# PROJECT MANAGEMENT ISSUES IN REMOTE CAD OUTSOURCING

Project management issues

G.L.M. AUGENBROE
Georgia Institute of Technology, College of Architecture
S.R. LOCKLEY
University of Newcastle upon Tyne, Construction Informatics,
Department of Architecture

Durability of Building Materials and Components 8. (1999) *Edited by M.A. Lacasse and D.J. Vanier*. Institute for Research in Construction, Ottawa ON, K1A 0R6, Canada, pp. 2559-2568.


## Abstract

The paper addresses the management of CAD outsourcing over Internet. Recent advances in group ware and work flow management tools have made Internet based outsourcing of CAD and GIS production an interesting and potentially viable business prospect. The proliferation of web technology has created the opportunity to distribute work to remote locations (e.g. in developing countries) and thus add to the gamut of electronic commerce opportunities. In fact, recent surveys have shown that many Architecture/Engineering (A/E) firms are already engaging in outsourcing experiments. Many of these experiments have ended in failure, mostly because of lack of proper distant management capabilities and agreed enforceable Quality Assurance (QA) procedures. As a response to 'risky' open partnership outsourcing, companies have started to establish remote affiliated offices to bilaterally manage the outsourcing of projects. This closed partnership approach is deemed less risky as it allows local implementation of established production processes and company styles of the client. The paper deals with the challenges that both types of outsourcing practices pose to the management of remote collaboration.

Keywords: CAD, Outsourcing, Remote collaboration

## 1 Introduction

The European funded project CaribCAD (Collaborative Approach to the Realisation of Internet Based CAD) project is developing the basis to turn outsourcing of CAD production intensive projects into a routine business process. The project acknowledges that outsource jobs come in many different flavours, and that there are few proven cases that can easily be generalised to work in all situations.



Present outsourcing in the A/E (Architecture and Engineering) industry ranges from the regeneration of old paper drawings in electronic formats (e.g. for optimal maintenance support, refurbishment and re-design) to the electronic storage of the built heritage for recovery, archiving and preservation. Other outsourcing opportunities exist in the input generation for GIS purposes and the preparation of renderings and VRML presentations of building designs.

CaribCAD focuses specifically on two cases, (1) the regeneration of existing paper drawings in CAD file format and (2) the support of communication needs in remote design collaboration. Both cases are demonstrated in PILOT projects, involving real life projects that are contracted between the European A/E firm (the client) and a CAD bureau in Latin America (the 'supplier' or 'CAD provider'):
Pilot 1: refurbishment of a hospital for which only paper drawings exist
Pilot 2: remote design of swimming pool and complex in Guyana

We will report on the progress of the CaribCAD project, with a focus on project management issues relating to distant collaboration, i.e. multi-social, multi-lingual, multi-time zone and multi-cultural co-operation. The challenge is to support the management of this co-operation by the right mix of group ware and workflow management techniques. The premise of the research is that the development of successful outsourcing will have to be based on an analysis of CAD production processes at both ends, eventually resulting in one single process definition shared and owned by client and supplier. Such process definitions are to be captured in formal process models, which typically contain a set of generic processes defining recurring operations in the generation, communication and revision of CAD drawings. Each particular project analysis (in an open or closed partnership contract setting) is consequently based on this set of generic sub processes with customised QA and document routing procedures built on top of them. The CaribCAD approach towards achieving these goals is explained in the following sections. Although contracting issues are recognised as very important, CaribCAD is not dealing with these issues as such, but rather providing and benchmarking the technology that could underpin outsource partnering contracts.

## 2 Requirements analysis

Many A/E firms have tried the outsourcing of CAD production work such as regeneration of CAD drawings, rendering and visualisation. It usually concerns low volume, incidental work with low demands on downstream re-use of the work delivered by the remote partner. Working relations and contracting are based on incrementally increasing work assignments. This establishes the necessary trust that the remote partner can deliver on time and achieve the required quality. This one-on-one outsourcing practice clearly has its limitations when it comes to high volume outsourcing with high quality demands. Moreover, as the business profit in outsourcing is mainly in the 'peak shaving' of CAD operator workforce fluctuation in the client's office, outsourcing becomes an inherently time critical job, which can not rely on the availability of the established and trusted supplier alone. To the contrary, large jobs will have to be outsourced to a group of suppliers simultaneously following a quick and open bidding process.

