Systematic design of healthcare processes

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In recent years, healthcare organisations have actively implemented modern approaches to the management of quality adapted from industrial practice.¹⁻⁵ Most of these efforts to improve quality have focused on incremental improvement of existing processes, or on the measurement and control of quality relative to standards. Relatively less effort has been put into the fundamental redesign of the processes of health care.

Juran⁶ points out that the design of a process sets the limit on what improvement and control is achievable. For example, consider a specialist referral process in a healthcare organisation that, by design, requires many paper forms that must be handled by several people. The inherent complexity that is designed into this process naturally limits achievable performance in time, accuracy, and coordination of care. The purpose of this paper is to show how the modern methods of process design, applied systematically, can further our existing efforts to manage and improve the quality of processes in health care.

Main concepts, definitions, and models

It is important to begin by understanding what we mean by process design, and how design compares with incremental improvement and efforts to measure quality.

CONTEXT AND GOALS

Like the methods for incremental improvement, the tools of process design or redesign are most often used by a multidisciplinary team in a defined project. (The methods described in this article might be used either to design a new process or to redesign an existing process. Therefore, I will use the term "(re)design" as a shorthand replacement for the phrase "design or redesign.") In a project to (re)design a process, the goal is to develop a new process, or completely redesign an existing process. The team fundamentally questions basic assumptions, traditions, and "the way we have always done it" thinking. This is distinctly different from an incremental improvement project in which the goal is to achieve a breakthrough in performance by making a few focused changes in an existing process.

INDUSTRIAL APPROACH TO DESIGN COMPARED WITH THE TYPICAL HEALTHCARE APPROACH

Industrial product designers use three overriding concepts in their approach to design: structured methodology, design for manufacturability, and design for reliability. The concept of structured methodology means that the design is meticulously reviewed at several points along the way to consider all the details of operation

and potential problems *before* the design is implemented. Design for manufacturability means that a design is not considered a good design unless it can be routinely manufactured by normal factory workers with standard methods and parts. The concept of design for reliability requires that designers explicitly take into account how the product will function over time and at extremes of stress in the user's environment. Realising that overly complex designs operating in stressful environments will often fail, product designers work diligently to simplify their designs.

By contrast with the rigor commonly applied in industrial design, figure 1 shows a typical design of a surgical consultation process in a primary care clinic. Although obviously oversimplified, this example is unfortunately not far from what actually occurs. The usual approach to design in health care is often at too high a level, it is assumed that the people involved will work out the details as they go along, little consideration of what might go wrong is involved, and little provision is made for the inevitable stresses that workload and urgency will place on the process. Healthcare leaders naturally expect to spend time immediately *after* the implementation of a new process, system, or service sorting out the problems. A key concept in the systematic approach to process (re)design is the suggestion that it is better to spend time *before* implementation designing away the problems so that they never occur in the first place.

MODELS

Just as there are models that guide teams seeking incremental improvements in existing processes, various authors have proposed high level road maps to guide the process (re)design.⁷⁻¹¹ Although these models differ in their details, there are common threads that run through them all.

The first step typically involves defining the scope and aim of the new process in a way that reflects the needs of the various customers that the process intends to serve. Process design models also stress the importance of involving workers and care givers directly in design; processes should not be designed by staff or managers who will never work in the processes themselves. The models typically direct these multidisciplinary design teams to begin by constructing flowcharts of an ideal process to meet the customers' needs. These flowcharts lead naturally to focused work on the internal handoffs between individual people and departments that are often the sources of breakdowns in the process. Next, the design team reviews the details of the ideal process step by step and makes plans to prevent or

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Figure 1 A typical design of a surgical consultation process for a primary care clinic.

react quickly to potential problems. Finally, the models suggest that the design team plan for the measurements and controls that are needed to assure quality.

