Since work situations vary greatly, we will formulate the question a bit more broadly and generally: "What happens when a computer seemingly operates on its own as part of the performance of a work entity?" *Does the comput-*

[1] We use the word "actor" to describe the performer of work, who does not need to be in an employment relationship, cf. employee, who usually has an employer.

er actually do something? What might it be aiming for and what is its motive? For example, it's difficult to imagine what a computer would do with a large amount of cellulose. The same goal-orientation problem also characterises another application area that currently seems to be receiving a lot of publicity. When a computer, without human intervention, guides a ship or car in traffic, we are left wondering where the computer might want to travel and what things it might want to do at its destination. In this book, it seems natural to us to think that the actions of artificial intelligence or a robot become understandable only when seen in connection with human activities and goals. In addition to naturalness, we are rewarded by not having to explain the special characteristics of a computer subject. Is its grumpiness due to childhood traumas or feelings of exclusion, for example? In other words, it is easier for us to conceive that it is appropriate to treat a computer more as a tool than as a colleague.

> Does the computer actually do something?

The first major project of the Laboris research group at the University of Turku was called the ***Knowledge Work Project***. Knowledge work is quite deliberately an everyday-sounding word. We have wanted to avoid labelling certain work situations as particularly ***knowledge-intensive***, which would then label all other jobs as non-knowledge-intensive. This division brings to mind the ***Taylorist***[2] principle, which sharply separated thinking and task planning, on the one hand, and hands-on work on the other. Our starting point is that when work is understood as goal-oriented activity, goal-orientation requires the involvement of knowledge; we need to know our goals and be able to monitor their realisation. So there really isn't work that wouldn't at the same time be knowledge work.

We know well that it's currently sexy to swear by the name of "artificial intelligence". Robots supposedly start doing more and more human work and will eventually take away their jobs. However, we don't want to end up with a juxtaposition of the "yes/no" front with respect to the agency of artificial intelligence. If such a frontal alignment were to occur, we would probably side with humans against robots, for the simple reason that we ourselves are humans. However, we do not wish to become a party to such a confron-

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[2] Taylorism is discussed more in the second chapter of this book.

tation nor do we wish to be advocates of the mystique of Artificial Intelligence. Through this book, we aim to demonstrate that it is possible to create a conceptual structure that explains the relationship between human activity and information technology, without us having to give the other party (whether called a computer, "artificial intelligence", or robots) properties that belong to the sphere of human, i.e., an acting subject. If we succeed in this thought experiment an opportunity opens for us to live and plan our activities without mysticism about self-acting robots and artificial intelligence. Perhaps we then might find it to be justified to talk about counterfeit intelligence instead of artificial one. If someone nevertheless makes the opposite choice, we know this to be a choice and can with full reason expect justifications to be presented for this choice.

The Content of the Book and the Legacy of Laboris

The content of this book is based centrally on the practical experiences and theoretical frameworks that emerged from the work of a research group operating at the University of Turku between, roughly, 1980 and 2010. The group called itself ***Laboris***, a name that hides both of the most important starting points: Labor and IS. Labor is Latin and means work, while IS is an abbreviation referring to information systems and their research. Laboris's field of research was thus the relationship between information systems and work; how we understand this relationship and how this understanding can be used to improve the beneficial use of information technology. Information technology has developed enormously, starting from its early days to the present. Despite this, people seem to continuously experience major difficulties in using this technology, and some even report that computers complicate or completely prevent them from doing their work. And the quality of the information systems produced doesn't seem to have convincingly improved either, as glaring scandals keep erupting into the public, one after another. So there's plenty to research.

During its operation, Laboris conducted a considerable number (30–40) of case studies in domestic organisations. Some of them received funding from public sector institutions (e.g., the Academy of Finland, the Work Environment Fund, TEKES, the Ministry of Labour), but in almost all cases the organisation that was both a partner and the object of research had committed to paying hard cash for the results we produced.

Laboris offered its clients a service package whose central aim was to evaluate the beneficial use of the organisation's selected information systems. The approach was

multidisciplinary, as the group had representatives from several disciplines. The research methods involved creative combinations of quantitative and qualitative methods. Semi-structured user interviews proved to be the best data collection method but questionnaires were very effective for certain issues. As a general observation, in virtually all cases we found a surprisingly large amount of fiddling about and ***tinkering***, which was our term for all activities not belonging to the actual work, including fixes and clarifications arising from uncertainty. According to our informed estimate, users spent at least one full working day per week pointlessly serving these computers.

These case studies have had a great significance for the formation and interpretation of the frameworks presented in this book. The majority of the results of these studies have been insufficiently reported in public, and they have not previously been presented in a compiled form, at least not together with the theoretical frameworks underlying them. We do not intend to present them as scientific theories now either; we will content ourselves with referring to these case studies as examples along the way, when it is appropriate to the topic. Storytelling is a genre that has also taken its own place in present-day scientific communication. In our opinion, the passage of time has hardly eroded the descriptive power of these stories. Mucking about seems to be an inexhaustible natural resource. On the contrary, we think that we can finally share our experiences without offending the privacy of any organisation or its employees.