A requirements analysis (CaribCAD 1998) was done to make the needs of the outsource partners explicit. Fig. 1 shows the distinction of the two major types of outsourcing partnerships that were established in the requirements analysis.

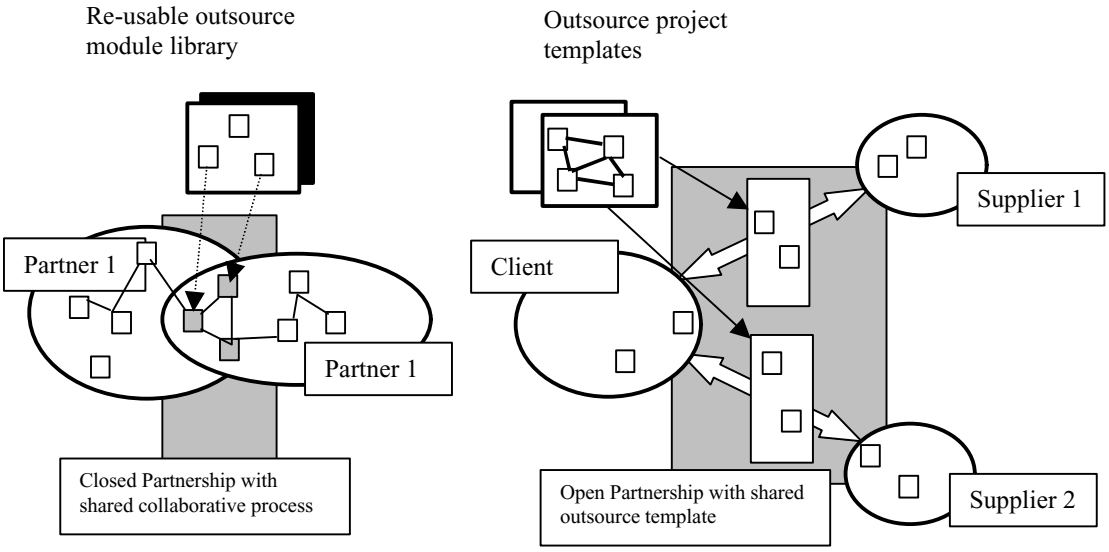


**Fig. 1 The characteristics of closed and open outsourcing partnerships**

Both types of partnerships pose distinct requirements on the type of group ware and WFM that is able to support them adequately. The production oriented open partnership stresses remote instruction, performance testing and reliable (rigid) project execution with flexible specification and enforcement of QA procedures. The collaboration oriented closed partnership stresses flexible project execution supporting autonomous actions by both partners and delegation of responsibilities between partners.

Fig. 1 (left part) shows how collaborative partnerships may be supported by a library of modules that can be re-used whenever applicable in a certain project setting. A module will typically contain task definition, work flow aspects and communication patterns for recurring 'collaboration events'. A module is spceific to the partnership and owned and maintained by the partners.

The right part of the figure shows the way in which open partnerships may be supported by template models of classes of outsource projects. The template model is not typical to the partnership but to the type of project. The requirement is that templates are defined such that they can be reused in similar projects with a different client and different suppliers.

A very important and underestimated aspect of CAD production outsourcing is the quality assurance (QA) of the generated CAD drawings. This subject is outside of the scope of this paper, but it needs to be stipulated that the generation of proper QA procedures is a major component of any re-usable module or template model. The lack thereof in present outsourcing practices has led to many failures and loss of investments. In fact, the embodiment of proper QA procedures and total quality management (TQM) in general, has formed the prime motivation for the CaribCAD initiative.

