

# Information Systems Development as an Activity

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## 1. Introduction

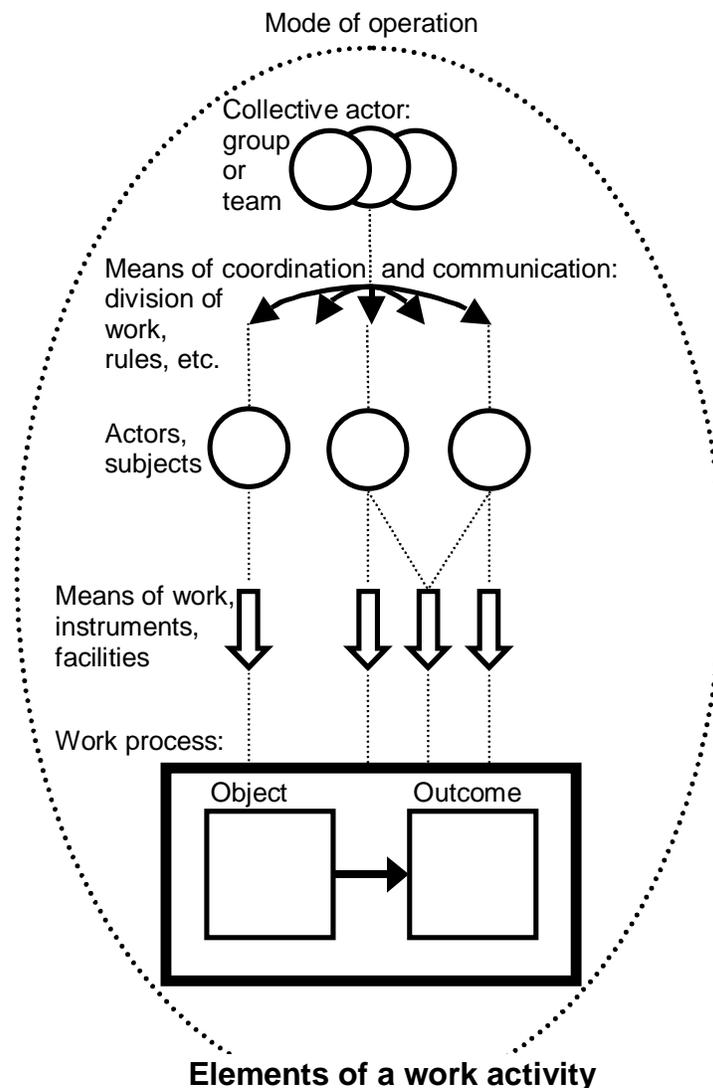
Activity theory has inspired a number of theoretical reflections on what information systems (IS) and information systems development (ISD) are about (e.g., Bertelsen 2000; Bødker 1991; Bødker 1997; Bødker and Petersen 2000; Hasan *et al.* 1998; Kuutti 1991; Nardi 1996). In this paper we carry on that tradition by applying activity analysis and activity network analysis on ISD as a work activity.

This paper is the second part of a series of papers applying activity analysis on information systems. In the first paper we introduced our framework of activity analysis and activity network analysis, and discussed how they can be used as a day-to-day method within ISD itself, by practicing systems developers (Korpela *et al.*, 2000 a). The objective of the current paper is to provide an operational research framework for studying ISD as a real-life work activity in context. The third paper applies activity network analysis in the relations between IS research and IS practice (Korpela *et al.*, 2001 a). The fourth one is a position paper linking the activity-level framework to wider societal levels of analysis (Korpela *et al.*, 2001 b). Further papers will present empirical results and link activity analysis to use case modeling.

The paper is structured as follows. First we briefly introduce the basic concepts of **activity** and **activity network** in the way we will use them in the rest of the paper. Next we define what we mean by ISD in broad terms, mainly in relation to software engineering on the one hand and work development on the other hand. Activity network analysis is then used for defining ISD's relations with neighboring activities in a few typical variations. The conceptual framework is then applied in analyzing ISD as a temporary work activity across an organizational border. Based on the analyses, we outline an action research methodology for studying how ISD is practiced and how it can be developed in a given real life setting – Nigeria in our case. Finally, we conclude by discussing the contribution and the relevance of our analysis.

## 2. The analytical framework: Activities and networks

Activity theory incorporates quite different psychological, educational, cultural and developmental approaches on human activity, based on Vygotsky (1978), Leontiev (1978) and other classical texts (for a summary, see Hedegaard *et al.* 1999). The specific analytical framework used in this paper is based on Engeström's (1987; 1990; 1999) Developmental Work Research, but in a slightly elaborated form. The framework is summarized below in a very concise form – more profound accounts on how the framework was derived and how it compares with related work by others, are published elsewhere (Korpela *et al.* 2000 a; Korpela 1994).