The left side of figure 2 describes the typical steps of a process (re)design project. For comparison and contrast, the right side of the figure describes a typical model for incremental improvement. Note that both types of projects begin with definition of the issue and organisation of a team to consider it, and end with explicit monitoring to assure that performance does not degrade over time. In an incremental improvement project, however, the team first conducts a thorough analysis of the process to identify root causes of poor performance, and then develops specific changes in the process. By contrast, in a (re)design project the team first develops new ideas for the process and then analyses these to prevent potential problems. Simply put, in incremental improvement the rule of thumb is: analysis first, then develop the change in the process. In (re)design, the rule of thumb is reversed: develop the change in the process first, then analyse.

WHEN TO USE

The incremental improvement approach is best used when the current process is definable and conceptually sound, and our goal is to bring about improved performance through a minimal set of focused changes. The (re)design approach is best used when the current process is non-existent, ad hoc, very far away from the desired level of performance, or undergoing massive change due to organisational factors such as staff reductions or the introduction of new job skill classifications. We might also choose the (re)design approach simply because we desire a fundamental rethink of the way something is done.

Because (re)design can be very disruptive to current operations, we should be selective in its use. At the same time, we should also realise

that taking an incremental approach to a process that really needs fundamental rethinking can lead to wasted time and effort.

COMMON PRINCIPLES UNDERLYING ALL EFFORTS TO MANAGE QUALITY

Although incremental improvement and (re)design projects differ, both types of efforts are built on a common set of principles of quality management.¹¹ For example, both approaches focus on process and customer needs; both use a team based approach to a project; both methods are systematic, scientifically based, and disciplined; both consider multiple sources of variation rather than blaming people for the problems of a process; and both types of efforts are subject to continuous monitoring, control, and improvement in the future. (Re)design projects are, therefore, a natural extension of the incremental improvement efforts underway in many healthcare organisations today. There is no need to discard or discredit past incremental improvement efforts when introducing the methods of process (re)design.

Methods and tools to support conceptual design in process (re)design efforts

Building on our understanding of the basic concepts and models of process (re)design, I will focus on the practical tools that teams can use in (re)design projects. My review of these tools will follow the typical sequence of their use in a (re)design project, as indicated in the model depicted on the left side of figure 2. In this section, I will describe the conceptual design phase; the next section describes the problem prevention phase. To illustrate the tools, I will use the example of the surgical consultation process (fig 1). (Assume that we have completed the project definition and organisation phases of the model — that is, we have an organisational commitment to redesign this process and a multidisciplinary team to do the work.)

ANALYSIS OF CUSTOMER NEEDS

A key principle in the modern approach to quality management is that quality is ultimately judged relative to the needs of those whom we intend to serve, our customers. Therefore, our (re)design efforts naturally begin with tools that help us to develop a clear and shared understanding of the aim, or purpose, of the process from the customers' point of view.

Successful analysis of customers' needs recognises and deals with two complicating factors. Firstly, most healthcare processes have many customers. For example, our surgical consultation process intends to serve the needs of patients, their families, payers, the physician, and the surgeon. We need to take into account the needs of all of these customers as we establish the goals and aims for the design of our new process. Secondly, quality is a multidimensional concept and is dependent on the situation.¹² For example, quality in health care is a complex combination of such high level concepts as appropriateness, availability,

Figure 2 Models for process (re)design and incremental improvement projects.

continuity, effectiveness, efficacy, efficiency, respect and caring, safety, and timeliness.¹³ Further, each of these high level concepts must be defined for each customer and specific process. If we were designing processes in emergency service in a hospital, availability might mean how far a patient must travel to get to the closest emergency ward. In our surgical consultation process, availability probably means how soon the patient can be scheduled to see the surgeon.

Focus groups and surveys are among the many tools that teams can use to get customer input in defining needs.^{8,14,15} A focus group is a face to face, open ended discussion with a small, but representative, group of customers; whereas a survey is a structured questionnaire designed to get input on specific questions from many customers. Design teams typically begin with focus groups to illicit detailed descriptions of needs. Structured surveys can then be used as a follow up to determine how widely held the needs are.

