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UNIVERSITY OF KENTUCKY

ELECTRONIC WORKFLOW
ON THE
WORLD WIDE WEB:
ONE YEAR LATER

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Abstract
At the University of Kentucky, we have designed and implemented a new piece of software for streamlining administrative workflow such as requesting multilevel approval chains. At CUMREC '96, we presented the basic elements of our package which we called Stream-On-Line. The process of phasing Stream-on-Line into the real office environment has created challenges for the University staff and for the developers. In this paper, we will discuss our year long experience with Stream-on-Line and how it affects the future directions.
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Introduction
An electronic workflow system, Stream-On-Line, was developed at the University of Kentucky. We presented its initial development and implementation at last year's CUMREC'96 conference. The software was designed to eliminate cumbersome paper documents by means of electronic submissions using a standard World Wide Web browser. The data in an electronically submitted document (form) is preserved in a SyBASE database. All the comments and approval decisions are made about the form as it passes through the chain of command. In this paper, we will describe the next stage in developing Stream-On-Line. The new version increases both the functionality and simplicity of the system maintenance. Many of the designing and implementation decisions in developing the next release have been based on our experiences with the first release of Stream-On-Line. This paper gives a one-year overview of the development of an electronic workflow system. The next section describes lessons learned in implementing the system engine, and Section 3 describes our experiences with developing a specific workflow application. Finally, we will comment on the human aspect of phasing in electronic workflow, and the problems and issues arising in shifting from a traditional paper-based office to an electronic-based office.

Lessons Learned in Developing and Implementing the System Engine
Creeping featurism is a term used to describe the gradual degradation of a program's internal structure due to features continually being added after the program's initial design. The first version of Stream-On-Line was designed in a few short weeks, coded in a few months and then brought into beta testing. In beta testing, many short-comings were identified. In general, the individual users of Stream-On-Line needed more control over workflow process. For example, users needed the ability to directly send a carbon copy of a form to another user; this copy could not be submitted to the next link in the chain of approval, only copied to other users. Users also needed a way to permanently move (delegate) a form into another user's inbox. To answer this need, an elaborate form of "delegation" was set up so that users could accept and reject delegation requests. Users needed an "outbox" to store copies of their submitted forms. Form designers also needed a way to specify incomplete chains of command, where the user could specify them at the time of submission. As a whole, we found our predefined chains of command to be powerful, but too strict in nature. Form designers needed variable length chains based on
input data, as well as the ability to insert a loop into the chain of command. These large changes were in addition to hundreds of minor changes such as adding time stamps of initial and consecutive submissions and storing them with the form. These combined changes resulted in an advanced case of creeping featurism whose only cure is a complete rewriting of the code.

Learning from the first version, the new version uses an event registration system that will allow the system to handle, as of yet undetermined, events without any future need for modifying the original code. The new version will take advantage of many C++ features not utilized in the original version. This will include a class hierarchy that provides better organization and modification ability. The new system will also allow for flexible workflow manipulation. To list just a few features:

- Multiple events will be able to occur in response to the events occurring in the system, such as when an action is taken by a user. For example, when a user submits a form it will be possible for an electronic mail message to be generated as well as an ASCII file created.
- Forms will support attachments. Users will be required to specify an accurate mime-type and the form creator will be responsible for placing a field for the user to enter the mime-type within the form.
- Roles may be delegated to other users so that workflow may continue during planned absences.
- Users will be able to delegate or send copies of forms with comments to other users on the system.
- User profiles will be maintained that will automatically fill in various fields on forms.
- Forms will be able to be automatically routed to another inbox if they have not been processed within a time specified by the system administrator.
- An instance of a form in the outbox will be able to generate another instance of a form of the same kind for submission, with fields filled in.