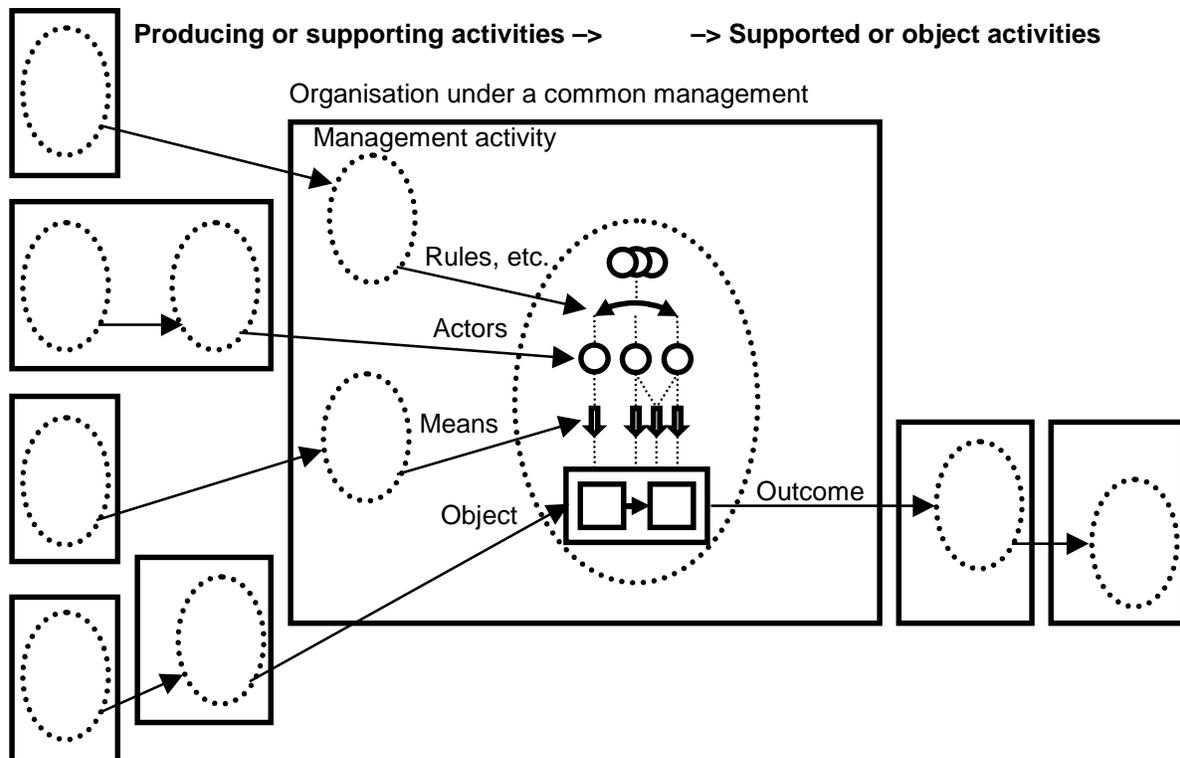


**Figure 1:** Collective work activity as a systemic entity.

We regard work activity as a systemic entity comprising of a number of elements which must fit together to some extent (Figure 1; cf. Engeström 1987, p. 78). When studying collective work, the unit of analysis must be activity as a system, as a whole, not any of its constituent parts in separation. However, the elements and the relations between them constitute the checklist for a researcher trying to grasp what an activity is. The elements of the model in Figure 1 are presented in an abstract way in the following, and illustrated in sections 3 and 5 through two ISD examples.

According to Leontiev (1978), the motive of a collective activity is in its shared **object** – or more specifically, in what the object transforms into during the activity, i.e. the **outcome**. For instance, the motive of a construction activity is to transform the raw materials into a house; the motive of scientific writing is to transform research results into a publication. Individual **actors** or subjects engaged in the activity may or may not be conscious of the collective motive, but it is yet the shared object and its transformation into the jointly produced outcome which define an activity.

The actors perform their individual **actions** of work on the shared object through mediating instruments or **means of work** which can be material (technology) or immaterial (language, skills, theories). For instance, a carpenter applies a hammer and his skills on some planks and nails in order to construct the scaffolding for a building; a researcher applies a word processor in order to transform her research results into an article. Each actor may have his or her own means, or some of the means can be shared. The individual actions taken together form the **process** through which the object is transformed to the output. In order to merge the individual actions into a collective activity, there needs to be some form of coordination between them, mediated by the **means of coordination and communication**; for instance rules, division of labor, timetables, meetings, phone calls, and so forth. In a way, the actors taken together as the **collective actor** of the activity operate through these means on the other elements. The means by which the individual actors act upon the object (i.e., the means of work) and the means which mediate the relations between actors (i.e., the means of coordination and control) can overlap – a medical record for instance is both a means for a physician in acting upon a patient’s disease, and a means of coordination and communication among a team of healthcare professionals.



**Figure 2:** A network of activities, split by organizational boundaries.

Finally, the systemic nature of the activity, the relative fit between the elements, is characterized

by the **mode of operation**. If, for instance, a publication activity is based on Microsoft Word 2000 as a shared instrument, but one of the co-authors can only use WordPerfect 5.1, then the collective activity does not operate properly and may even break down. In general, the **misfit** or contradictions between various elements, or between one element and the common mode of operation, is the main source of dynamism in the model. Some element lags behind the others and needs to be “improved” in order to better fit in the mode of operation; after a number of such small improvements, the entire mode of operation starts to lag behind the most “advanced” elements, and a new balance, a new fit must be found through a new mode of operation.

Most often the outcome of an activity is not intended for the same collective which produces it, but to be “consumed” by some other collective in some other activity. Construction workers do not build houses for themselves only; researchers write publications for the scientific community to make use of. The **activity network** (Figure 2; cf. Engeström 1987, p. 89) describes the producing activities for each element of an activity (the left-hand side of Figure 2). Seen from the other direction, the outcome of each activity is consumed by one or more other activities (the right-hand side). For the sake of simplicity, we have depicted only one producing and one object activity for each relation, but in reality the network is of course more complex. The relations between activities in a network are also mediated, by **means of networking**.

The final aspect of our framework are **organizational boundaries** which cut across the activity network, embracing some activities under the control and coordination of a shared management activity, while forming seams between other activities of the same network.

### 3. ISD: Between work development and software engineering

In day-to-day parlance, the term **information system** is used simply as a synonym for a multi-user computer application (multi-user software package). In information systems research, the term refers to a systemic entity which includes both technological and social elements (Avison 1997; Davis 2000). However, in activity theory the systemic unit of analysis is a work activity defined by a shared object, not by the technology being applied within the activity. The information technology used among the various means of an activity may not form a systemic entity at all, but a collection of bits and pieces of information technology which happen to be needed (Korpela *et al.* 2000 a). Even as a social system, i.e. as an information management process, an “information system” is seldom an activity in itself, but a subset of the actions needed in a work activity which aims at producing something else than information as the main outcome. In the cases when the object of a work activity is indeed a need for information and the intended outcome consists purely of information, we regard it less confusing to call such activities ‘information processing activities’ or ‘information management activities’, rather than ‘information systems’.

