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SCIENCE DIRECT
Advanced Engineering Informatics 19 (2005) 81–92
ADVANCED ENGINEERING INFORMATICS
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Designing with ethnography: An integrative approach to CSCW design

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Abstract

This paper presents a part of wider research endeavor within the field of Computer Supported Cooperative Work (CSCW) to leverage the use of ethnography for systems design. It investigates the role of ethnography in the development of CSCW systems and its relevance to real world problems, particularly, to uncover the social organisation of work practices. The usage of ethnography to inform CSCW design constitutes many challenges to systems design. The most significant of these design challenges is the inevitable need for well-established methods for applying the ethnography within CSCW to inform systems design. We have developed an integrative approach based on ethnography and meta-modelling for use in the context of CSCW research and practice. We have also applied this approach to the analysis of cooperative work in the academic domain of investigation.

Keywords: Requirements engineering; Ethnography; Meta-Modelling

1. Introduction and motivation

In order to develop cooperative working support systems that are acceptable to users, a good understanding of how users interact must be achieved. Good design relies on thorough analysis. In this paper, we continue the theme of the Computer-based Mechanisms of Interaction in Cooperative work (COMIC) project [3]. COMIC has investigated the relationships between the social organisation of work practices and the system-development context. In fact, it has initiated a grand work that establishes a relationship and affinities between requirements engineering methods and system development. However, the COMIC has not proposed any structural framework that can be used as an effective tool for analysis and design of CSCW systems.

This paper intends to address this issue by developing an integrative environment for CSCW design. An integrative environment, in our context, is one that supports the social analysis of cooperative activities as well as their formal representation. A route to developing the integrative environment is through the connectivity between the ethnographic analysis and the system design using Meta-modelling. As we perceive, CSCW has two predominant aspects of research: 'the social', which focuses on understanding the nature of the cooperative work in order to establish a foundation for designing a system to support it, and 'the technical', which reflects the working practices of the people in the development of a system [2]. Most importantly, the problems do not lie with these strands. Ethnography is well suited to the first strand and the software engineer can develop a functional system. The problems are in the connectivity between the ethnography and the system design. This paper will serve the following objectives:

- To understand the role of ethnography in the development of CSCW systems and its relevance to real world problems.
- To explore the role of ethnography to uncover the social organisation of work practices.
- To investigate a means to present the ethnographic findings as a component of CSCW design and show how ethnographically derived knowledge of work practices can be made useful for design.
- To examine a social means of analysing the work practices in the university focusing on social and organisational aspects.
- To analyse effectively the social aspects of the work practices in a university using the state-of-the-art

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doi:10.1016/j.aei.2005.05.003

technique of ethnography. Such an analysis provides a rich and concrete portrayal of the situation and thus helps systematic design of CSCW systems.
- To use *meta-modelling* architecture in order to represent and model the findings of the ethnographic analysis.

The rest of the paper is organised as follows: Section 2 presents an overview of ethnographic research; Section 3 discusses the *meta-level* architecture that is used to bridge the gap between ethnographic analysis and system design; Section 4 presents an analysis of the cooperative activities in the University. The discussion focuses on the way people interact with each other, activities involved and the procedures to perform these activities; Section 5 closes this paper with some conclusions on the work described.

2. Ethnography in system design

It is recognised that human, social, and political factors have a significant impact on system design. The usage of ethnography has been successful in addressing this and informing system design. For example, research on 'office automation' has promoted the potential for ethnography to tackle design issues related to the social organisation of work practices. The failure of 'office automation' systems to support a group of individuals performing their usual tasks was based on inadequacy of incorporating social aspects of groups and merely focusing on functional requirements of individuals. The history of 'office automation' and also the emphasis of ethnography on 'detailed observation' of people in the work organisation have encouraged the CSCW researchers to explore the ways in which the 'work is done' in the natural settings using the state-of-the-art techniques of ethnography.

Ethnography has risen to a position of prominence within CSCW research to explore the ways people work [1,11,12]. Many researchers and practitioners have found that ethnographic analysis of work settings can provide useful insights to the work processes and settings that help system design. An ethnographic research has been carried out in the University in order to understand the needs of the people. This study enables us to develop an appropriate computer support that reflects the needs of the people in the academic environment.

In recent years, a growing number of CSCW researchers have recognised the value of ethnographic research for CSCW [1,11,12,20]. The origins of ethnography lie mainly in anthropology. It became a part of the sociological tradition through the research activities of members of the Sociology Department at the University of Chicago in the 1920 s and 1930 s. It became closely associated with Symbolic Interactionism and latterly with Ethnomethodology [3].

Ethnographers immerse themselves in the life of people they study [3]. They try to situate the phenomena studied in their social and cultural context. Ethnographic research has emerged as an important means of studying the context. The co-operative context is characterised by the activities, actors, interactions, and workflows [14]. Ethnographic research explores the ways and tasks people like to perform in the work organisation. The coordination between the related activities, the division of labour and the workflow should be analysed through ethnographic research.

Ethnographic research requires an ethnographer to spend a reasonable length of time in the organisation, which results in an extensive amount of data being generated. This provides a rich, textual and concrete exposition of the analysis of working practices. Many researchers have proposed different approaches for the presentation of research findings in a manner that can be utilised in the design of the system [23,24]. We propose that the *meta-level* concepts should be used to present the analysis of the information captured through ethnography. The advantage of this approach is that it can be used to control the extensive amount of information but still provide a 'rich' and 'concrete' portrayal of the situation, which can be used to transform and model the findings to the design of the systems.