Among the general requirements of an 'outsource package', we suffice to mention that tools must operate in a collaborative group environment, allowing specification of group members, their authority and security settings, etc. All group members are connected by email, and have (permanent or dial-up) access to the Internet for file transfer and web browsing. The remote users should have minimal specialised software, typically a WEB Browser and a mail tool The tools must allow easy specification of a tailored 'project information repository' enabling all group members to have flexible access to all project documents. The repository must support versioning and setting of user permissions for browsing and editing. An adequate group ware solution must be selected to meet these requirements.

The tool set must allow the generation of a project specific central task repository that enables process building and enactment through the assignment of tasks to group members and the monitoring of execution The model underlying the 'workflow execution and support' should have a graphical representation transparent to all users.

Based upon these requirements the implementation by the CaribCAD team adopted a three layered approach to the creation of a collaborative working environment,

- Communication
- CAD file and Document Management
- Collaboration and Work Flow

For the first two layers, the strategy was adopted to create an Intranet within the Internet building upon the Microsoft Exchange Server environment. This allows each remote partner to access their group-ware environment through a simple Web browser interface using standard HTML protocols and at the same time high levels of sophisticated development at the server side. The end result is full support for mail, shared calendars, databases and tasks with no sophisticated software configuration on the client side, essential when reliable and quick deployment to new remote users is essential. The following sections will focus on the third layer.

## 3 Template models for outsource projects

It is one of the goals of the present research to develop generic models for sets of similar outsource projects. Such a generic model will serve as a 'best practice' template for a particular type of outsourcing project. CaribCAD is developing three project templates, i.e. for the two PILOTs described before and an additional one for a particular type of GIS input/analysis collaboration. In (Augenbroe and Lockley 1998) the general approach to establishing joint agreement on an outsourcing project of the Pilot1 type is explained in detail. The approach is based on a modelling effort that spans three clearly defined stages:

*a) First stage model: web enabled heuristic model*

A 'neutral' representation of the workflow and document flow capturing the procedural flows of tasks and their dependent documents. This stage of the modelling process is 'web enabled', i.e. the model is built as a web model that can be browsed by all (prospective) partners and decompositions of tasks can be traversed. An example top level model for Pilot 1 is shown in Fig. 2. The example shows the three top-level tasks:

1. Provide instruction (exchange and reach agreement on instruction set)
2. Do performance test (a designed test to ascertain worker skill level at the supply side and agree on QA procedures)
3. Conduct actual project ,starting with the negotiation of the contract, and ending with the delivery of the CAD files

The models contain all the documents that are either externally provided or generated in project tasks and routed to other tasks. Each task, decomposed subtask, and document can be inspected by traversing hyperlinks. Associations between documents and tasks can also followed. At the lowest decomposition level, atomic drawing tasks are encountered that relate to the CAD file and layer structuring that is encapsulated in the set of manuals and other instruction documents supplied by the client..

This stage of the model makes all 'communication requirements' and task dependencies explicit. The model allows each organisation to verify quickly whether the template adequately supports the type of project they seek to outsource. Furthermore, the model can be used to perform risk analyses, e.g. looking at the critical process factors such as the demands on resources, transmission speeds, expected operator skill, etc.

*b) Second stage: IDEF-0 activity model*

The second stage formalises the model into an activity and information flow diagram, reflecting the functional aspects of the project. The activity modelling language IDEF-0 is used for that purpose. IDEF-0 formalises the semantics and creates an important link between the easily accessible stage 1 models and the formal process built in stage 3.

*c) Third stage : WFModel .*

In this stage the activity model is projected on a collaborative group setting, taking all operational and dynamic issues, actors, deadlines, authorities, resource allocations, etc. into account. The WFModel defines precisely what is done, by whom and when. Fig. 2 shows the three modelling stages during the process building stage. It is important to note that in the runtime workflow environment the models of the two previous stages are accessible from within the WFModel. For instance, hyper-links can point from a particular workflow item in the WFModel to the corresponding task on a web page. This page may contain links to particular instructions and provide guidance for the group member who is assigned the work flow item. Moreover, during the execution of a project, the linked pages would be maintained to always contain up to date instructions.