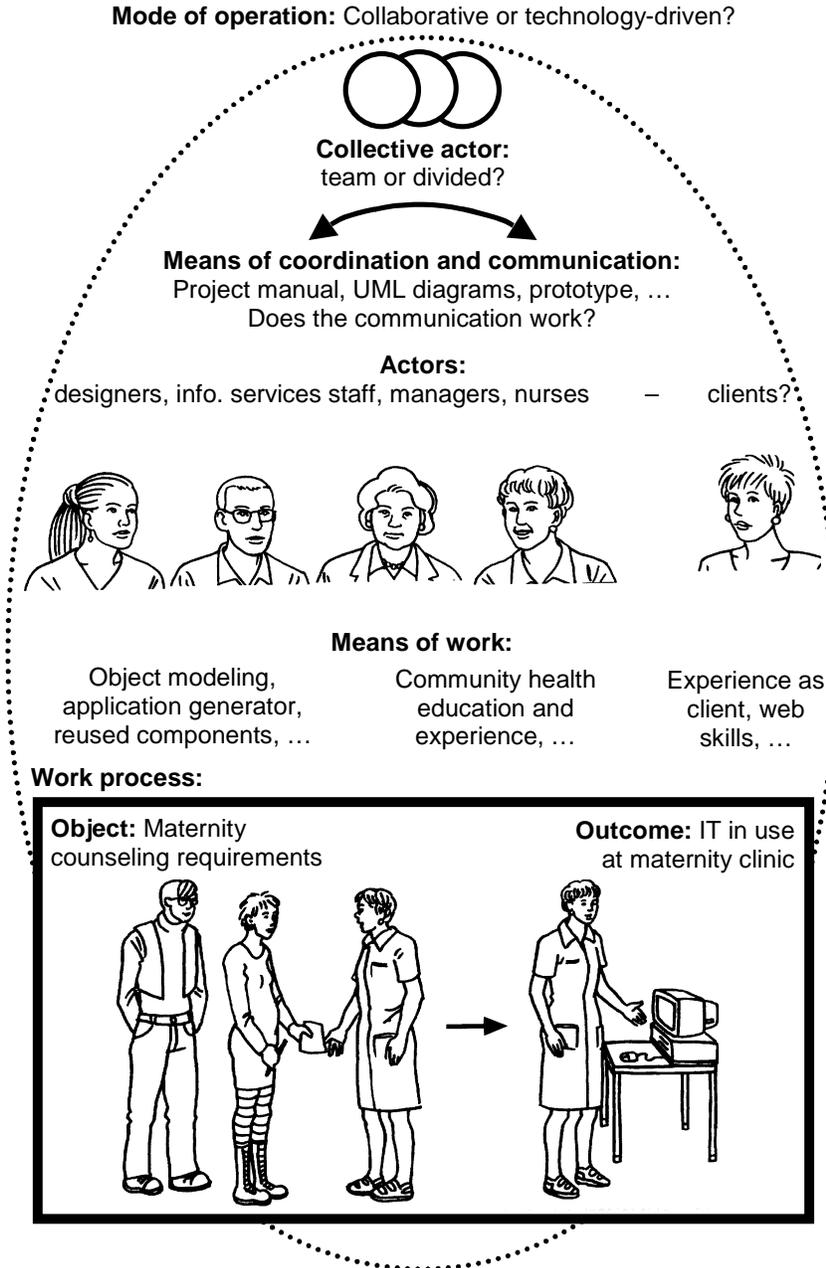
Thus, regarding what the term ‘information system’ usually tries to capture, we speak about:

*the use of information technology (manual or computer-based) in a collective work activity, either as means of work or as means of coordination and communication, or between activities as means of networking.*

Correspondingly, we define that:

*Information systems development (ISD) is the process by which some collective work activity is facilitated by new information-technological means through*

*analysis, design, implementation, introduction and sustained support, as well as process management.*



**Figure 3:** A sample ISD activity in maternity counseling.

Figure 3 presents an example of an ISD activity in maternity counseling as a case (adapted from Korpela 1999 a). The aim of the ISD activity is to facilitate the maternity counseling activity by new information-technological means, in this example by a web-based information service to pregnant women and their relatives. The object of the ISD activity is the need for improved information facilities in maternity counseling perceived by the community health nurses in question, and the intended outcome is to have the counseling activity better facilitated. ISD is usually practiced in projects which draw together a multi-professional group of people – in this case at least systems designers from a software company (the ISD professionals proper), technical staff from the healthcare institution's (the customer's) own Information Services Department,

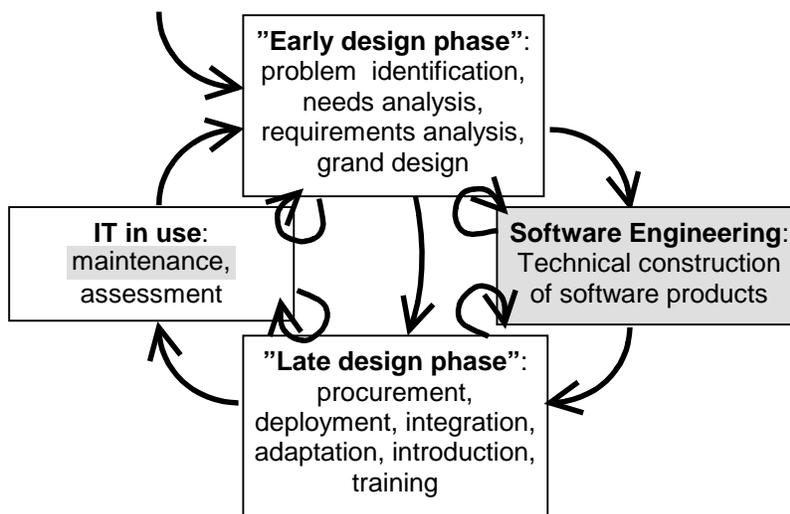
representatives of the customer's management (maybe a community health matron in this example), as well as the community health nurses themselves for whose work activity the would-be system is intended to.