3. Meta-level architecture

CSCW systems are developed based on concrete and well-established models and theories. Most of these models and theories have emerged from the social sciences and have an important position in CSCW design. They provide meta-level concepts that can be used in the analysis and development of CSCW systems. These meta-level concepts are based on the strengths and communality of different models and theories vis., Coordination theory [18], Activity theory [14], Action/interaction theory [9], Task Manager [16], and the Object-oriented activity support model [22]. meta-level concepts are used for the analysis and design of computer based systems due to the level of abstraction they provide. The meta-level concepts have long been used in a variety of applications, for example, reflective computing [4]. In Section 3.1, we will briefly discuss some models and theories from which meta-level concepts are extracted to be used in the architecture.

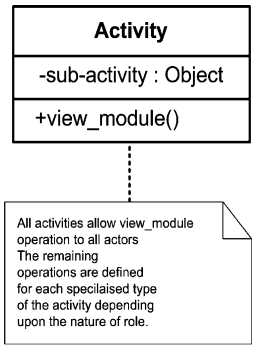
Coordination theory consists of a set of principles that manages interdependency between the activities performed to achieve a common goal [18]. The theory focuses on coordination problems such as identification of goals, the mapping of the goals to activities, the ordering of activities, the selection of actors to perform an activity, the management of interdependencies between activities and the allocation of resource for an activity [6]. Malone [18] has analysed coordination and distinguishes four components of coordination, viz. activities, goals, actors, resource and interdependencies. He recognises the following coordination features:

- Prerequisite; i.e. the output of one activity is required by the next activity. Coordination is achieved by ordering the execution of these activities.
- Common resource; i.e. a resource is required by multiple activities. Coordination is achieved through the allocation of the available resources.
- Simultaneity; two or more activities occur at the same time. Coordination is achieved via synchronisation.

Another popular theory used in cooperative work is Activity theory [17]. This theory consists of a set of concepts such as community, active subject, material object, activity, action, operations, and tool. The activity is the basic unit of analysis. The activity is realised through a series of actions. The actions are carried out through a series of operations. An activity involves a community of participants. The participants can be active or passive subjects. The theory also considers the cultural mediation of the relationship within an activity. The activity is the basic unit of analysis. Tools mediate the relationship between the active subject and the material object. Rules mediate the relationship between the active subject and the other participants. The division of labour mediates the relationship between the object and the community.

The Action/interaction theory [9] has been used to develop a CSCW environment called *WORLDS*. The theory emphasizes two aspects, action/interaction concepts and social world concepts. Task Manager [16] has been developed for the management and specification of cooperative work. It focuses on the concept of tasks. The users share a common document in order to perform their common tasks. The sharing mechanism is supported by email systems. The Object-oriented activity support model [22] provides a framework for CSCW. It involves the concepts of activity, actor, context and tool. The activity can be divided into sub-activities and actors perform these activities. The actor includes a single person, or a group of persons or even an agent.

We have used the meta-level concepts based on the above models and theories to analyse the work practices in Coventry University in order to strengthen the ethnographic approach. The meta-level concepts, which have been derived from different models and theories, have an advantage that they are independent of target applications. The representation of the concepts at meta-level is common to all applications. This level is similar to the enterprise viewpoint of the RM-ODP [7]. This provides the most abstract description of the system [6,8,15] The application concepts are derived from the abstract level according to the requirements of the application. The meta model consisting of meta-level concepts and relationships between them is shown in Fig. 1. The meta-level concepts such as activity, actor and resource are discussed below. We believe that the use of the meta level concepts bridges the gap between ethnographic analysis and systems design. In the next sections, we describe meta level concepts and then go on to show how they can be applied.



activity name **is**
attributes: properties of the activity;
components: composition expression defining sub-activity;
description of activity: [Description in free text form;]
end name

Fig. 1. Activity as a *meta-level* concept.

3.1. Description of the meta-level concepts

3.1.1. Activity

An activity is the basic unit of analysis and design [6]. It is called task in Task Manager and represents a cooperative procedure [16]. The activities have two properties; a goal and a state [8]. Activity theory, Task Manager, Action/interaction theory and the Object-oriented activity support model allow an activity to be decomposed into smaller units such as sub-activities and actions. Coordination theory, on the other hand, views an activity as an atomic concept. Activities can be tied with a relationship. The following are the examples of relationship types [15]:

- the disabling of an activity by another;
- the sequential execution of two activities;
- the synchronised execution of two activities.

The activity is depicted as a class diagram and shown in Fig. 1. This gives a brief description of the abstract level concept including its attributes and components.

3.1.2. Actor

An actor is an active entity and responsible for performing an activity. The actors may communicate with each other in order to perform the activity properly using different communication channels such as email messages, telephone line, video conferencing, and even a live channel in which the actors are co-located in the same room [8]. Thus, different actors are playing different roles, such as sender and receiver. An actor is not part of an activity but is associated with one or more activities with the intention of performing that activity [9,18,16,22]. A role and a set of coordination rules are the attributes of the coordination association class established between the actors

and activities. A role describes the part taken by an actor in an association. An actor can be involved in different activities and thus can play different roles in different activities. Coordination rules maintain the relationship between different actors performing the same activity using policies or floor control mechanisms.

Coordination theory and the Object-oriented activity support model use the concept of actor without any distinction. Action/interaction theory considers the role of actor as member and interactant. An actor has many roles in Activity theory. A human actor can be considered as a subject and a community of participants, which can be active or passive. Task Manager also offers different roles such as participant, observer and person.

