Modifiable Templates Facilitate Customization Of Physician Order Entry

Michael J. Franklin, Dean F. Sittig, Jennifer L. Schmiz, Cynthia D. Spurr, Debra Thomas, Eileen M. O’Connell, Jonathan M. Teich

Clinical Systems Research & Development
Partners Healthcare System, Boston, MA

Abstract
Physician order entry is a key factor in improving the quality of healthcare, while simultaneously reducing its cost. This paper describes an editor, a database, and a run-time system for creating and executing highly customized, user modifiable, order entry templates. The system allows non-programmers to create new order entry templates rapidly. Over the past 18 months, the templates have been used on over 2500 patients to enter over 40,000 separate orders.

INTRODUCTION
Physician order entry (POE) is one of the most important information system-based changes a healthcare institution can make to improve the quality of healthcare, while simultaneously reducing the cost (Sittig, 1998). Unfortunately, development and implementation of POE is also one of the more difficult challenges an IS department can face both for technical and sociological reasons (Sittig, 1994).

One of the most important acceptance factors for order entry is minimizing the time it takes to enter orders (Lee, 1996). In an attempt to reduce the time required for physicians to enter orders, most successful POE sites use some form of order sets. Order sets consist of a group of related orders which a physician can place with a few keystrokes or mouse clicks. Order sets may be constructed by individuals or as departmentally sanctioned standard sets; the latter are valuable in providing consistency among physicians’ orders for certain situations.

Order sets are more useful if they have some flexibility: a physician may wish to choose among several alternative orders, or to modify parameters such as dose and frequency. At Brigham and Women’s Hospital, we refer to sets of orders which can be modified by the user at order time as templates. Development of these templates requires programmers to design and manually code programs that present these specialized ordering screens. Between the inception of Physician Order Entry in May of 1993 (Teich, 1993) and the availability of Modifiable Templates in October of 1996, we developed 110 of these manually coded templates. Each required 3 - 12 weeks to design and implement by a Mumps programmer, and to test by a clinical analyst. While physicians liked these templates, the Order Entry programming staff soon fell behind the many requests; the time spent developing these detracted from the time spent adding to, or enhancing functionality for the overall order entry system.

We also found that there were special features and functions (e.g., entry of an admission diagnosis, or verifying that allergies have been checked) which commonly appeared on templates. These sometimes required weeks of effort, as each template had to be checked and modified individually.

To address these issues, we have designed an editor, a database, and a run-time system for creating and executing modifiable order entry templates. Using the editor, clinical analysts can build complex, user-modifiable order entry templates without the involvement of programming staff. While entering orders for a particular patient, clinicians can choose from a list of order sets with modifiable parameters. This paper describes the new modifiable order entry template system and our experience after 18 months of routine clinical use.

BACKGROUND
Brigham and Women's Hospital (BWH) is a 750-bed tertiary care academic medical center in Boston, Massachusetts. Computing services at BWH are provided by the Brigham Integrated
Computing System (BICS) [Teich, 1996]. BICS runs on a personal computer-based local area network; most application software is internally developed in Mumps and data are stored in a Mumps database. The Order Entry system makes extensive use of Hyper-M, a Mumps-based windowing system. Over the preceding years, various programming teams at the BWH have developed simple tools to allow clinical analysts to customize complex clinical applications (Hiltz, 1994). The work described in this paper presents one of our more ambitious efforts at tool creation.

**DESIGN CONSIDERATIONS**

There were three primary design considerations: first, that modifiable templates could have the same functionality as had been built into manually-coded templates. The same functionality was required because future templates would be at least as complex as the ones built manually.

Second, we required that all information necessary to display and run a template be contained in a database rather than in programs.

A table-driven design is the basis for modifiable templates, since it allows the template and order properties to be changed by a clinical analyst rather than by a programmer modifying software. Allowing non-programmers to create and maintain modifiable templates should greatly improve turn-around time. All special order features and functions should also be represented in the database; then they will be immediately available to all of the templates.

Third, we required that the newly created templates allow user modifiable parameters at run-time. For example, clinical analysts should be able to create a group of multiple orders from which a clinician will choose one order at run-time, set default values which can be modified (i.e., a dose for a particular medication), and various navigational aids.