Bataldin and Nolan¹⁶ have noted the importance of digging deeper and understanding what drives customers to define quality in the ways they do. For example, why is getting an appointment in a few days so important to patients in the surgical consultation process? Probing this customer need might lead us to understand that anxiety is the real driver. This insight, in turn, leads us to understand that improvements in consultation scheduling must be done in conjunction with efforts to reduce patient anxiety during the wait. We may decide that allowing an extra 10 minutes for the

patient to question the primary care physician is a more important thing to design into the new process than a complex computerised scheduling system.

Related techniques that are also helpful in analysis of customer needs are the *moment of truth method*¹⁷ and the *critical incident technique*.^{18,19} The theory behind each of these techniques is that quality is a composite of impressions that customers get at various points of contact with an organisation. For example, moments of truth in the surgical consultation process might include being informed of the need for a consultation, working with the clinic secretary to secure a convenient appointment, being informed of the appointment, finding the surgeon's office, and so on. At each of these moments of truth, the patient develops an impression about our level of care, attention to customer needs, and ability to provide service. Again, we can use focus groups and surveys to deepen our understanding about what is really important to patients at each of these moments. Similarly, other customers — such as the surgeon and primary care physician — have other moments of truth in their interactions within the process. Understanding what is important in each of these moments of truth helps us design processes which better meet everyone's needs. Gustafson and colleagues¹⁹ have applied these methods to the treatment of patients with breast cancer, and Nugent *et al*²⁰ describe their use in the context of cardiac care.

Despite the use of these tools, I must point out that analytical market research can never

fully identify all customer needs. Kano speaks of “surprising quality” — giving the customer something they had not thought of before — which delights them when they do experience it.^{21,22} Focus groups and surveys will never uncover such ideas directly; innovative thinking and experimentation is the only way.²³

STATEMENT OF AIMS OF THE NEW PROCESS

Customer needs analysis provides us with input on the needs that we should intend to serve with the new process. We now need to synthesise this input into concise guiding statements to express the overall intent of the new design. For example, an excerpt from a statement about the aim of a project to redesign patient intake in emergency services at the Brigham and Women’s Hospital in Boston, Massachusetts, USA is given below:

“The new emergency ward triage process should assign patients to treatment rooms in a timely manner and in a priority order that reflects the relative acuity of the patients in the emergency room. While in the waiting area, patients should have a sense that they are being cared for. Monitoring in the waiting area should assure detection of worsening acuity and appropriate changes in priorities....”

Note how this statement of aims balances the needs of many customers. It does not say that each individual patient will be seen immediately, although that is probably what any patient who has come for emergency services would want. Rather, reflecting the needs of the other patients and the staff in the ward, the statement of aims suggests that the new process should have a clear mechanism for assessing acuity and should use that information to establish the order of service.

The statement of aims is a critical document in a (re)design project and should be the product of several hours of work by the design team. The statement of aims quoted is merely an excerpt of a multipage document. Rohe and colleagues²⁴ present a similar multipage statement of aims for the redesign of patient care units in an acute care hospital. This document was the product of months of effort involving nearly every member of staff affected by the redesign. Such consensus building is time well spent. Diving headlong into the details of design without a good understanding of the aims is likely to leave us with an overly complex process with limited potential for performance; precisely what we have today in many cases.

FLOWCHARTS FOR IDEALISED DESIGN

With a good understanding of what we are trying to accomplish, the design team can now turn its attention to the details of the new process. The primary tool that teams use in this portion of the effort is a familiar and simple one: flowcharts.

Typically, the team begins by constructing a high level flowchart showing the three to 12 main blocks of activity in the new process. This high level flowchart should identify the main types of people involved in the process and the key handoffs between them. As in the concept of

design for reliability, we want to make our process as simple as possible; involve as few people and interfaces as possible. For example, in the high level flowchart of the surgical referral process in figure 1, we might ask why it is necessary to involve a clinic secretary in scheduling the consultation. Passing the patient to the secretary provides an opportunity for miscommunication or patient dissatisfaction; for example, the patient may think of a question but be unable to ask it because the primary care physician is now off with another patient. Can we provide a support system that would make it easy for the primary care physician to schedule the consultation while he or she is still in with the patient? A networked, computerised, scheduling system is one elaborate way to do this. Another way would be for surgeons to pre-allocate a certain number of appointment slots to each primary care physician.