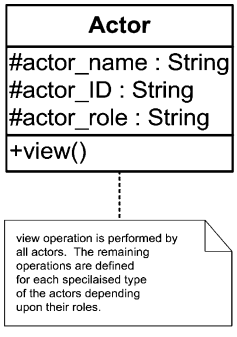
The actor, as a meta-level concept is diagrammatically shown in class diagram in Fig. 2. This gives a brief description of the abstract level concept including its attributes and available operations.

3.1.3. Object (resource)

A resource represents any kind of electronic data such as messages, documents, or database records which are used, produced or transformed by an activity [6]. The concept of information can be related to any kind of resources without any distinction between computerised and non-computerised information. Non-computerised information may include rooms, budgets, machinery [16] or even services provided by a secretary [6].

An actor can share information with other actors in order to perform activities. A concurrency control mechanism is required in order to cope with the simultaneous access to the information. In the meta-model, the concurrency association class provides a concurrency control mechanism. The class is established between the activity and the shared object [6].

The object (i.e. resource) as a meta-level concept is shown in Fig. 3 in a class diagram. This gives a brief description of the abstract level concept including its attributes, and available operations.



actor name **is**
attributes: properties of the actor;
operations: list of applicable operations;
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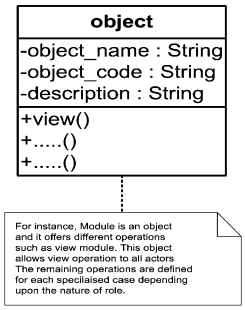
end name

Fig. 2. Actor as a *meta-level* concept.



object name **is**
attributes: properties of the object;
operations: list of applicable operations;
description of object: [Description in free text form;]
end name

Fig. 3. Object as a *meta-level* concept.

3.1.4. Service/tool

Another meta-level concept is a tool, which is also known as technology or artefact. It provides computer support for the execution of an activity. A tool represents any kind of groupware system such as co-authoring system and video conferencing system or a non-groupware system such as word processor, e-mail system and so on [6]. The meta-model represents any kind of computerised or non-computerised service. For example, a non-computerised service may include a service provided by a secretary such as typing a letter or helping in sorting out some information or a service provided by a room in conducting a meeting.

4. Cooperative work in the university

An ethnographic study has been carried out in Coventry University in order to understand the social organisation of work practices and the needs of the people. This study has been concerned with two administrative systems within the school of Mathematics and Information Sciences (MIS): the Document Management System (DMS); and the Module Assignment System (MAS). The interest of this research is to inform the system design in order to develop an appropriate computer support that reflects the needs of people running these crucial operations.

This research has gained insights into the working practices involved in the two operations. The principle methods of data collection used were in-depth interviews, questionnaires, participant observations, documents and informal social contact with the participants over an extended period of 2 years. This period not only focuses on data collection but also includes the development of the proposed approach, literature review, evaluation, and further iterations. Additionally, data is also gathered informally during coffee breaks, and organised meetings. These social gathering have produced an understanding of the work practices. Data collection focused on the roles of administrator, subject leaders and other academic

and non-academic staff (such as secretary) in the university. The important information has been extracted and described along the discussion of the MAS. The DMS has not been discussed due to space limitations. The description of DMS can be found in [15].

Throughout the research, the focus has been on the analysis of the activities like monitoring modules, revising modules, reviewing modules and assigning modules to the lecturers. During this study, different aspects have been highlighted such as, the manuals of instruction and procedures, the job description, the dependencies between the activities, the workflow, the actors involved and their roles. This also includes a review of paper-based documents such as reports, definitive module list, QAA procedures, and the constitution of the Subject Quality Group (SQG) and the Module Approval and Review Panel (MARP), etc. Some of the information is available on the university site via swift (university intranet) while the other information is available in the form of reports. As the field work lasted for more than 2 years, necessarily much data has been omitted. Piles of materials from field notes and tapes, the detail of the routine work, official and audit trial documents have all been censored from this study. However, this study has been influenced by all these resources.

Module assignment plays a central role in the academic institutes. The performance of academic staff may rely on module allocation. Therefore, module allocation may have a positive or negative impact on the performance of the academic staff depending on correct or inaccurate module assignment. The assignment operation becomes more complex if the number of subjects and the lecturers are increased or even if the number of the lecturers decreases.

An efficient coordination among the staff is central for this operation. It involves all academic staff directly or indirectly contributing towards the completion of assignment operations. For example, lecturers fill in the module preference sheets, and pass them on to the subject leaders; the subject leaders compile these sheets, and send them to the administrator. In other words, all the academic staff contribute their part in order to implement the idea of division of labour. They are engaged in cooperative activities of various sorts in the academic environment. They organise themselves and their work in order to solve their problems collectively.