**Lessons Learned in Developing Workflow Forms**

In our experience in developing Electronic Workflow at the University of Kentucky, we have gleaned an enormous amount of information about how organizations work and brought this information to an electronic plateau where the best of the paper-based world and the best of the electronic world meet. We have learned that a good workflow system allows for all of the flexibility that a paper system provides, yet introduces structure and organization to the process. This section elaborates on the events that have occurred over the past year as we have attempted to bring several forms into production. We have learned a great deal about workflow from this process.

**Designing a Workflow Application**

The Medical Center Physical Plant Division at the University of Kentucky performs work, as do most physical plant divisions, on a work order system. The PPD receives work orders that are submitted from all areas of the Medical Center requesting various kinds of work to be done. Everything from changing light bulbs, to replacing roofs is handled
through the same work order. Our goal in moving this paper system to an electronic system was to not compromise any of the functionality that the current system includes. After our first meeting with the PPD, we felt as if their needs were relatively simple to accomplish. They had a straight form approval process and it seemed that there were very few exceptions to the general case for the way forms were processed. We gradually realized that things were not as simple as they were initially presented to us. Many details that are obvious or transparent to people handling paper forms on a daily basis simply didn’t surface at that time.

From our first meeting we drafted an electronic work order, defined the form approval process, and wrote all the templates that would be used at each approval level. We presented the system to the PPD a few weeks later and they began to realize that their process for handling work orders has far more exceptions and the approval process has many more branches than they had originally thought. We had to restart the design process. The second attempt at moving the PPD from a paper system to an electronic system was much more interesting than the first. Many more people in PPD were involved in the process as it became known that moving to an electronic workflow system would affect a great number of people. The various members of the work order approval process were now in attendance expressing their concerns and desires. We welcomed the enthusiasm and tried to channel their energy into one complete system that would service the needs of both the users and the managers. It was clear that a solution existed, but realizing it required a greater understanding of the workflow process for all the people involved. After several meetings that included various people from the different parts of the PPD a definition (in fact, a redefinition) of the way the work orders were processed was achieved. We assimilated all of the concerns and suggestions that were expressed into a final design that not only represented the current paper system, but improved on its efficiency by rearranging the approval process so that managers were only involved in the process when they were needed. The new approval process was defined in the system. The cosmetics of the electronic forms and templates were refined to include only the information necessary for the use at each level of the approval process. The application was moved to a production site where forms could be submitted and processed. A description of the corresponding chain of workflow is given below.

<table>
<thead>
<tr>
<th>Role</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submitter</td>
<td>Begin the work order process. The submitter will list their name and department as well as the location of where the work is to be performed. A meaningful description of the work to be done is also required. The submitter should indicate if the work is maintenance, or if it is to be charged to a service contract or an account. The priority, desired completion date, and call back status should also be specified.</td>
</tr>
</tbody>
</table>
The PPD Work Order Router is responsible for getting the work order to the people who do the work. If the PPD Work Order Router knows the name of the craftsperson who should fulfill the work order, then the Router can enter that craftsperson's name in the "Assigned To" field, print out the work order, and give it to that person. If, however, the Router is unsure as to who should complete the work order, then the work order should be delegated to an appropriate shop supervisor. The shop supervisor will then fill out the form and assign it to a craftsperson. In either case, whoever fills out the form should send an email message to the submitter telling them when the work is to be completed. The person who fills out this form is responsible for the following:

1. Entering the relevant data into the system.
2. Selecting a priority for the work order.
3. Verifying if the work order is a call back, and if it is entering the original request number.
4. Verifying if the work being done is in a patient's room.
5. Assigning the work order to a shop or craftsperson.
6. Selecting a start date and time.
7. Sending email to the submitter to tell them when the work is to be completed and who they should contact if they have any questions regarding the work.

The PPD Work Order Closer is responsible for closing the work order in the system and entering information about the cost of the work.