The technically trained actors and the nurses have widely different means of work at their disposal, despite the shared object and intended outcome. The IS professionals are usually trained in some formal methods of analysis and some programming languages, database management systems, application generators, or other system implementation tools. The IS professionals' means of work are quite strange to their customers, who in turn must mainly rely on their everyday understanding and professional education in trying to explicate their requirements into information system specifications. The same bipolarity can be seen in the available means of coordination and communication between the IS professionals and their customers – most of these means are technologically oriented, and even the rules and practices of project work are often unfamiliar to the end user representatives. Correspondingly, in our example at least, the entire mode of operation of the ISD activity vacillates between collaborative teamwork, which is required for a quality outcome, and a technology driven, technologist dominated mode due to the technologically oriented means.

In the example above we have intentionally emphasized the close relation which ISD has with **work development**. All the actors in the ISD project try to first analyze the requirements of maternity counseling as a work activity. This is exactly what any work development consultants would embark on in a developmental intervention, be it Developmental Work Research, Total Quality Management, Business Process Re-engineering or so.

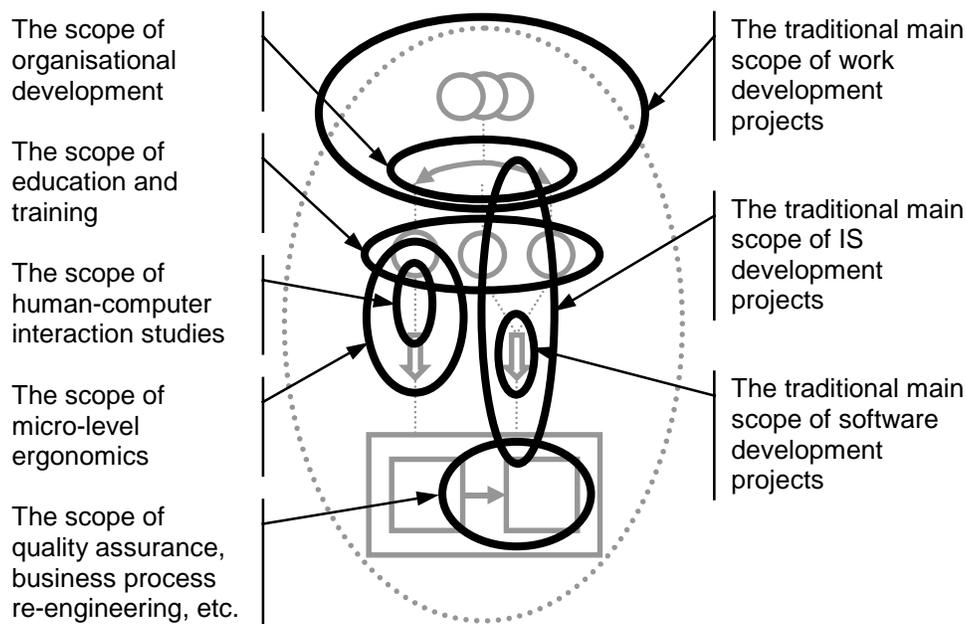
Both various work development consultants and IS developers are external facilitators who, for a more or less limited period of time, engage in a collaborative activity with their clients in order to jointly improve the latter's work. In both cases, a process of mutual learning and partnership needs to emerge. In both cases it is also imperative to start from a holistic view of developing the entire mode of operation of the activity, as well as all the component elements which require to be improved in each case. If, during an IS development project, we find out that the technological facilities are alright but the users need new skills or a different division of labor, then even an IS developer should leave the technology alone and concentrate in educational and procedural interventions. Thus ISD professionals must also be work development professionals to some extent.

When ISD as a profession emerged in the 1970s and early 1980s, the bulk of an ISD project was spent in developing the software application which was specified in the beginning. Even today an ISD process usually, but not always, contains some programming or **software engineering** of individual "bits and pieces" of the information-technological facilities which are not readily available. However, today ISD deals increasingly with *adjusting* and *integrating* prefabricated pieces of software to fit the needs of a specific work activity (Figure 4; cf. Lyytinen *et al.* 1998; Russo 2000). In some cases it is realized in the "early design phase" that there are commercially available packages which are sufficient to facilitate the target activity as required, while in other cases the required information-technological means must be constructed from scratch. Thus software engineering and ISD are two closely related but separate fields of enquiry and practice.



**Figure 4:** The roles of ISD (white) and Software Engineering (gray) in IS lifecycle.

“Work developers”, IS developers and software engineers are but few of the many developers and consultants focusing on various aspects of work activities (Figure 5). Traditionally and because of their very educational backgrounds, various work development consultants have been more helpful to their clients in dealing with the most holistic aspects of the clients’ work activity – e.g. mode of operation, rules, process – and less helpful in designing the specific technological or educational interventions identified as necessary. IS professionals have traditionally been at their best in the grand design of the collective information-technological facilities for a work activity, and less helpful in dealing with the more holistic and less technological aspects. On the other hand, when dealing with the detailed construction of these collective IT facilities, IS professionals’ expertise ends and software engineers take over.