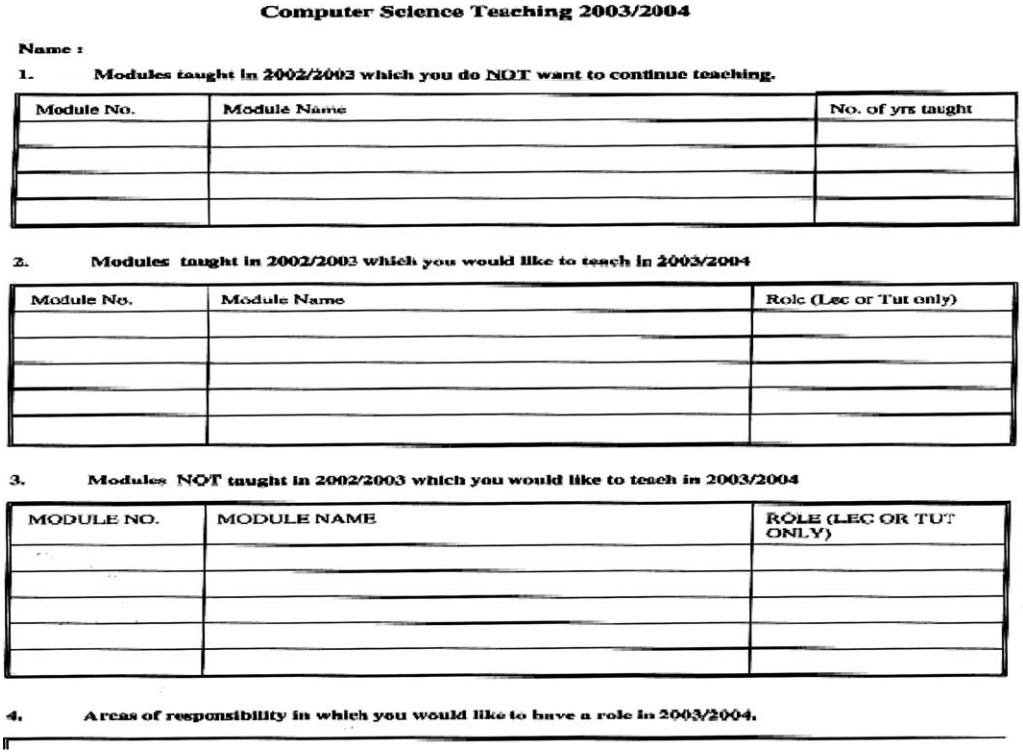
The Computer Science department in Coventry University offers about 90 modules in different subject areas such as Computer Systems, Data Modelling AND AI, Information Systems, and Software Engineering. The modules often have more than one occurrence during the year. The department has about 50 members of staff who are involved in teaching these modules to undergraduate and postgraduate students. This also includes supervision of final year and postgraduate project students. Most of the members of staff are also engaged in various administrative duties and international programs. Some members of staff are also involved in research activities such as supervision of PhD students, writing proposals for funds and so on. An increase in all these activities has direct influence on the complexity of the module assignment. The administrator has to take into account all these activities for module allocation.

MAS is a term we use to describe the activities related to module assignment or allocation. Module allocation is a general term being used by the academic staff in the university. MAS involves three main activities. These activities include retrieval of lecturers' information from different sources (Retrieve lecturer list); getting information about modules from various sources such as 'module document', 'definitive directory' and 'previous year spreadsheet' (Retrieve module list); module allocation requires 'decision making' and the assignment of different modules to the lecturers by keeping in view preferences of the lecturers (Assign module to lecturer). These activities are dependent on each other. The dependencies in these activities make a workflow for the MAS. Subsequent sections will show this workflow as a means of achieving coordination in the university. This will lead to exploring the plans and procedures and the awareness of work as part and parcel of the workflow of the MAS.

4.1. Module assignment process

Currently, a Microsoft Excel spreadsheet is used to assign modules to the lecturers. The administrator distributes a sheet of preferences to the lecturers every year. This sheet is normally issued as an official memorandum. The memorandum contains lists of subject areas covering all the modules, which the school intends to run in that particular year. It also attaches some forms, following the module list in the memorandum, asking the academic staff to list down the modules: they have taught in the previous years but they do not want to continue teaching; they have taught in the previous years and they still like to teach; they have not taught before but they would like to teach in the coming year. The next page of this memorandum invites the suggestions or any other important information, which the academic staff would like the administrator to consider when carrying out the allocation. A part of this memorandum (Pages 13 and 14) is shown in Figs. 4 and 5. The academic staff state their preferences and send them to their respective subject leaders. The subject leaders compile these sheets and send them to the administrator or take them along to the meeting.

Upon receipt of a preference sheet, the assignment operation is initiated. At this stage, coordination between the subject leaders and the administrator is very crucial for successful completion of module assignment. This leads to synchronous communication and face-to-face meetings. They conduct real time meetings and arrange discussion in order to decide 'who is going to teach what'. The administrator always chairs these meetings. Eventually they come up with an initial draft of module allocations, in



Computer Science Teaching 2003/2004

Name :

1. Modules taught in 2002/2003 which you do NOT want to continue teaching.

Module No.	Module Name	No. of yrs taught

2. Modules taught in 2002/2003 which you would like to teach in 2003/2004

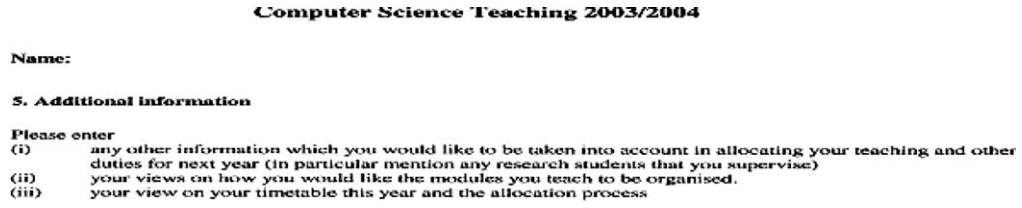
Module No.	Module Name	Role (Lec or Tut only)

3. Modules NOT taught in 2002/2003 which you would like to teach in 2003/2004

MODULE NO.	MODULE NAME	ROLE (LEC OR TUT ONLY)

4. Areas of responsibility in which you would like to have a role in 2003/2004.

Fig. 4. A memorandum Page 13.