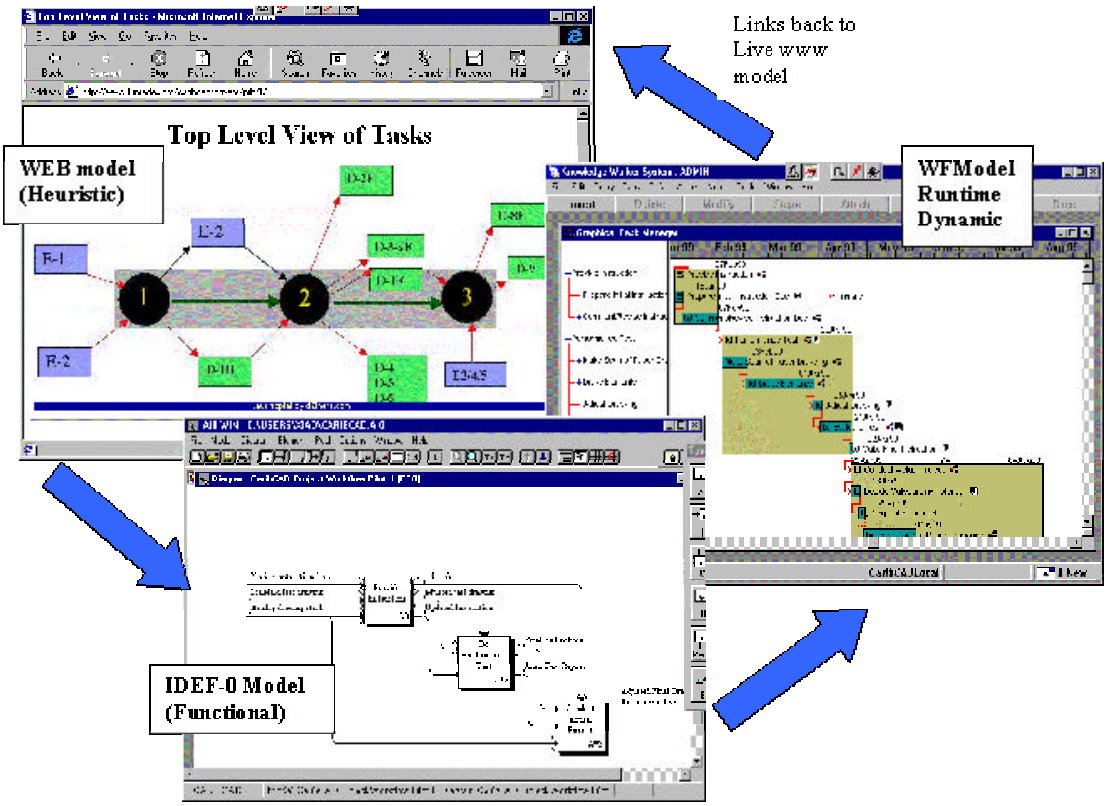


**Fig. 2: Three stage modeling strategy of outsource project: three different versions of Pilot 1 project**

The three modelling stages provide the framework for describing the sequences of tasks and protocols to work collaboratively. Without such a framework, any integration will be informal, ad-hoc and unreliable. Existing practice is for each company to have their own internal and informal workflow models and for them to agree, on a project by project basis, the interface points where information is exchanged. By the creation of template WFMs for inter-company exchange, organisations can enter into new and repeat collaborations more effectively and with improved levels of quality control.

The methodology for definition of the template models is de-facto based on the Information and Business Process perspectives identified in (Medina-Mora et al. 1992). The business process perspective is given to the Activity models by moving the focus to client satisfaction, in this case through the definition of quality assurance mechanisms and procedures.

The next section deals with the choices that have to be made in terms of most suited workflow paradigm and type of run time support in each particular case.