When we organised the evaluation event for our first project, one of the evaluators noted that the research group had had good luck in finding a target that had so many problems (mucking about) to investigate. Interestingly, this luck continued uninterrupted throughout Laboris's entire operational period. The work-oriented analysis method seemed to help us find serious problems in the beneficial use of information systems in almost all organisations. A couple of times, the problems contained such major scandals that we noticed the careers of the target organisations' responsible persons were in danger. We rushed to support them by assuring decision-makers that problems of this level occur in absolutely all organisations. We were also often able to give good hints for recovery from these difficulties.

A large number of researchers have actively participated in Laboris's work, while its operations have continued for a good twenty years. There are so many of them that I must content myself with simply listing them in alphabetical order without further personal reminiscences. Many thanks to all of them! Or to all of us! I included my own name in the list, "I was there too, after all; perhaps I knew something, too." To-

gether we worked towards an important cause.
Here they are:

Satu Aaltonen	Pirkko Karhu	Berit Mäkeläinen
Inger Eriksson	Jari Kesti	Jukka Niemelä
Anneli Finneman	Pia Ketola	Markku I. Nurminen
Ulf Forsman	Mika Kirveennummi	Pekka Reijonen
Jukka Heikkilä	Juha Koivisto	Marjo Snellman
Riitta Hellman	Kalle Koota	Kimmo Tarkkanen
Katariina Jalonen	Pekka Lehtiö	Vesa Torvinen
Olli Järvinen	Tarja Meristö	Hanna Tuohimaa
Johanna Kaakinen	Tatjana Murtojärvi	Antti Tuomisto
Petteri Kaitovaara	Pekka Muukkonen	Jaana Vuorenheimo

The work of Laboris has crystallised at the University of Turku into a sub-area of information systems research, which has been given the name ***Work Informatics***. Within the discipline it still fertilises the university work of the research group both in teaching and research. This book continues—and will, hopefully, also support—this legacy.

Our version of work informatics is based on the use of multiple perspectives[3] or viewpoints. For example, the basic idea that a computer or system does not do anything in its own name, but that the system's actions can be seen as people's intentional acts, itself helps us to identify many sorts of mucking about in knowledge work. This kind of social interpretation challenges the mainstream of such ways of thinking, where people seemingly stand by and watch what happens to them as artificial intelligence and robots change the world. It is as if we do not want to understand the situation and the actors have moved to the audience's side of the auditorium to watch the robots' activities. This basic idea of work informatics offers an alternative perspective. The aim is to increase awareness that many generally accepted scientific views have been based on ***paradigms***[4] that it has been possible to change. These include, for example, views of the Earth as a

[3] Markku I. Nurminen: Three Perspectives on Information Technology. (Kolme näkökulmaa tietotekniikkaan). WSOY. 1986.

[4] See also Thomas S. Kuhn: The Structure of Scientific Revolutions. Chicago University Press. 1962.

flat plane and the centre of the universe; even the theory of relativity may have broken paradigms in force at its time. In this spirit, we set out to explore whether it is conceptually possible to understand and apply a philosophy of information technology use where agency is unambiguously reserved for humans. Then there is no need to resort to artificial intelligence when genuine intelligence is also available. Thus, we invite the reader to join us in a thought experiment that seeks to outline such a framework. As an additional bonus, the reader will be able to acquire skills in forming a social interpretation and thereby in preventing mucking about.

We structure work in this book from three perspectives, which we will call the ***modalities*** of work. They are a) individual work, b) collaboration, and c) service. In most work situations all of them are naturally present, but in a specific situation, one or two of them may be more emphasised than others. We sharpen these perspectives by opening and characterising each of them in turn. In this way we will get a better picture of the modalities and their interdependencies. The approach resembles Max Weber's procedure when he defined the ideal type of bureaucratic organisation (see Chapter 2).

These three work modalities naturally form the first three chapters of this book. The power of information technology as a tool for knowledge work emerges in individual work, while its use as a means of collaboration and coordination is the main message of the second chapter. Service, in turn, transcends the boundaries of a single organisation and the employment relationships used within it. The logic of services seems to have gained more momentum as they have landed in electronic services.

In addition to these three pillars, the book has two further chapters. The strong presence of information technology in our work has provoked a fourth chapter, which explores what kind and what type of knowledge is needed in work and how it can be processed using information technology tools, for example, what areas seem to remain outside information technology. The fifth chapter is then dedicated to change, both spontaneous and self-induced. As recently as thirty years ago a book on information technology and organisational change would most likely have focused on designing a new information system and design methods. Its appendix would have briefly mentioned that the implementation of the system might cause some unforeseen organisational changes. Now such changes can be anticipated a bit better, and the entire area and logic of change have taken on a completely new appearance: organisational change is often seen as having a decisive impact on information systems rather than vice versa; hopefully, this impact is predictable, manageable, and positive.

