# Modeling Workflows and Work Products in a Multiple Sclerosis Clinic to Guide the Design of a New User Interface

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**Abstract**

*The following describes a work-centered design methodology that combines the strengths of contextual research, participatory design, workflow modeling, and the cognitive analysis of conceptual work products. We present an application of this method to the design of a user interface to support case management and care coordination in a multiple sclerosis specialty clinic.*

**Introduction**

Traditional approaches to designing health information technology (HIT) that are *feature-based* may fail to consider users' workflows. The resulting HIT products can have unintended negative impacts on efficiency, user satisfaction, and care quality.[1,2,3] The method of work-centered design (WCD) was developed to address problems inherent to feature-based approaches.[4,5,6] WCD extends user-centered design to include analysis of conceptual work products and modeling of the workflows that produce them. Workflow modeling is a powerful technique for understanding HIT users' work processes and for designing improvements, but this technique has not previously included the design of new user interfaces (UIs) to support those improved processes.

We applied the WCD method to develop a novel UI that supports case management for chronic disease, an expensive and rapidly growing type of care. In addition to modeling current work processes, we modeled the ontology of the product of those work processes: the *conceptual work product* (CWP). And we modeled the operations required to transform the CWP from its initial state to its goal state that must be satisfied in the workflow. The WCD methodology produced requirements for a system in which users and computing infrastructure work in concert to achieve the desired end. We describe the steps we used to understand case management workflows at a multiple sclerosis (MS) clinic, and then demonstrate the stages of analysis that guided the design of the UI.

**Method**

The subject MS clinic is part of a large VA Medical Center. We conducted 60-minute, semi-structured interviews with the clinic director, two doctors, an exam nurse, and a nurse coordinator. Each interview team consisted of a practitioner-expert, a co-principal investigator, and a graduate research assistant. We translated interview and observational data into models using a custom suite of software tools.[7] We elaborate on these models below.

**Analyses and Results**

Our initial interviews revealed that patient-centered care for MS delivered by the clinic depended critically on the work done by the nurse coordinator between each patient's visits to the clinic. The nurse coordinator's work is replete with overhead tasks associated with manually updating and monitoring disparate information resources, including: (1) a paper stack of doctors' plans to review recent visits, (2) a spreadsheet to track and prioritize follow-up care activities between visits, (3) the electronic health record, and (4) the clinics' schedules. We focused