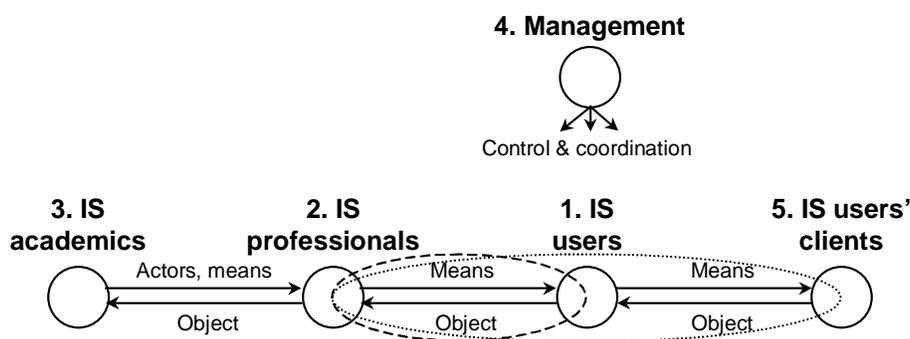
**Figure 5:** The scopes of various developmental interventions on work activities.

It is not necessary or even possible that IS developers would become full-scale “work developers”. However, in order to do their job well, in order to develop the kind of IS facilities

the users really need, they must start from a work development perspective. This is actually most important in relatively small-scale development projects which do not give rise to heavy, long-term, resource-consuming, full-scale work development undertakings which would justify the involvement of a hard-core work development expert. In such cases, which are becoming increasingly common in the “Information Society”, it is very much up to the IS professional’s ability to apply a light and rapid version of work development, whether a technological change becomes detached from a holistic transformation needed by the users, or integrated in it.

#### 4. ISD within a network of activities

Let us now proceed to analyzing the network of activities around IS development (Figure 6). The activities in the diagram are named according to their “collective actors”, which taken together form the main stakeholder groups in ISD. They are as follows:



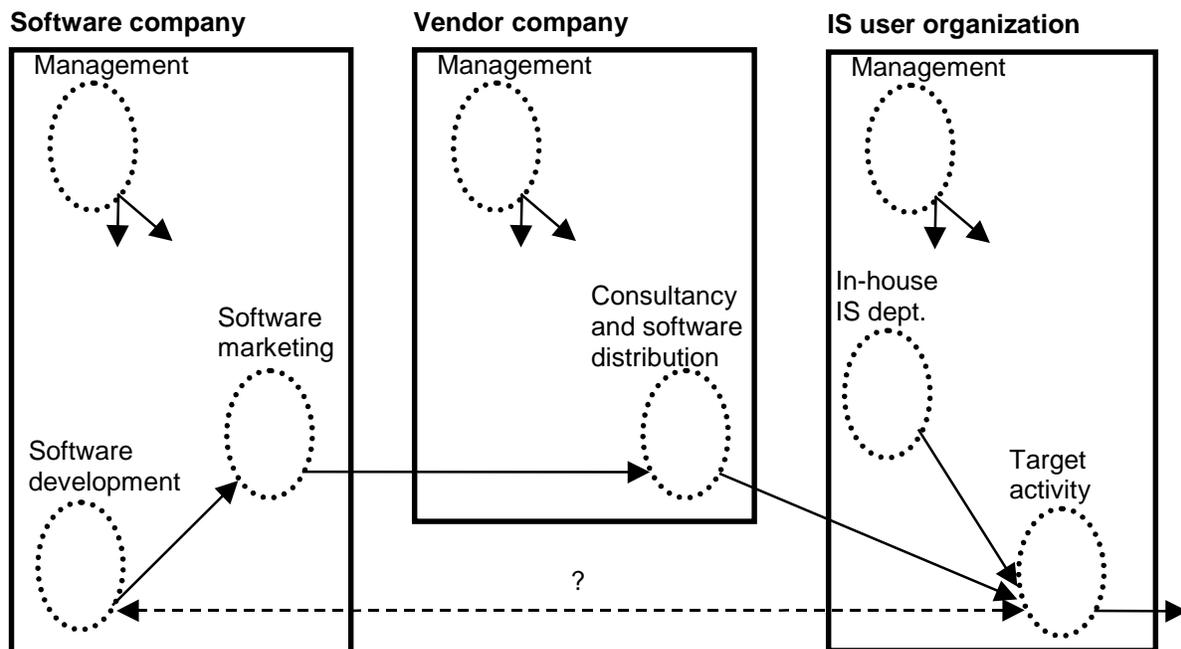
**Figure 6:** The main stakeholders/activities and relations around IS development.

1. The **IS users’** work activity is the “reason for existence” for ISD – according to our definition above, the very purpose of ISD is to facilitate this work activity by new information-technological facilities (means of work or means of coordination and communication).
2. The **IS professionals** are needed in order to identify, obtain, design, construct, install and modify the technological facilities for the users. In the traditional way, ISD was purely the IS professionals’ job – they just peeped at the users’ activity in the beginning in order to “capture the requirements”, and then delivered the finished “system” to them after some time. In the modern, participatory or cooperative way, a *temporary multi-professional activity* should emerge between the IS professionals and users during an ISD project (the dashed-line ellipse in Figure 6; cf. Bødker 1996; Bødker and Petersen 2000).
3. **IS academics**, through educational and research activities, produce the professional actors and some of the means (ISD skills and methodologies) to the development activity. IS practice is the “reason for existence” for the IS educational and research activities, and provides the object for the latter. Again, education and research can be conducted in a unidirectional way in which students and practitioners are regarded as passive recipients, or in a participatory or cooperative way in which students and practitioners become co-actors of a joint activity.
4. **Management** provides the specific “rules of the game”, in addition to the more generic rules provided by societal activities like legislation, professional bodies, and cultural heritage. The management activity should provide, organize and apply much of the means of coordination

for the other activities, and ideally align the misfits between the different activities within the network. How many management activities are involved and what are their respective scopes of control, depends on the organizational boundaries which are not depicted in Figure 6. We return to this issue later.