Computer Science Teaching 2003/2004

Name:

5. Additional information

Please enter
(i) any other information which you would like to be taken into account in allocating your teaching and other duties for next year (in particular mention any research students that you supervise)
(ii) your views on how you would like the modules you teach to be organised.
(iii) your view on your timetable this year and the allocation process

Fig. 5. A memorandum Page 14.

the first one or two meetings, which is not visible to the academic staff. Normally, three to five meetings take place in order to finalise the draft. There is always sufficient gap between these consecutive meetings so that any issue if raised during this tenure could be resolved in the next draft. A final draft of module assignment is shown in Table 1.[1] This does not show calculations of the workloads and other related tasks. It only shows the name of the module, module code, number of expected students, and name of the lecturer. This identifies whether the lecturer is a module leader or assisting the module leader in teaching. It also shows the name of the 'moderator'. The moderator is a particular lecturer who does the internal moderation of the examination and coursework in the university. A complete spreadsheet, which includes different internal and external factors, criteria to measure them and the workload in hours is omitted.

[1] Fake names are used for confidentiality.

4.2. Presentation of analysis

"I suppose you can say some kind of pooling of knowledge really, pooling of information and they take all those lists away then and sometimes they email me to tell me if something is missing."

The activities and the people performing these activities require coordination for the successful completion of the module assignment operation. Clearly, the activities are performed in the university as a pattern of tasks and operations within the division of labour. For example, disintegration of activities and the assignment of roles performing these activities revolve around the idea of division of labour.

In order to make coordination more visible and intelligible, the tasks are distributed in terms of time and space as well as responsibility. In this way, the success of this operation relies on everyone making an effort towards the completion of this operation, while the administrator

Table 1
An example of module assignment (spreadsheet)

No. of students	Module	Module no.	Module lecturers (ml = module leader)	Internal moderator
300	Introduction to E-commerce	115IS	P. Baru, G. Lipu (ml), W. Fernado	L. Piadak
40	Introduction to E-commerce (s2, Wed eve)	115ISP	P. Baru, G. Lipu (ml), W. Fernado	L. Piadak
150	Applications of Computers	122CS	L. Sohail (ml), M. Olive	J. Fariaser
350	Intro. to the Internet and Multimedia	124CS	A. Scitt (ml), T. William, F. Birdgewater	G. Pickow
40	Intro. to the Internet and Multimedia (s1, Th eve)	124CSP	A. Scitt (ml), F. Birdgewater	S. Alow
50	Prof.and Study Skills in Usability (s2, Wed eve)	125IS	H. John (all)	S. Bridgewater

plays a central role in order to coordinate the activities, and make decisions, and in the overall success and quality of this operation.

The assignment activity involves collaboration among all the academic staff in general and administrative/managerial staff including subject leaders in particular. In this environment, much of the coordination work consists of distributing and collecting relevant information: from the administrator to the academic staff (the module document); from academic staff to the subject leader (module preference sheet) and from the subject leader to the administrator (a complete compiled sheet) and keeping this flow of information going as a routine state of affairs (sending the module assignment sheet to the staff and resolving any conflicts that arise). All these people as participants of a cooperative endeavor contributing towards the completion of tasks in order to 'get the assignment operation done'. These activities are strongly tied with a relationship of interdependence, which is shown in the conceptual model of MAS (see Fig. 6). This is an abstract level model developed based on meta-level concepts discussed in the previous section.

The administrator gets information on modules from different sources such as 'definitive module directory', 'module document' and last year's spreadsheet in order to finalise a list of modules. Additionally, informal information comes from the subject leaders especially for those modules, which have not yet been formally approved and documented but the subject leaders are aware of such plans. There are many iterations in this process. For example, the administrator may have to exclude those modules, which have been included earlier on provisional basis and they have been delayed or rejected later on. The final version of the module list is distributed to the academic staff to make them aware of the updated list of modules and let them decide what they want to teach.

"…we send a piece of paper around to staff—information about what module is running and what module is not running and we give the opportunity to say which module they want to teach next year and which they do not want to teach next year".

The lecturers fill in their preferences and pass this on to their respective subject leaders. Mostly, they submit their preference sheet to the subject leader during the time of their appraisal. They also discuss various issues with the subject leaders during their appraisal. They provide justification, "why they do not want to teach this module and want to teach that". During the discussion, the subject leaders are used to penning some comments on the preference sheet for their own memory and also to pass these on to the administrator. This mutual communication and coordination between the lecturer and the subject leader plays an important role in the assignment operation.

Although, most of the academic staff submit their preferences and discuss these with the subject leader, there are some who do not submit their preferences. They assume that the administrator and the subject leader should understand "what I am teaching and what I like to teach". Therefore, the subject leader has to make sure that all staff have submitted their preference sheets. An interesting point here concerning flexible means of coordination is that the academic staff feel free to submit their preferences sheet in the form of 'order' rather a request. To add the comments of the subject leader;

"I try to make sure that all my staff (Information System Group) have submitted their preference sheet as I know some people do not bother and if there is something peculiar down on it then I try to talk to them about it. Though often people come to see me and say, look, I have said I do not want to teach that and make sure I am not forced to teach it."