When the team has completed the high level flowchart of the process, it can begin work on the details under each main block of activity. For example, suppose we decide to use the high level design concept of prearranged appointment slots. What exactly will be the process by which these slots will be established? Who needs to be involved? What support systems are needed? What should we do with unused appointment slots? In keeping with the industrial design concepts of design for manufacturability and reliability, the team should design these details for simplicity overall, and with consideration of the skills and standard supports available in typical primary care and surgical clinics.

The design team needs to develop detailed flowcharts of the processes involved in each main activity block on the high level flowchart. As a check for comprehensiveness, the team should consider four basic types of detailed processes for each main activity: patient flow, information flow, materials flow, and clinical decision making flow. The resulting design document will resemble the multiple pages of an architect’s plans for a new building. Although this will require a great deal of effort on the part of the design team, this effort is critically important if we are to design processes that work well from the moment they are implemented. Hanan⁹ notes that it took a team of eight people a total of about eight hours to work through the details of a measurably better process for paying invoices in a primary care organisation. Rohe and colleagues²⁴ involved ward staff for over a year in various details of the design of the “ideal patient care units” at the St Luke’s Episcopal Hospital in Houston, Texas, USA. The design work that led to the highly successful “one-stop neurology clinic” at the Leicester Royal Infirmary, Leicester, UK required a similar time commitment.²⁵

As a practical matter, design teams often find it necessary to secure space in a conference room where they can build their flowcharts flexibly over time by use of adhesive backed note paper, or sheets tacked to the walls. Design teams also often find that the standard one hour a week team meeting for incremental improvement projects is inadequate for design

projects. There are simply too many details to keep in mind; large portions of the one hour meeting time are taken up with simply trying to remember where we were in our deliberations when we ended the last meeting. Three to eight hour meeting blocks are more typical for successful design teams.

BENCHMARKING, DIRECTED CREATIVITY, AND ANALYSIS OF THE CURRENT PROCESS TO STIMULATE THINKING ABOUT IDEALISED DESIGN
Flowcharts document innovative ideas for process design, but simply constructing a flowchart is no guarantee that the (re)design process will be much different from past processes. Fortunately, there are tools that design teams can use to stimulate thinking that leads to innovation.

Benchmarking is the process of comparing an organisation's performance and practices with that of others.²⁶⁻³² Benchmarking studies begin with measurement to identify good performers in the topic area. Although many so called benchmarking studies stop at this measurement phase, the next step in true benchmarking is to deepen our understanding by making site visits to other organisations to understand why there are performance differences between seemingly similar processes. Knowing why something is better is the key to redesigning our own processes.

As we are specifically searching for innovative ideas beyond our usual approach, our search might go beyond geographical borders (how do they do it in Sweden or Germany?), specialty bounds (how are mental health consultations handled?), or even outside health care (what processes do estate agents use to help home buyers and sellers coordinate their needs for information from various "specialists"?). Published reports of best practices gleaned from benchmarking studies are another source of information. Gift and Mosel²⁹ described several sources of such information. Bader³⁰ reported on how healthcare organisations have used benchmarking to support service and clinical process redesign. Patrick and Alba³² described the use of benchmarking to support the redesign of clinical care processes in the multihospital Sun Health Alliance in the southeastern United States.