5. Finally, the **IS users' clients** provide the “reason for existence” for the IS users' work activity – the IS users produce the outcome of their activity so as to facilitate the work and life activities of their clients (or customers or patients). The IS users don't need the improved information-technological facilities just for themselves, but in order to better facilitate their clients. Thus, if for instance we are developing improved IS facilities for a healthcare activity, we should not just look at how doctors and nurses can work more efficiently, but how their patients (or citizens in general) can get better healthcare services as a result of the new IS facilities. As we have argued elsewhere (Korpela *et al.* 1998) and questioned in the example in Figure 3, this implies that the scope of participatory or cooperative ISD should be expanded to involve the users' clients as well (the dotted-line ellipse in Figure 6).

In-house development, contracted IS consulting, and designing IS artifacts for future markets are fundamentally very different settings for ISD which are characterized by different opportunities and obstacles for a cooperative design activity to emerge (Grønbaek *et al.* 1993; Grudin 1991). Figure 7 presents one possible setup in which a software package is developed for future markets within one company and introduced to a work activity in another company by consultants employed in a third company. In this case the development of IS artifacts is separated from the use of the artifacts by several organizational boundaries. In the classic ISD project setup of the 1980s, consulting and software development are merged into one activity in one company. In-house development is similar to the classic case except that the organizational boundary between developers and users is between departments rather than companies, and thus under a common management.



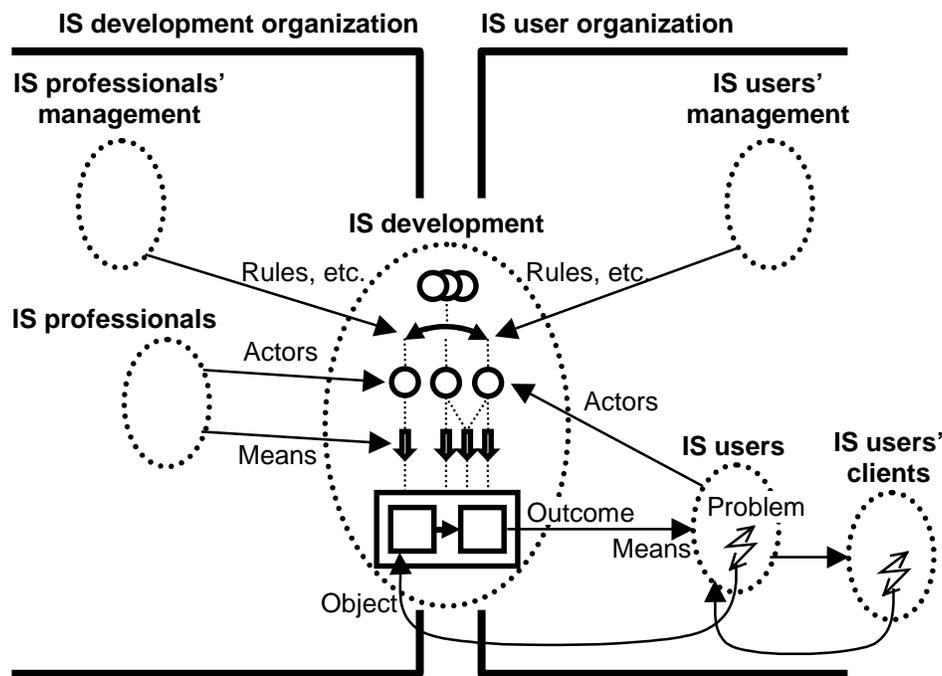
**Figure 7:** Different settings for ISD along the activity network.

While in-house IS professionals may have a long-term relation with the IS users and a bias

towards the work development aspects of the profession, contracted IS consultants usually operate on a short term and across an organizational boundary. Software package developers may have only a very indirect relation with the end users of their products in a number of customer organizations. However, at least during the initial design and later re-designs, the requirements for a software package must emerge from a range of work activities which it is to facilitate.

## 5. ISD as a boundary-crossing activity

In a more detailed analysis, the core of IS development can be seen as a temporary activity at the border of two departments, companies or other organizations (Figure 8).



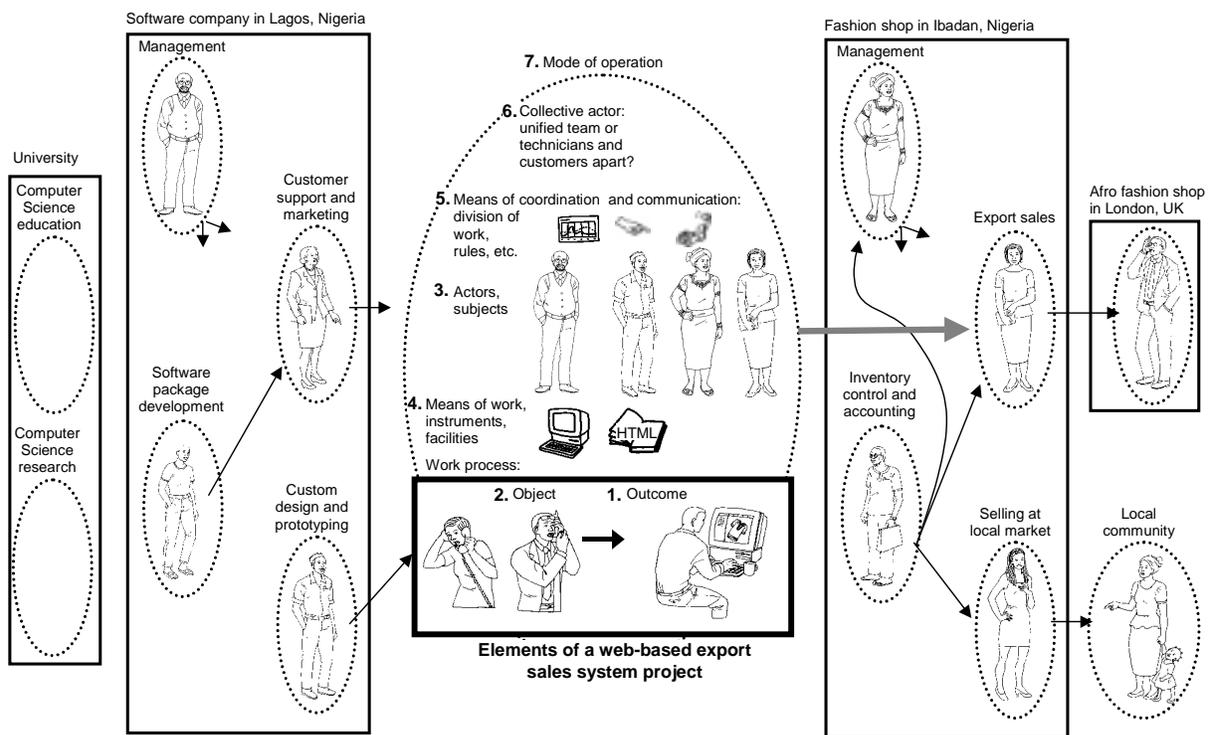
**Figure 8:** The composition of IS development activity.