Thus, the subject leaders are involved in coordinating with the academic staff of their respective groups, not only simply collecting preference sheet but also listening their comments throughout the year. They are also involved in coordinating with the administrator. For example, the subject leaders compile the preference sheets and inform the administrator that they are ready to have a face-to-face discussion on module allocations. So, the major role of administrator is to monitor and coordinate the activities of the subject leaders. Coordination is achieved by means of mutual adjustments and direct supervision. The subject

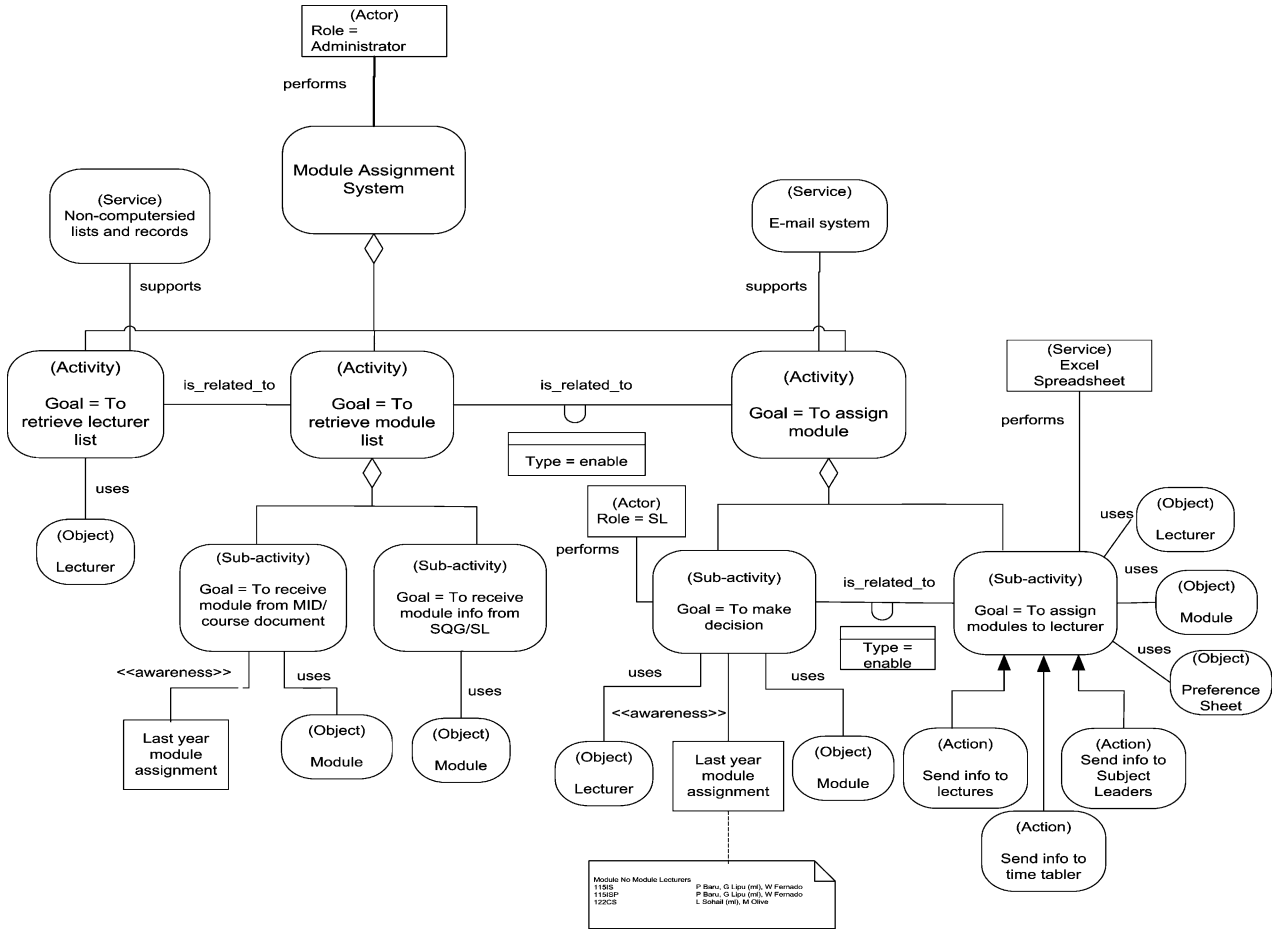


Fig. 6. A conceptual model of MAS.

leaders also assist the administrator in order to make decisions on the module assignment.

"…it is their responsibility really and I am in-charge of coordinating it."

Distributed coordination may take many forms depending on the work setting and the activities concerned. For example, another way of achieving coordination between the teaching team is to keep somebody on the module who has taught the module. This is an effective means where at least two members of academic staff can coordinate with each other through sharing their knowledge and past experience.

"We have some rules, such as we normally like to keep somebody on the module who has already taught that module."

Coordination is also visible in the sense that the tasks are systemically divided among the administrative staff and the subject leaders. The subject leaders are supposed to discuss working load and module assignment with the academic staff working in their groups.

The assignment operation requires the availability of the updated lecturers' list at the time of assignment. The information about the lecturers is known by the administrator from the previous year's list and also checked against a directory, which is maintained in the School office. New staff not appearing in the directory are identified to the administrator by school office and added to the list. In the academic environment like this people know each other and they even know who is teaching what. Sometimes, they seek help of each other in order to make their teaching more effective and efficient. The social contact with the academic staff means that the administrator knows their name as a matter of routine. In the module assignment operation, this knowledge is used to make the module allocation mechanism faster.

"…the lecturer list does not seem to be problem really, because I know all the lecturers, there are 50 of them, it is not an issue."