Directed creativity is a second set of tools that teams can use to stimulate innovative thinking in design projects.^{23 33-35} Directed creativity is the purposeful production of creative ideas in a given area, followed up by deliberate effort to implement some of those ideas. Directed creativity is based on the modern understanding of the self organising nature of the mind, which suggests that everyone is capable of creative thought.^{23 33 36-38}

The tools of directed creativity are based on three simple principles: attention, escape, and movement. For example, returning to the surgical consultation process depicted in figure 1, the design team might focus attention on the final high level step, in which the surgeon reports back to the primary care physician. We can go on to further focus attention by noting that the basic concept here is that the primary care physician needs information before seeing

the patient again, and that the current mechanism for this transfer of information involves the sending of a letter from the surgeon's office. The team can next practice mental escape through the use of a deliberate provocation: they have passed a law making it illegal for surgeons to employ people who can type and post letters! What would we do in such a situation? Remarkably, the mind is capable of mental movement that can result in a creative idea.

- Ask the surgeon to telephone the primary care physician immediately after the consultation to report the results. Unfortunately, this seems like extra work for the surgeons and would be disruptive for the primary care physicians.
- Ask the surgeon to telephone a report to a voice mail box in the primary care clinic. Secretaries in the primary care clinic will then listen to and type up these reports during slow periods of the day. The primary care clinic keeps one copy of the report to place in the patient's medical record and faxes another copy of the report to the surgeon's office for their records.

There are many tools that support directed creativity in design efforts. Plsek^{23 34 35 39} described the application of analogies, role plays, random words, and concept fans in the (re)design of several common healthcare processes.

A third way to stimulate innovative thinking in (re)design projects is to conduct a quick, but deliberate review of current processes looking for specific things that we might want to design out of the new process. For example, our surgical referral process team might produce a quick count of the number of interactions and hand-offs in the current process and then set a goal of reducing these by half. (Let's see.... The physician interacts with the patient and the clinic secretary about the need for a consultation. The secretary and patient interact. The clinic secretary must interact with the surgeon's secretary. The secretary must interact with the postal service in sending a letter informing the patient of the appointment date. The patient, on seeing that the date is inconvenient, must interact again with the secretary.... Surely, we could streamline this process.)

INTERNAL CUSTOMER SUPPLIER PLANNING

Although one of the principles of (re)design is to simplify the process by reducing the number of interactions and handoffs, there will almost always be some interaction required among people within the process. The experience gained through incremental improvement projects is that the root cause of many problems with the performance of processes can be traced back to the interfaces between people, departments, and organisations internal to the process. It is therefore important to plan for smooth interaction at these interfaces in our new process.

A key concept from quality management is the notion that processes are a series of customer supplier relations. In the case of the

referral process, it is natural to think of the patient as the overall customer of the process. But, referring again to the flowchart in figure 1, we can also think of each person at the head end of a flow arrow as a customer and each person at the tail end of a flow arrow as a supplier. For example, at the handoff between the first two steps of the process, the secretary is a customer of the primary care physician, who is in the role of a supplier of information about the specifics of the needed consultation. At some other point in the process, the secretary will become a supplier to the physician; for example, when the secretary files the surgeon's report on the patient's medical record and hands the record to the physician at the patient's next visit. In this way, everyone in the process plays a dual role of both customer and supplier to others within the process.⁸

The typical approach to planning these internal customer supplier relations in a design project is to assemble a representative group of the types of people who will play a part in the new process — the original design team, plus others. After a review of the design of the new process, each person first focuses on their needs as an internal customer and compiles a detailed list of all of the things they need from others to make their work go smoothly. For example, our clinic secretary might note that, to make the scheduling proceed flawlessly, he or she needs from the primary care physician the patient's medical record, the unambiguous name of the specific surgeon desired, a clear idea of how urgently the consultation is needed, the names of several other acceptable surgeons in case an appointment is not available, and so on. The secretary might even want to specify how this information could be best delivered to avoid miscommunication and inadvertent failure at busy times in the clinic; for example, put it on a coloured form and place the form sticking out of the patient's record in the box on the corner of my desk.

With all the internal customer requirements listed, each person is next asked to make similar lists indicating what they see themselves supplying to others in the process. Matching up the two sets of lists shows many gaps that, if left undiscussed, will become the sources of problematic handoffs in the process.