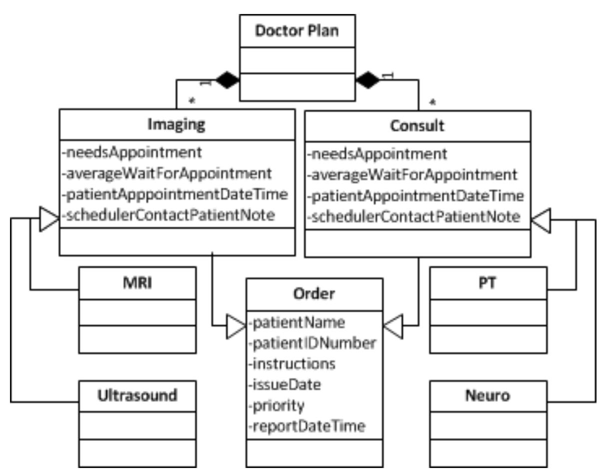


**Figure 1. Subset of the conceptual work product**

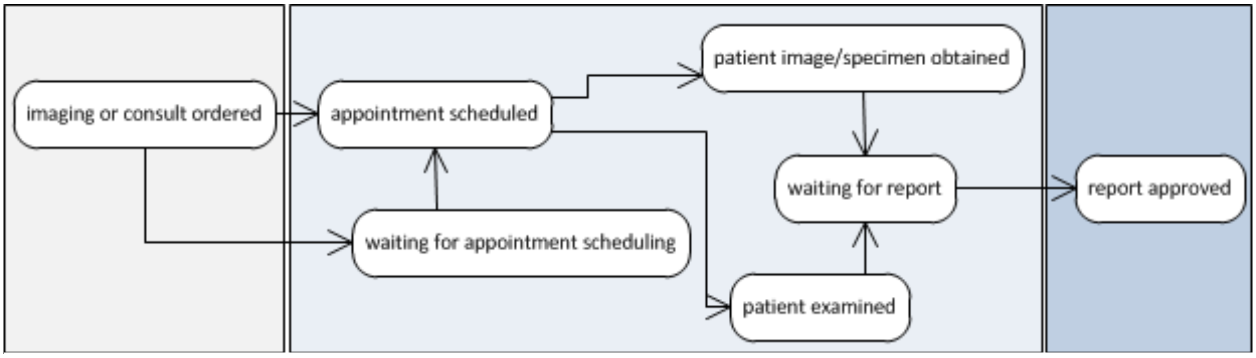


**Figure 2. Subset of states the conceptual work product can reach**

our modeling efforts on addressing these inefficiencies by integrating these disparate information resources[8] to reduce overhead and redundant tasks.

After an initial round of interviews we began modeling the clinic's workflows, incorporating work done by doctors, nurses, and scheduling staff. We conducted follow-up interviews with the nurse coordinator and those with whom she collaborated. After the workflow models stabilized we conducted a cognitive walkthrough in which the nurse coordinator confirmed the accuracy of the models. We followed this with job shadowing to further verify the model. This iterative analytical process of gathering information to refine workflow models solidified our understanding of the products of the nurse coordinator's work. We then analyzed the essence of the nurse coordinator's work products. We identified four primary CWPs: (1) preparing the patient and test results for upcoming patient exams, (2) review of doctors' plans post-visit to ensure doctor's orders were correctly entered, (3) managing timely completion of orders and expediting aging orders, and (4) problem-solving ad hoc requests from patients.

The class diagram in Figure 1 shows a subset of the nurse coordinator's CWPs. The state diagram in Figure 2 shows a subset of possible states of the CWP. This diagram is agnostic of any particular technology that could be used to implement the nurse coordinator's workflow. Together, the class diagram and state diagram provide fundamental requirements for the design of HIT to support a workflow that achieves the CWP. Because they remain abstract, these models allow consideration of a range of potential workflows that transform the CWP as required. Figure 3 shows a prototype dashboard meant to produce the four CWPs listed above. We iteratively designed UI prototypes and updated the class and state diagrams. The CWP is especially valuable in focusing the UI on the information that is of the highest value to the user.


**Figure 3. Partial view of UI for chronic care management**

## Ongoing Evaluation

As a refined version of the UI emerged we developed a new, streamlined workflow model to represent the more efficient activities the nurse coordinator will follow to achieve the CWP using the new UI. We ran discrete event simulations to compare the time spent by the nurse coordinator in the new workflow model versus the model of current care processes. All timing parameters to the simulation were equivalent for tasks that were equivalent across workflows, and other tasks' timing data were recorded from user testing or estimates from users. The simulations showed that the work-centered design workflow required 18% less time for case management work tasks than the current workflow. Based on an evaluation of the UI prototype using Kieras's extensions to KLM,[9] users will have one-click access to frequently used information, resulting in an effective, efficient, and satisfying user experience. This contrasts sharply with the current workflow, which requires processing disparate paper and electronic data sources. As of publication we are recruiting participants to conduct usability evaluations of the work-centered design UI prototype. We are also defining measures of secondary impact, such as the value of timely completion of doctors' orders and the reduction of the number of exams that begin without needed test results. The MS clinic leaders are actively engaged in developing the cost-benefit case and plans for full implementation.

**Conclusion**

Using examples from ongoing research efforts at a multiple sclerosis clinic, we demonstrated how modeling the workflow of current care established a baseline and revealed the conceptual work products of case management. Analysis of the states of the work products provided requirements that guided the design of a UI that enabled measurable gains in efficiency over the baseline workflow.

**Acknowledgements**

This project was supported by grant number R01HS021233 from the Agency for Healthcare Research and Quality. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality. This material is the result of work supported by resources from the VA Puget Sound Health Care System, Seattle, Washington.

The research with human subjects was conducted in accordance with VA IRB MIRB0553.

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