The assignment operation requires the updated versions of lecturer lists, the module lists, and the preferences of the lecturers. However, a major part of this operation is 'decision making' at different occasions such as the receipt

of same preference from more than one lecturer or from none of them. It requires some sort of brainstorming to find the most suitable person. An extensive discussion and brainstorming plays a central role to the 'decision making' activity. The following extract puts it more concisely.

"We go through each member of staff, we look what they are doing, we look at the preference sheet that has been submitted and we try to make allocations that we think will be appropriate. We try to bear in mind their preferences. You cannot always follow all their preferences though…"

Once the decision has been made on the assignment of the modules, the administrator sends the allocation sheet to all the academic staff including the timetabler. The timetabler acts on the receipt of this sheet. To discuss timetabling is out of the scope of this research. Most of the time, assignment operation requires some adjustments in order to meet timetabling constraints and to suit personal requests of academic staff.

Although efficient coordination and communication among people takes place in order to assign modules to the lecturers, problems emerge from different directions such as module preferences, the spreadsheet itself, decision-making, workload and so on.

4.2.1. Interdependencies between the activities

Different interdependencies can be viewed between the activities discussed above. Most of these interdependencies can be viewed in the form of sequences. This type of interdependence refers to the enabling and disabling relationship. This relationship can be considered at a higher level. For example, the activities such as retrieval of modules including preference sheets and the retrieval of lecturers enable the administrator to assign modules to the lecturers as shown in Fig. 7. In this way, the output of the first two activities is required by the third activity. The coordination process for managing interdependency requires ordering activities and moving information from one activity to the next. There is a sequence in activities and operations. Most importantly, the assignment operation is also dependent on the 'decision making' activity, which is mainly performed by the assignment team before the modules are allocated to the academic staff.

4.2.2. Plans and procedures

"…What it does not do is set a cut off point. You knew when you had more than 510 h per year teaching. That is too much and contractually you are allowed to say no. You also know from your contract that you do not have to teach more than two evenings. But those are the only two rules that apply and the teaching loads have grown every year. So, we try not to let the people be overloaded but they are increasingly loaded every year."

Clearly, plans and procedures are in action in the academic environment and provide an idealised description of the process. For example, a stepwise process involves delivering a module document to the lectures and getting back their module preference sheet, getting information about lecturers from different sources, discussing workload with the subject leader, and resolving any related conflicts.

"So, that sheet goes around first, once we have got replies we start meetings with the subject group leaders where I speak to subject group leaders to decide who is going to teach what."

The purpose of plans is to coordinate the work of different people so that separate work activities, either in parallel or serially, have a coherence in order to meet and come up with an appropriate and balanced workload sheet. In order to get an appropriate sheet, many meetings are conducted and even minor problems are resolved throughout the year. Some allocation rules are also used for the assignment of the modules to the lecturers. The rules are transparent to all the lecturers and discussed below in brief:

- Staff should normally expect to teach the same module for at least 3 years.
- When two people have shared the teaching of a module this year at least one of them should continue to teach it next year.
- Members of staff should not normally be expected to teach more than two modules which they have not taught before.
- No member of staff should be asked to teach more than two evenings a week.
- The expressed wishes of staff will form the starting point for the allocation process.
- The administrator issues a memorandum with a subject of 'Computer Science Teaching'. This memorandum contains a set of information regarding the programs, and modules for the next year and a form asking for lecturer preferences.

Sometimes, these rules are relaxed upon the discretion of academic staff. For example, a member of staff requests that

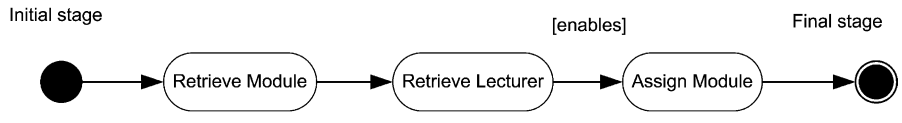


Fig. 7. An activity model of MAS with enabling relationship.

he/she has taught that module one year and really hated it due to some personal and unknown reasons or he/she might have taught a module for one or two years but now new modules come up and the administrator wants them on the new modules or they really want teach the another module. So, such exceptions can always occur in the context of the MAS. Plans and procedures are also associated to decision making in order to resolve any conflicts of allocation.

4.2.2.1. Role and responsibility. The activities described in the previous sections require different actors to perform actions on the activities. The actions differ and depend on the role played by an actor. The roles are perceived as a relationship between the activities and actors. In actuality, an actor can play one or more of the following roles and a role can be played by many actors.

- The first and the most important role in this application is that of an administrator who is allowed to view the modules and allocate these modules to lecturers. The administrator also views the preference sheet when assigning modules to the lecturers in order to see who wants to teach what.
- The second role is of a viewer who can view the module but cannot modify it. In the example, a viewer can be a lecturer who can view the modules but cannot modify them. The administrator assigns this role to the lecturer when the allocation operation is completed. The lecturers are also supposed to fill in their preference sheet and submit them to the administrator and to the subject group leader. The administrator assigns this role to the lecturer before the allocation operation starts.
- The third role is of subject leader who collects the preference sheet from the lecturer and also discusses it with them during appraisal time. The subject leader discusses these preferences with the administrator and also assists the administrator to assign modules to the lecturers.

4.2.3. Glossary of terms

A glossary of terms can be used to capture the information presented in the application domain. A glossary maintains standard terms used in the system [7]. In software engineering, an engineer uses a data dictionary or model dictionary, which is similar to glossary of terms in UML. An entity in the glossary should contain the name of the term, and its type such as actor, activity, rule or policy. It should also contain a brief description of the term. The glossary is maintained and updated as the development of the system continues. Such a glossary of terms has been developed for the MAS and is exemplified in Table 2. It defines all the terms that require clarification in order to improve communication and reduce risk of misunderstanding. In other words, it is a means of creating and maintaining a standard documentation of the concepts identified at the abstract level.