The Shop Supervisor is responsible for reviewing the form for accuracy before it is sent to the Submitter in the form of
<table>
<thead>
<tr>
<th>Role</th>
<th>Action and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Submitter-- Sent via email</strong></td>
<td>The Submitter is given a cost estimate of the work that was done, and is requested to go to a URL to fill out an evaluation of the work performed. The feedback form would be a separate form from the work order form. It will not be listed on the Forms Menu, but will be available from a given URL.</td>
</tr>
<tr>
<td><strong>Submitter</strong></td>
<td>The Submitter goes to a URL that is sent to them via email and fills out an evaluation of the work performed.</td>
</tr>
<tr>
<td><strong>PPD Shop Supervisor</strong></td>
<td>The Shop Supervisor reviews the evaluation and makes comments.</td>
</tr>
<tr>
<td><strong>PPD Director</strong></td>
<td>The Director will see the evaluation as well as the shop supervisor's, if the Submitter selects to send a carbon copy of the evaluation form to the director.</td>
</tr>
</tbody>
</table>

Through the process of defining, developing, and implementing the PPD work order form, we learned a great deal about how organizations work and how best to deal with them. It is essential that the organization as a whole understands how their paper workflow process is performed before they attempt to move it to an electronic process. Fortunately, we were still learning the process ourselves and had the time to work with the PPD and help them to realize what their goals in an electronic process are. Redesigning and modifying forms is time consuming because of the number of templates that are used at each level of the approval process. For the new version, we should keep the same structure we have now, but include a way to consolidate templates that are used repeatedly so that when the customer requests a modification, it can be performed quickly and easily. We have realized that the flexibility and power of our system is derived from the way we define the approval process. By creating roles in the process, we have been able to accommodate scenarios that we did not even consider when we were designing the system. A flexible approval definition scheme has proved to be invaluable.

**Moving from Paper to Electronic Documents - A Medical Center Perspective**

The development of Stream-On-Line was made possible by strong support at senior levels in the Medical Center for movement away from paper and towards electronic transmission of information. The workflow product was thus part of a general attempt to move faculty, staff, and students further into the electronic world, though such mechanisms as extensive use of email for communication, electronic versions of paper publications, and the
development of informative web pages. The Medical Center has invested a significant amount of money in the last two years to wire the campus extensively. This infrastructure not only made electronic workflow possible but also provided the basis for the strong argument that electronic workflow capitalizes on the Medical Center's investment. Support for workflow at both the senior level and the user level was strong from the start because of obvious deficiencies in the flow of paper forms. Paper at the University of Kentucky moves slowly through many levels of approval, and each form is handled by many people. This is costly, slow and inefficient. Workflow provides an obvious way to speed the processing of forms, to ensure that there are fewer routing errors, and to decrease costs involved with handling paper. These were especially persuasive arguments in the case of money transfers, where business officers have a special need for transfers to be accomplished accurately and with dispatch. Support at the user level was strong in part because of fairly long experience at all levels of using email for communication in the Medical Center. It turned out to be a natural step to go from email to electronic forms. There were some benefits to electronic workflow that increased user support significantly more than we expected. With paper forms, people can only discover on whose desk a paper form is languishing by phoning a number of people to chase down the form. This causes considerable frustration and irritation. Stream-On-Line allows immediate access to information on the location of the form, and thus makes it easier to contact people with a request to speed processing or to otherwise modify a response to the form. Support at the user level was also heavily influenced by the existence of paper forms with multiple copies that need to be typed. It takes a great deal of time to type responses in specific boxes on dense forms, and an error often means that the entire form needs to be retyped. Stream-On-Line makes it easy to enter data, and so saves both time and hassle for the people most immediately affected by forms, namely those who submit them.

Summary
Developing electronic workflow applications is a challenging process. The developers are required to have accurate knowledge as to how the workflow process is to be performed. They should have a system to perform the workflow that is flexible enough to allow for the most complex approval processes, and at the same time simple enough to require little work to make modifications to an application. We believe that Stream-On-Line, brings an excellent offering to the electronic arena.