Thanks to the Support Team!

I retired a full decade ago. Even after that, I have had the pleasant opportunity to participate in teaching the ***Knowledge Work*** course in collaboration with my successor, the Professor of Work Informatics, Jukka (Jups) Heikkilä. Almost every year, we have managed to shake out a new production of this opus (cf. opera performance), which has once or twice also been cast in a distance learning format. These joint productions have given rise to ever newer and more enticing offshoots to the unfinished book project. This is the main reason for the offshoots of this book. My humble apologies and thank you for all of them, Jups! The idea of publishing the book has been continuously in progress. In addition to course participants, wishes have also been heard from companies and organisations operating in the area. We can also thank the course participants for those reminiscences of times past, which I have not had the heart to omit. I planned to do so, but just then a course work pair came to tell me how interesting precisely those stories are. If the reader doesn't like them, it would be best just to skip over them!

The form of the book and the efficiency of its processing have varied quite a bit. At times, a two-part work was envisaged rather than a single book. In addition to the domestic languages, Finnish and Swedish, parts of the drafts have also been written in English. I decided on my native language, Finnish, as the language of publication because I want to do my part in maintaining the position of Finnish as a language of education and culture. Co-writers have been sought mainly from the prospective field of work informatics. Interest has been shown from several quarters, but when it came down to it, texts of their own haven't emerged from very many pens. The magnificent supportive spirit from my former work community has nevertheless kept the project alive and even accelerated it.

However, a book is much more than just a stretch of text. My manuscript has been most abundantly commented on in various stages by Antti Tuomisto, Jukka Heikkilä and Pekka Reijonen. The graphic look and layout work have been taken care of by Susanna Eerola. Without the contributions made by all of them this work would be poorer in content and appearance.

Living with an unfinished work from year to year risks hollowing out the author's self-confidence and leading to its interruption and burial. Tenacity has been created by the uncompromising support, advice and conditions of my immediate environment. Without the continuous proximity and care of my wife Maija Saario, we probably would

not have reached the finishing line. Access to nature in Kuusisto has been an excellent source of inspiration, so thanks, Mikko! My other loved ones have also earned thanks for their encouragement.

The style of scientific writing ran into difficulties when the number of reference sciences and, at the same time, the diversity of applicable frameworks grew and grew. Even a slightly more thorough presentation would have raised the page count, if not to a thousand pages, then well over half that. Couldn't the matter be dealt with in a somewhat lighter approach, through stories? Let Laboris's case studies form a kind of basic set for this storytelling. From these, the framework of this book has been built by combining this body of experience with elements from various classics. I believe that such conceptual work will withstand the wear of time. After all, all of my likely readers have the internet as a dictionary and reference work: everyone can, if they wish, produce their own version and bibliography of this intellectual product and its offshoots. Google It Yourself!

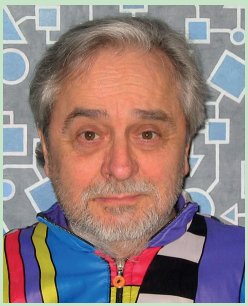
Turku, May 2023
Markku I. Nurminen

Whose Work Does the Computer Do?

Foundations of Work Informatics

In this book, which belongs to the field of Information Systems Research, work informatics refers extensively to information technology and information systems. Its point of departure, however, is work itself, while technology must settle for playing the role of being a tool. The goal of an information system thus lies outside itself—in the goal-oriented activities of an organization. In work informatics, work takes on three faces: individual work, collaboration, and services. For its part, information technology combines to serve all of these.

The case studies provided by the Laboris research group underline the descriptive and explanatory power of work informatics. The collection of Laboris accounts takes its structure from a selected set of theoretical and conceptual frameworks, most of them drawn from the human sciences. Work informatics sheds new light on agility, a goal pursued by many organizations. It also helps actual knowledge workers—individuals and groups—to grasp the silent and invisible questions of internal working life, which, given their nature, often seem to escape even the slightest touch.



Markku I. Nurminen

Markku I. Nurminen is Professor Emeritus of Information Systems Research at the University of Turku. His speciality is work informatics. In the course of a quarter of a century (1985–2010), along with his research group (named Laboris) he carried out some two or three dozen case studies focusing on Finnish organizations in both the private and the public sectors. The common thread running through these projects was the beneficial application of information systems. The benefits produced by their use were intended to improve organisational activity, but extracting them from the system turned out to be a surprisingly difficult task. In consequence, there was no shortage of interesting projects.

Professor Nurminen discovered many of the fundamentals of work informatics while maintaining connections with research groups in information systems research not only in Finland but also across the whole Nordic area. One of the most important contributions he introduced into his own research community was a multidisciplinary approach that was also used by the Laboris team. Professor Nurminen retired in 2009. Since then, he has participated in teaching work informatics at his old university, while at the same time crystallizing its foundations. Work informatics continues to be researched and taught at the University of Turku. (https://workinformatics.utu.fi/)

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