**SYSTEM DESCRIPTION**

Creating a modifiable template involves several steps (see figure 1). First, the designer creates a "regular" order set containing all of the orders that the end-users may want to place. Order sets are created by first specifying a name of the

---

**Figure 1.** Diagram of the process used to develop and then run a modifiable order entry template. The process begins with a request from a clinical department to one of our clinical analysts. The clinical analyst first uses the order set builder and then the template designer to create the order set database. The clinician, using the run-time module, modifies the orders contained on the template to fit a particular patient.
order set, and then entering orders — as if one were placing orders for a patient. In some cases, the template designer may enter a question mark "?" in place of a specific parameter, such as a medication dose, or frequency. This indicates that if the end-user selects this order, the parameter with the "?" will have to be filled in at run-time (see figure 2).

Second, the designer uses the Modifiable Template Builder to manipulate the display and navigation features — for example, specifying spacing and color, whether orders are selected by default, which groups of orders are mutually exclusive, etc. This information is all stored with the order set. The run-time module reads the order set database to determine how to display orders, and what features and options are available to the end user.

The template builder also allows for special ordering functions. These include an Admission header (admit/transfer to a location, name of House Officer to be called, coded admitting diagnosis, coded condition), options to require allergy specification, an option for height/weight (no display/display only/display & edit), a default information line at the bottom of the screen, and whether orders are dependent on other orders in the set (see figure 3).

Using the template editor, the clinical analyst can modify the display of the order to include an alternative display text for an order (displayed on the template instead of the "standard" order display), whether or not the order can be deselected at run-time, and special formatting features such as spacing and color.

**CLINICAL EXPERIENCE**

The first modifiable template became available for clinical use in September 1996. Since then a total of 22 modifiable templates have been created and put into routine clinical use (see figure 4 for an example of a template). The average template contains 28 separate orders (range 7-71). Over the 18 month period, the templates have been used on over 2500 patients to enter over 40,000 separate orders (average 15.8 orders/patient). Both the number of patients for whom the templates were used and the number of orders placed using templates has increased steadily since September 1996 (from 500/month to 5000/month). In November 1997, the total number of templates available for use by clinicians increased from 12 to 19 (since this time two more templates have been created and put into routine clinical use).

The time required to create a new modifiable order entry template has been reduced from 1-3 months to 1-3 weeks. Using our new system, the
Figure 3. Screen used to modify the final "look" of the template.

Figure 4. Run-time view of the post-op aortic surgery template.
majority of the time to develop a new template is now spent by clinical analysts working with users to create the format for new templates, rather than by programming staff. This is a benefit to both the information system's department since it frees up valuable and scarce programming resources, and to clinicians since the final product more closely meets their needs.

Clinical response to the new modifiable templates has been excellent. The only noticeable change from the clinical standpoint is that the time from conceptualization to implementation of a new Order Entry template has decreased significantly. In fact, clinical analysts responsible for working with clinicians to create new templates report that clinicians now spend more time requesting changes to templates than before since the changes can be made so quickly.

Another indication of the success of the modifiable template builder is that over the past 18 months, programmers have been required to manually code only two additional templates. One of these templates was for a complicated chemotherapy regime which required functionality outside the normal scope of templates. The other was for labor and delivery and required functionality that was not available in the template builder at the time it was created. We have subsequently added a function to allow analysts to create structured free-text data entry fields. Using this feature the analyst can create simple validation rules which will be executed at run-time. For example, the data entry field may require that the user enter a number, or if the user enters a physician's name the template will automatically add the pager number.

**CONCLUSION**

One of the keys to successful implementation of physician order entry is that system developers must be able to respond rapidly to clinician requests for new features. The modifiable template builder has both enabled clinical analysts to create new templates rapidly as well as freed up programming resources to work on adding new functions to the existing system.

**Acknowledgments**

We would like to thank, Kerry S. Beliveau RN, BSN, Linda Winfield RN, BSN and Cathy Glynn RN, MSN for their support while testing and using the template builder and for suggesting many new features.

**References**