The starting point or object of the ISD activity is a problem in the users' work process – a need for better facilities. If the users or their management regard that the problem can be solved by some new IT facilities, at least to some extent, then the users' management will usually set up a project, i.e. an ISD activity, to study and solve the problem. There is thus a loop of relations between the IS use and IS development activities – the former provides the object (requirements) for the latter, and receives the outcome of the latter as new means for itself. Similarly, the IS users need their improved facilities to address problems in their clients' activities. The clients' activity implies what kind of facilities the users will need.

The temporary ISD activity gets its actors from two permanent activities – the users' and the IS practitioners' ordinary activities. The latter actors can be from an in-house department within the user organization, or hired from outside, as discussed before. Even in the case of in-house development, the rules of an ISD activity also stem to a large degree from two different management activities, presenting different organizational cultures. As already discussed, the various means of the ISD activity tend to originate from the IS professionals' side. The process of the ISD activity, the "systems development lifecycle", has been thoroughly dealt with by the

theoretical and practical ISD literature, while the other elements and the network relations have received much less attention.

Let us illustrate the abstract analysis above through a specific case. Figure 9 presents an imaginary case from Nigeria, used when introducing the research framework to ISD practitioners in three real Nigerian software companies which we studied (Soriyan *et al.* 2000). The customer organization, on the right, is a medium size company selling locally designed fashion dresses at the main market in the city of Ibadan, South-West Nigeria. The owner of the company is a successful trader, Chief Mrs. A. (virtually all market traders are women in South-West Nigeria). Besides the local sales, she exports dresses to a Nigerian-born young businessman in London who sells the dresses among the Afro-Caribbean community there. Because of the economic hardship in Nigeria, the export sales activity is an important source for additional income, and Chief Mrs. A. would want to find more customers abroad. However, her export salesperson has great difficulties in trying to communicate with existing and prospective resellers because of the highly inadequate telephone infrastructure in the country.



**Figure 9:** Illustration of a sample ISD project, used as an interview guide in Nigeria.

In our imaginary case, Chief Mrs. A. had also realized that the manual inventory control and accounting activities in her company were too slow and burdensome for the expanded businesses. She contacted a Dr. O. who owns a small computer company in Lagos and had installed inventory control and accounting systems to other market traders. The export sales problem was mentioned in passing, and Dr. O. suggested that his technical experts should develop a web-based catalogue that would make Chief Mrs. A.'s wonderful dresses visible and purchasable all over the "global village". After all, there are a few Internet Service Providers in Nigeria who hire space for web sites, and they have better telecommunications facilities than ordinary small and medium size enterprises. Chief Mrs. A. accepted the proposal and a project was set up to develop

the web-based support system for export sales.

In our empirical case studies in Nigerian software companies, we stop the narrative here and start to ask questions. When your company last time had this type of a high-risk project dealing with a leading edge technology (not necessarily the web), which people were included in the project? What kind of skills and development tools did they have at their disposal? From where did they get the skills and tools? What kind of interaction there was between your own staff and the customers, and did you experience any problems in understanding each other? How did you organize the project, what kind of planning and monitoring techniques did you apply? What kind of phases or stages did you experience between the project establishment and its completion? If you compare this type of a pioneering project with a more routine project dealing with inventory control and so (illustrated by another diagram), what was organized in a different way? In the latter case, do your system developers deal with the customers directly or do you have a separate department or group for customer installations and after-sales support? And so on.

## 6. How ISD can be studied and developed as an activity

There is little empirical research on how ISD is practiced in real life today (for a major exception, see Kensing *et al.* 1998). Most large-scale studies are from the 1980s, and arguably the theoretical understanding of ISD as a work practice – and consequently the ISD education provided by universities – is also still heavily influenced by the situation in the 1980s. There is thus a high need for empirical studies on today's ISD, and for methodologies to guide such studies (Russo 2000).

The model arrived at in the previous section can be used by IS researchers as a framework for studying ISD as a practice, or by IS practitioners as a framework for analyzing their own work in order to identify “misfits” and thus areas for improvement. Optimally, IS researchers and practitioners will engage in joint action research projects to simultaneously study and develop ISD as a work activity. We have published elsewhere such a long-term research programme to study the special requirements of ISD in the severely constrained context of Nigeria, and to ultimately produce “Made in Nigeria” systems development methods and practices which are better adjusted to the specific requirements in question than the “universal” methods found in ISD literature (Korpela *et al.* 2000 b; Mursu *et al.* 1999; Mursu *et al.* 2000; Soriyan *et al.* 1999).