## 4 Workflow management issues

WFM is a basic ingredient of CSCW in general. CSCW is defined in broad terms as computer support for groups (Greif 1988), delivered through software defined as GroupWare often referred to as Workgroup Computing. There are many

flavours of CSCW and (Schäl 1996) proposes that these flavours are characterised by the degrees of "Information Sharing" and "Activity Synchronisation" they contain. He identifies three distinct forms of CSCW, "Co-operative working", "Collaboration" and "Co-decision" and sustains that the predominant technique for co-operative working is activity synchronisation and the predominant technique for "Collaboration and Co-decision" is information sharing. He further states that it is essential in the early stages of CSCW implementation to determine the appropriate flavour to adopt and identifies the specific features that are required to support these three methods of working, the following have been adopted in the implementation of the CaribCAD Pilot project environment:

Co-ordination
- Distribute and select easily messages
- Link messages into conversations
- Record and clarify messages/conversations with their status

Collaboration
- Structure information in a way that reflects how it was created
- Access information with different rights depending on members' role in process
- Support questions and answers about on-going task

Co-decision
- Share all information that is useful for a decision to be taken
- Share and make comparable the decision criteria
- Share the decisions already taken
- Manage conversations for possible clarification and orientation

Inspection of the Pilot projects indicated that Pilot 1 is more of the ‘co-operative’ working type where each participant in the process plays a role and acts in a well-planned sequence of activities to achieve an outcome. Whereas Pilot 2 is oriented more towards "Collaboration and Co-decision", whereby individuals work together and joint decisions have to be taken.

Accordingly different approaches have been adopted for the development of the CSCW environment for each pilot. Pilot 1 is synchronisation biased, where there is limited information sharing and the outsourcing partner is executing a pre-planned sequence of tasks largely initiated by the main partner. Pilot 2 is information sharing biased with limited co-ordination as each organisation is operating largely autonomously, both parties raising and responding to tasks on an ad-hoc basis as definition of the final outcome is agreed. The differences between these two pilots are highlighted in the types of workflow models that are generated.

### 4.1 Application of WFM technology

A workflow is a unit of work that happens repeatedly in an organisation, every workflow has a customer and involves the movement and tracking of people, documents, products or information. There are two distinct types of WFM technology, e-mail driven and database driven, reflecting the development from either a communication system which acquired embedded WFM or a WFM system which acquired communication support. According to (Swenson 1994) the e-mail driven

systems have several disadvantages, the email inbox is private, once mail in user inbox it cannot be moved except by the user.

Both approaches are being examined in CaribCAD through the selection of different workflow engines, Keyflow™, which is e-mail based and KWS™, which is database centric but is also able to support notification driven work flows.
Fig. 3 illustrates the overall system architecture of the Pilot 1 implementation.