The assembled internal customers and suppliers next work in ad hoc groups in the context of the meeting to identify these gaps and negotiate specific handoff requirements. In practice, as everyone is both a customer and a supplier at different points in the process, these negotiations take on a remarkable air of practicality, reasonableness, and mutual compromise.

It is important to keep the overall aim of the process in mind during these negotiations. A process that operates smoothly from the point of view of the clinical staff might not meet the needs of the overall customer, the patient. In general, when internal customer needs seem to conflict with the overall customer needs captured in the statement of aims, the overall customers' needs should prevail (or perhaps we can use directed creativity to find a unique way to serve both sets of needs).

Controversial handoffs may require several follow up meetings with larger groups before they are finalised. Time spent building consensus will save time in finger pointing and problem solving after implementation. Hanan⁹ described using structured input collection forms and regular staff meetings to aid internal customer-supplier planning in her organisation's invoice payment design project. Sullivan and Frentzel⁴⁰ similarly underlined the importance of having provided time for everyone to have their say in a design project involving the transport of patients at the Massachusetts General Hospital, a large medical centre in Boston, USA.

We have now reviewed the typical tools and techniques used in the conceptual design phase of the model depicted on the left side of figure 2. At this point, the team should have a defined and well documented process, with requirements at each handoff that have been mutually agreed.

Conceptual design is, by nature, a chaotic and messy process. Teams rarely proceed sequentially and smoothly through the design. We may need to recompose the design team several times as roles are designed out of and into the process. Insights gained from a benchmarking visit might cause us to completely scrap entire segments of the detailed flowcharts that we have so meticulously constructed for the new process. Detailed discussions among internal customers and suppliers might show that the sequence of events depicted in a flowchart is simply not possible. Good design is hard thinking work that typically requires many person-hours of effort and the iterative use of a variety of tools.

Methods and tools to prevent problems in process (re)design

After all of the effort required to get a good conceptual design on paper, it is tempting to rush quickly on to implementation. The model of process (re)design in figure 2 cautions against this by explicitly calling for a problem prevention phase. In this phase, the team will go through the process at least once looking for things that could go wrong, and then go on to develop the prevention and control mechanisms needed to assure smooth operations.

FAILURE MODE AND EFFECTS ANALYSIS (FMEA)
A failure mode and effects analysis (FMEA) table is an essential tool in the phase of problem prevention in a design effort. The objective of an FMEA exercise is to force the team to take a comprehensive and systematic look at the new process, identify potential causes of failure, and prioritise these by likelihood of occurrence and severity of impact.^{41 42}

A typical FMEA table has six columns (fig 3). In the first three columns we list potential failure modes and their causes for each step in our new process (as defined by the detailed flowcharts from the conceptual design phase of the project). The potential failure modes and their causes come from the past experiences and intuitions of the team members. In the

Process step	Potential failure mode	Possible causes	Likelihood	Severity	Overall effect

Figure 3 A schematic outline of an FMEA table.

fourth and fifth columns, the team estimates the likelihood and severity of each failure mode and cause; typically with a scale of 1 to 5, where 1 is low and 5 is high. Again, the basis for these scores might be past experience, data if available, or simple intuition. To avoid becoming bogged down in details and to assure a balanced review of the entire processes, teams usually set time limits — such as three minutes of discussion for each step in the process. Even so, it is not uncommon to document dozens of potential failure modes in even the most carefully designed process.

With limited resources, it will be impossible to prevent every possible failure mode; the team must set some priorities. The final column in the FMEA table is the key to this priority setting. The final column contains the estimate of the overall effect formed by simply multiplying the likelihood and severity scores in the preceding two columns. Items that are highly likely to occur and have severe impact get high overall scores; $5 \times 5 = 25$. The team will want to consider these failure modes. How far down the list of scores we go is a judgment made by the design team and the leadership group that commissioned it, based on available time and resources. In practice, items scoring 15 or higher (combinations of 3×5 , 4×4 , 4×5 , and 5×5 from the likelihood and severity columns) typically demand some attention.