Table 2
Glossary of terms of MAS

Name	Type	Description
Administrator	Actor	The person who views the lecturer list and module list and then assign modules to lecturer. Also discuss with the subject leaders
Subject leader	Actor	The person who are responsible for discussing workloads and assignment with the administrator
Lecturer	Actor	The person who fills in preference sheet and submits to administrator and the subject leaders. The person who is assigned different modules
Module	Object	The document on which different operations are carried out by the Administrator
Retrieval of modules	Activity	Activity performed by the administrator through which updated information about modules is gathered from different sources
Retrieval of lectures	Activity	Activity performed by the administrator through which updated information about lecturers is gathered from different sources
Assignment	Activity	Activity performed by the administrator in which modules are assigned to lecturers and a decision is made on running modules

5. Evaluation

Concept based evaluation [21] has been applied to evaluate the theoretical concepts of our approach. Using this method, the applicability of the approach can be compared with the existing approaches to evaluate representation and completeness of our approach. A suitable and comparatively different approach presents a conceptual model of CSCW consisting of three complementary models: the ontological model; the coordination model and the user interface model [5,13]. On the social side, a framework for ethnography has been proposed [12] which organises discussion around three themes: distributed coordination; planned procedures and awareness of work.

The conceptual model of CSCW can be used as a tool to evaluate the proposed approach [5]. The purpose of both is to analyse and design CSCW systems. Evaluating the proposed approach in this way means that the concepts of our Meta-modelling approach should be mapped onto the CSCW model. A mapping between the approach and the conceptual model of CSCW is shown in Table 3. Some overlapping can be noticed between the mappings. Reference to the framework for ethnography [12] is also given. Mapping our approach to these other frameworks provides evidence that the approach is representative and complete.

The ontological model is a description of the objects and operations which system provides to its users. This model can directly be mapped onto the object model. For example,

Table 3
Mapping between our approach and the CSCW model

Ethnography (ethno)	Meta modelling (model)	CSCW model
Plans and procedures	Use case models, concepts models, role-activity models and glossary of terms	User interface model
Awareness of work	Object models, activity-resource models	Ontological model
Distributed coordination	Sequence/interactional models, activity models	Coordination model

MAS offers objects such as 'module', 'module list' and 'lecturer'. Example operations on the 'module' are 'assign module leader', 'assign lecturer' and 'remove from list. Example operations on the 'lecturer' are 'assign module' and 'assign role'. The administrator, subject leaders and staff may activate different operations as part of their role in the system

The coordination model is a description of the activities that the users perform and how these activities are coordinated. This model can be mapped to distributed coordination and thus can be modelled using sequence/interaction and activity models. However, the activities in the coordination model cannot be structured into smaller units. This model considers operations as sub-units of an activity but operations cannot be decomposed. The meta-model supports the structure of the activity into smaller units

The possible relationships between different classes of objects and activities is seen for example where 'construct module list' enables 'retrieve module list', which with 'retrieve lecturer list' enables for example 'request preferences', 'retrieve module', 'retrieve lecturer', 'assign module' and 'view module allocation'. There is a sequence in activities and operations. An administrator constructs a module list first, then requests preferences, then subject leaders review preferences and consult staff, then allocation is done with iteration of these activities at various points. There is dependency of sequence amongst the activities. Levels of coordination can be categorised into two i.e. activity level and object level [5,19]. An example of the activity level coordination is when activities are carried out in sequence. An example of object level is when more than one actor may perform operations on the same object simultaneously. In this case they must on the basis of mutually agreed protocols. An example of this is where administrator and subject leaders may update the module allocation list apparently simultaneously but based on agreed protocol.

The user interface model is a description of how the users interact with the system and with each other. This model can be mapped onto plans and procedures, which refer to use case models showing the interaction of the users with the systems. While the concepts models can be used to show interaction between the users. Another aspect of user interface model is that it provides the following contextual information to the users: view of information objects and local operations; view of participants; view of context. In this way, this model can also be mapped to the awareness of work, which eventually leads to object and activity resource modelling. The proposed approach maps onto existing frameworks for ethnography and CSCW and thus is considered to be representative and sufficiently complete for its role as an integrative framework

6. Conclusions and future work

In this paper, we have discussed the potential of ethnographic research in the context of CSCW development. Towards this direction, we have presented the meta-level architecture and applied it to transform and model the findings obtained through ethnographic research to the design of an administrative system in a university. Another important contribution of this paper is to bridge the gap between the output of a traditional ethnographic study and the required input to systems design through meta-modelling.

From this end, we will move on to introduce patterns in future using the meta-modelling approach. Patterns have already been introduced to software engineering and have proven to be a useful aid to system development. Applying the meta-modelling approach to some other case studies may provide sufficient knowledge of the general practices. The patterns can be produced from this generalisation. We will also apply the proposed approach to other domains in order to test its validity and applicability to different fields. Another future direction will be to investigate and develop an automatic tool, which can transform the ethnographic analysis into the design of the system such as UML notations. The tool will also help the end-users to manipulate and interact with it in order to provide requirements for the system design. A route for achieving this direction might be through the transformation of unstructured text into standard text. Thus the standard text can incorporate nouns and verbs, which can be transformed into the modelling language using the proposed tool.

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