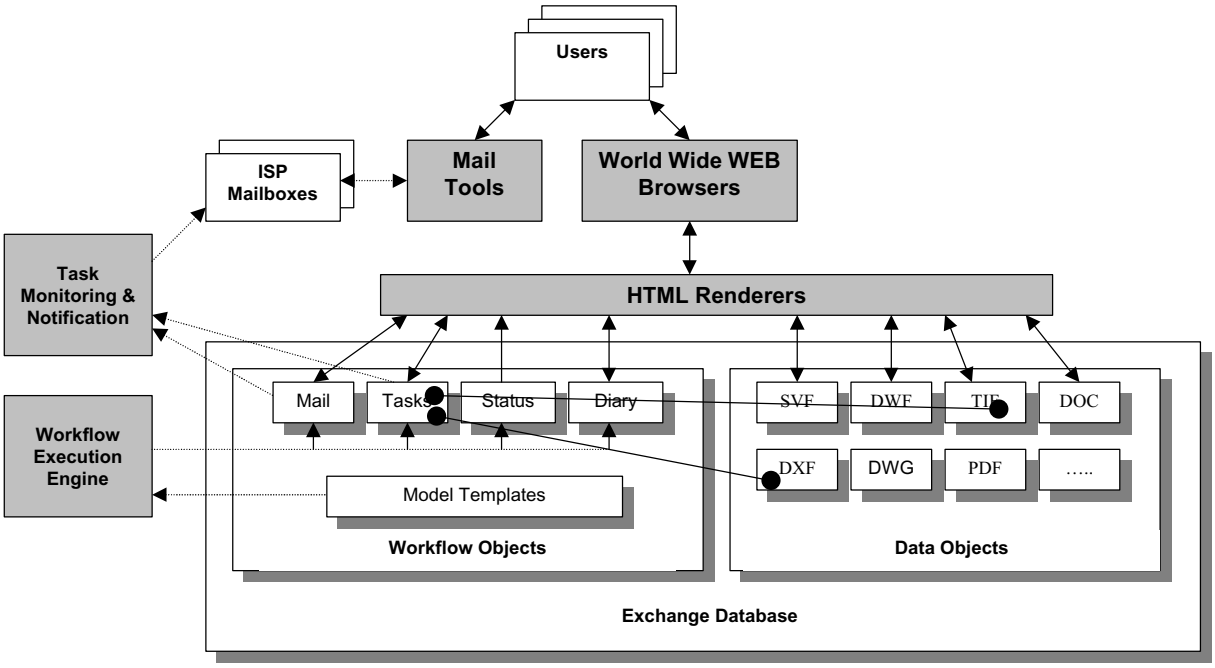


**Fig. 3 CaribCAD system architecture**

This architecture was derived from the requirements analysis discussed in section 2. It comprises a data repository built on top of the Microsoft Exchange Server which provides a storage mechanism for all objects such as documents, CAD files, tasks, mails etc. together with the relationships between these objects. The object model holding this data is based upon the Collaborative Data Objects Model and the interfaces to these objects are compliant with the MAPI standard. The following briefly describes the operation of the CaribCAD environment.

Workflow Models are developed using a graphical design tool that is embedded inside Microsoft Outlook, the output of this tool is a specially formatted e-mail message that is stored as a workflow template that can be executed many times. Fig. 4 illustrates a simple Keyflow generated workflow from Pilot 1. Each node in the workflow has a role and a time scale, together with the data required for its performance. The workflow is initialised through a WEB forms interface, which supplies the relevant data for that particular execution; roles are substituted by actual performers, CAD files and other documents are attached. Once executed the state of the flow is monitored and progressed by the WFM server, a separate application. As each node is processed, mails and tasks are placed in users task list on the server. A separate application monitors these task lists and as tasks arrive sends a notification

mail to the user's normal (local) mailbox. When a user receives a notification they use the WEB browser to access remotely the CaribCAD Pilot project server and view their tasks and associated data. These tasks are rendered on the server into HTML using Outlook WEB Access and other server side scripts. This allows quite complex information to be presented in the client's browser and limits the amount of Internet traffic required. For example, the user can browse and select through a range of CAD files, each of which may be several megabytes in size without downloading the entire file. This is achieved through server based applications which translate the graphical content of the CAD file into HTML.