The emergency services redesign team at the Brigham and Women's Hospital, whose statement of aims I introduced earlier, used an FMEA table to highlight several potentially serious failure modes such as those that occur when foreign speaking people attempt to use the service. Hanan⁹ reports that her invoice payment team used FMEA to uncover the fact that, for security reasons, only one person had ever been trained in the proper operation of the cheque printing machine. When that person was unavailable, serious delays or uncashable cheques could result.

PROBLEM PREVENTION CONCEPTS

Having identified the causes and problems with the highest overall scores in the FMEA table, the team must now look for ways to prevent, minimise, or plan around them. Some common strategies for accomplishing this are listed, in order of desirability.

- **Error proof design** — Make it literally impossible for the cause to occur or for the problem it generates to propagate further down the process. For example, we might design our computerised scheduling system

with screens that will not close unless all necessary fields of information are entered.

- **Robust design** — The process is designed to accept wide variability in some factors without degradation of performance—it is immune to the causes. The emergency ward triage team at the Brigham and Women's Hospital designed multilingual forms with simple tick boxes for patients who do not speak English. By comparing the location of the ticked boxes with that on the English language form, the nurses could establish some communication with the patient even while they awaited the arrival of a translator.
- **Self control design** — Give the people in the process the feedback system needed to detect the presence of the cause and fully empower them to take immediate action as part of their normal job responsibilities.

These strategies are generally the most effective and least costly approaches. The next three strategies are less desirable, but they may be the only alternatives in some situations. These strategies do not prevent the cause of the problem, but they do seek to minimise the severity of its impact.

- **Redundant design** — Provide back up systems and procedures that allow the process to continue in the event of a breakdown in the normal system or procedure. For example, provide access to a data base that contains information that might be missing from a form.
- **Design of inspection** — Add checking steps to the process, and define specific inspection standards, with the goal of detecting the problem at the earliest possible point in the process. In our consultation process, we might want to check the medical records of our patients in the primary care clinic who should have been seen by a surgeon to assure that the consultation occurred and we have the results.
- **Design of rework** — Add specific steps for rework in the process, with defined responsibilities for data collection and action, and with the goal of making rework as fast, infrequent, and inexpensive as possible.

Regardless of the approach taken on a specific item, the goal is to have a clear plan for dealing with the predictable failure modes of the process. Of course, new failure modes might spring up unexpectedly and unlikely modes of failure might occur more often than we expected. We will not achieve absolute perfection in our process design. However, with simple tools and a disciplined approach, we can routinely get much closer to perfection than we have in the past.

PLANNING FOR MEASUREMENT AND CONTROL

The best time to establish the measurements and controls that we will need for the daily management of the new process is when the design is still on paper. Although the design of the control system is only explicitly mentioned late in the model in figure 2, it is something that we have been implicitly considering from the beginning of our design effort. The customer based statement of aims describes many of the key variables that we

should measure to assess the overall performance of the process. Log books, electronics forms, and other such data capturing mechanisms will naturally occur as the team makes flowcharts of the new process. The internal customer-supplier requirements are another source of topics for measurement and control. The FMEA table gives us a ready made list of failure modes to watch for and our prevention activities may have included the establishment of specific checks and controls on the process. So, at this late step in the project, the team's efforts are mainly those of compiling the measurements and controls that are already built into the process, and checking for comprehensiveness.

Juran⁴³ points out that there is more to control than simply measuring. Process control requires a clear understanding of what is supposed to happen and deliberate reaction when conditions change. To maintain on going control, therefore, the design team must plan for the training of both the existing and future personnel working in the process. Importantly, this need not mean formal training classes. Explanatory text on the back of the new forms used in the process, or help screens designed into the new computer system, can provide quick on the job answers to the "what am I supposed to do?" question for future personnel. Further, the design team needs to plan for the natural evolution of the process as conditions change. This might be as simple as indicating who is in charge — that is, designating a "process owner." On the other hand, processes that span many traditional departments, organisations, or geographical locations may require a more elaborate system of operational planning, shared governance committees,⁴⁴⁻⁴⁷ or self directed work teams.⁴⁸⁻⁴⁹

ISSUES OF IMPLEMENTATION

After completion of conceptual design and activities to prevent problems, the team comes finally to implementation and the potential issues of resistance to change. Studies of efforts to change indicate that it is not so much that people resist change, but more that *they resist being changed by someone or something outside their control*. If the design team has taken steps to involve people all along in the (re)design effort, implementation will simply be a logical, albeit hard, next step. If they have not adequately involved people, they should prepare for the most frustrating experience of their lives!