In transforming the abstract framework of Figures 1 and 2 into a practicable research methodology, the first step was to produce a checklist which the actors of a work activity can use in identifying the main elements of their activity. The following kind of a checklist applies for any activity (Korpela 1999 b):

- 1a. **Outcome:** What services or products do we produce?
- 2a. **Object and process:** What raw materials or prerequisites do we start from? How do we produce the services or products from the inputs we have?
- 3a. **Actors:** Who are we – what different kinds of people are needed to produce these services or products?
- 4a. **Means of work:** What kinds of physical tools and knowledge, skills etc. do each of us need for this work?
- 5a. **Means of coordination and communication:** When we work to produce the services or products, what kinds of rules, division of labor, communication etc. apply between us, so that each one's work can contribute to a joint process?

- 6a. **Group or team:** Taking all the actors together, what kind of a group are we – a closely related team working together all days, a hierarchical organization, a group of people who work occasionally on the same issue but actually never meet, etc.?
- 7a. **Mode of operation:** Summarizing all that has been said, how can we characterize the way we are conducting our work as a whole – what is the spirit or “custom of the house”?

The following kind of questions can be used to identify the network of activities:

- 1b. **Outcome:** Who needs our services or products? For what do they need that – to produce some services or products to some others?
- 2b. **Object:** From whom do we get our “raw materials”? How do they produce what we need?
- 3b. **Actors:** Where do we come from – who educates and raises the kinds of people needed here? How does that happen?
- 4b. **Means of work:** From whom do we get the tools and knowledge we need? How do they produce that?
- 5b. **Means of coordination and communication:** Who sets the rules for us? How are the rules generated? Where do we get the means we need to communicate with each other?

In November 1999 we developed the first version of a more specific checklist applied to ISD activities, and tested it in three software companies in Lagos, Nigeria. The framework, introduced by the researchers through a couple of illustrated imaginary cases of which Figure 9 was one, was immediately understandable to the practitioners. We were able to grasp vivid pictures of the projects, practices and networks in question in a couple of hours. However, it was also obvious that the specific ISD checklist needs further improvement in interaction with practitioners working in different settings, as discussed in section 4 above (Soriyan *et al.* 2000). The case studies have been continued in 2000–2001, and the results together with an improved ISD checklist will be published later.

The answers to the questions in the checklist provide a snapshot, a static view of the activity as perceived by its actors at one specific moment. The next step is to analyze how the activity, particularly the overall mode of operation, has changed over time. Since ISD projects are temporary gatherings, the historical change as analyzed by experienced system developers will refer to a different set of projects than those referred to by experienced user representatives, even if such users are available. Another way of assessing the “progressiveness” or otherwise of the current mode of operation is to compare it with what is known through literature or personal contacts about the way other ISD projects are conducted by other actors.

For a descriptive study the data gathered through the steps so far are sufficient to portray the ISD activity in a given case, and to draw comparative conclusions over a number of cases. For a study with prescriptive, developmental ambitions or for the work development objectives of the actors themselves it is necessary to continue into jointly analyzing the “misfits”, “tensions”, “defects”, “challenges”, “conflicts” or “contradictions” within and between the various elements, the overall mode and the network relations. A future workshop or a similar technique can then be used to draft another snapshot view of the desirable improved mode, elements and network of the ISD activity in the future. The educational, technological, process-related or administrative interventions needed to proceed from the current situation to the aspired one can then be identified and implemented.

## 7. Discussion and conclusion

The main contribution of this paper is to apply some basic concepts of activity theory for analyzing information systems development as a complex work practice across an organizational boundary. The results are summarized in the analytical framework presented in Figure 8, supported by the illustrated case in Figure 9 and the checklist outlined in section 6. We suggest that the concepts, the framework and the treatment of the cases can help information systems practitioners to understand their own practice, and information systems researchers to study ISD practice in empirical settings. We argue that particularly the concept of **activity network** is useful in analyzing work practice in context, but network analysis has not received sufficient attention in previous activity-theoretical studies.

In comparison to other approaches used in studying work practice – for instance ethnomethodology and anthropology – we think that the main strength of the activity-theoretical framework is in providing a **theoretically founded** but **detailed and practicable** procedure for studying ISD as a work activity in context. The framework is not just an *ad hoc* list of issues to be looked at during the research process, but based on a long theoretical tradition. At the same time the framework, particularly when illustrated by real-life examples, is not only an abstract theory, but can be immediately applied and grasped by lay people as well. Although we have so far applied the framework in a descriptive way only, the approach has a very strong tendency for not just describing how things are, but for becoming a tool for practitioners to identify needs for improvement in their practice and to proceed into **work development**.

We argued that there is an acute need for up-to-date empirical research on how ISD is practiced in real life today. Activity theory provides an exceptionally **comprehensive** basis for understanding the human, technological, temporal and organizational aspects of work as a systemic whole. Therefore those IS researchers who are familiar with activity theory have a special responsibility to organize empirical research on ISD in different countries and different organizational settings. Our framework can be adapted to such studies. However, the checklist presented in section 6 is still in a general form applicable to any activity, and must be adapted to the specifics of ISD activities. The brief experience we have from Nigeria and Finland in applying the checklist suggests that much remains to be done before the framework and the checklist are specific and flexible enough so that for instance ISD practices can be compared across countries using the framework as a standard “minimum data set”.

The main limitation of the framework is that it is still fairly abstract. To that end, further action research is required in different kinds of full-scale IS development projects in which IS practitioners, user representatives and IS researchers jointly use the framework in analyzing and developing their ISD activity. Although an IS project is a temporary gathering, the results of developmental activity analysis can be carried over to new projects both by IS practitioners, IS users, and particularly by IS researchers through educating new practitioners.

## Acknowledgements

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