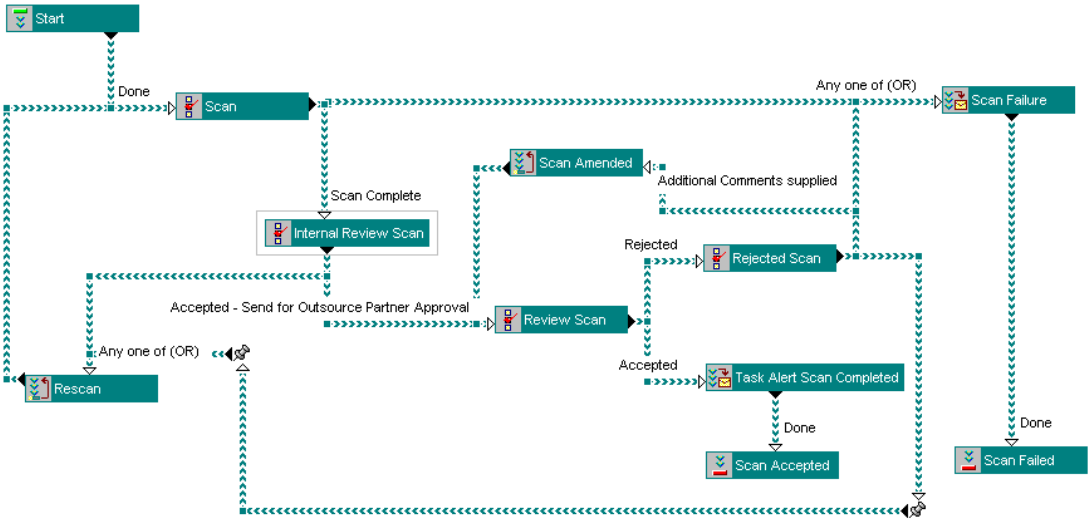


**Fig. 4 Typical workflow template**

### 4.2 Workflow modelling formalisms

Although there are now emerging software environments which are moving towards fourth generation of WFM technology as defined by (Abbot and Sarin 1994), it is clear that there are two distinct types. (Schäl 1996) defines these as "workflow systems" and "Procedure processing systems", the key difference being that the latter has no explicit and logically distinct workflow model, only a specification model.
The importance of the model has been highlighted in case studies and serves to make the execution of the workflow transparent to the participants.
At present the models for Pilot 1 are being translated from procedural models to the activity models and it is too early to determine if the message based workflow paradigm will be successful, but initial tests look promising. Analogously, the Pilot 2 models are being translated in the database centric work flow environment of KWS

## 5 Conclusions and further work

One of the ambitions of the CaribCAD project is to establish proven cases of successful CAD outsourcing and develop a CSCW outsource package for their support. Re-usable models for two significant classes of outsource projects have been developed with input from leading A/E firms. A three stage development track of the

template models has been proposed, going from (1) heuristic procedural models via (2) activity models to (3) the ultimate CSCW models that can be executed to support the work flows in an actual project. It has been shown that the different templates or project modules in different partnership settings may require different workflow paradigms and tools to support them.

The remaining work in the project will be dedicated to the benchmarking of the models in a CSCW environment with real life pilot projects. The close monitoring of the pilots will show whether the ambitions of the project to provide generic support to outsourcing can be reached.

## 6 References


Abbott, K.R., Sarin, S.K. (1994). Experiences with Workflow Management: Issues for the next generation. In Furuta, R.; Neuwirth, C.; (eds). *Proceedings of the Conference on Computer-Supported Cooperative Work.* ACM, 22-26 October, Chapel Hill, North Carolina, pp. 113-120.

Augenbroe, Godfried, and Lockley, Stephen (1998) CaribCAD: a technology to outsource CAD production work. In *Proceedings of ECPPM*, (ed. R. Amor), BRE, pp. 29-36.

CaribCAD (1998). Requirements analysis of CAD outsourcing (internal document)

Medina-Mora, R., Winograd, T. Flores, R. Flores, C.F. (1992). The Action Workflow Approach to Workflow Management Technology. In Turner, J.; Kraut, R.; (ed.). *Proceedings of the 4th Conference on Computer Supported Cooperative Work.* ACM, 31 October-4 November, Toronto, Canada, pp 281-288

Greif, I. (ed.) (1988). *Computer Supported Cooperative Work: A Book of Readings.* Morgan Kaufmann Publishers, San Mateo, California,

Schäl, T. (1996). Workflow Management Systems for Process Organisations, Springer (pp 200)

Swenson, K.D. Maxwell, R.J. Matsumoto, T. Saghari, B. Irwin, K. (1994) A business process environment supporting collaborative planning. *Collaborative Computing,* Chapman & Hall, March, 1-1, pp 15-34.

WinoGrad, T,, Flores, C.F. (1986) Understanding Computers and Cognition - a new foundation for design. Ablex Publishing Corporation, Norwood, New Jersey.