Hammer and Stanton⁵⁰ asserted that resistance to change is natural and inevitable. The advocates of change should expect it, find it, understand it, confront it, and manage it. I find a simple, four element model that I first learned from Dr David Gustafson at the University of Wisconsin to be a great aid in planning for this human side of change. Gustafson asserts that advocates of change must consider four issues:

- *Creating tension for change* — How will we convince others that there is truly a need for the change?

- *Identifying an effective alternative* — How will we convince others that the new way is better?
- *Providing social support* — What will we do to avoid the inevitable feeling of "I'm all alone in making this change"?
- *Developing self efficacy skills* — How will those who must make the change learn to make the new way work?

Considering these questions leads us naturally to consider such things as small scale pilots of the new process, formation of implementation teams, establishment of forums for discussion and hot lines for complaints and issues, and so on. Wise design teams think carefully about the use of such mechanisms and target opinion leaders for special communications and visible roles in the change effort.

Various experts in the management of change point out the central role of communication in successful change efforts.⁵⁰⁻⁵² The main point to remember is this: overcommunicate. Kotter⁵¹ asserts that most organisations undercommunicate new ideas by a factor of 10. Hammer and Stanton⁵⁰ suggest the rule of seven times seven: "The same thing must be communicated seven times in seven different ways before anyone will believe it." My own rule of thumb is that you are ready to implement the change only when people interrupt you in the middle of your explanation of the new process and say with some exasperation, "Enough already, we have heard about this... when are we going to get on with it!"

Publications on re-engineering, innovation management, and change management are filled with other useful advice applicable to the implementation of new designs for processes.^{23 50 52-54} Hanan⁹ reported that whereas the implementation of her design team's new process took twice as long as initially planned, managers were so impressed with the thoroughness of the team's work and the lack of problems after implementation that they thought it was time well spent.

Conclusions

We have seen that there are various methods and tools to support a more systematic approach to the design and redesign of healthcare processes. These tools are not conceptually difficult to grasp. The main challenge is committing the time needed to use them and rejecting the old way of "just implement it, we will work out the bugs later." The problem with this old way is that there never seems to be the time to truly work out the bugs once the process is implemented. Further, after the implementation, improvement efforts get clouded by finger pointing and the pressure of trying to change the process while it is in daily operation.

We must not, however, become bound by technique, continually using the tools but never really getting on with the work that needs to be done. Organisations and individual teams should use good judgment in applying these techniques in a time conscious manner. We

cannot speak to every external and internal customer to understand their needs, nor can we prevent every potential mode of failure. Practically speaking, organisational leaders and teams should set reasonable deadlines for the design process, while allowing some flexibility. Then simply move on when it is time to move on. The main point to keep in mind is that any rigor that we can apply to process design is likely to be more rigorous than was previously applied. Our new processes will not be perfect, but they will be better.

The need for (re)design of processes is acute in health care today. Although the urgency certainly differs from organisation to organisation and country to country, all healthcare organisations are feeling the pressure to do more with fewer resources. Although we might be able to cope for a while by eliminating slack and simply asking people to work harder, in the long run we cannot keep up unless we actually rethink the way work is done. Many organisations are coming to realise this. However, if we redesign work with the same, relatively haphazard, approaches we have used in the past, we may end up with processes that are different, but not really better than those we currently have. It is an opportune time now for healthcare organisations to build on their past quality management efforts by adding to their tool kits these methods for systematic design of processes.

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