

# The Master Schedule

*How Cognitive Artifacts Affect Distributed Cognition in Acute Care*

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**Dissertation Abstract:** Much of the cognitive activity in complex, high hazard, high tempo work settings such as air traffic control and military operational commands is directed toward anticipation of future requirements, deadlock prediction, reaction to evolving situations, and resource reallocation. These complex cognitive activities are difficult to study because they involve both deep domain knowledge and a detailed understanding of the myriad local details and contingencies that offer opportunities for action and constrain those opportunities. Cognitive artifacts such as schedules and status boards help to manage such knowledge, making cognitive activities more robust. The study of artifacts reveals how cognitive activities are accomplished and also shows their strengths and vulnerabilities. This research explored the creation and use of a set of cognitive artifacts in a major urban teaching hospital's surgical operating room unit through laboratory studies and field studies. The laboratory studies examined the factors that shape the anesthesia assignment schedule by tracing protocols of coordinators as they planned the next day's anesthesia staff assignments to meet heterogeneous demands for care. The field studies showed how the schedule makes possible and supports the cognitive activities of the workers in the operating room unit. Applications of information technology to support complex technical work often convert pen-and-paper cognitive artifacts into computerized replicas. The success of these applications depends on producing artifacts that are suited to users' cognitive activities. Detailed study of the creation and use of cognitive artifacts can inform the creation of computer-based artifacts. Prior studies of cognitive artifacts have focused primarily on how they function as representations of the current state of a process. This research explores how the assignment schedule reflects the deliberate anticipation of the kinds of situations that can occur. It depicts the schedule as a dynamic artifact that is carefully created to embody the variety of constraints and concerns that play out during the workday. It demonstrates that the schedule artifact encodes an assignment plan that foresees opportunities, potential challenges, and uncertainties in the day ahead. It also broadens and clarifies the functions of cognitive artifacts and the details of representation that make those functions possible.

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Section (in bold) of the author's 2003 doctoral dissertation in human factors/ergonomics

Preface

Chapter One: Acute Health Care and Patient Safety

Chapter Two: Research in Acute Care Cognition

Chapter Three: The Evolution of "Medical Error"

Chapter Four: Distributing Cognition

Chapter Five: Making Cognitive Artifacts

Chapter Six: Summary and Prospects

**Bibliography**

**Appendix: Analogies, Case Studies, Schemata Analyses**

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# Appendix

The following items are provided as data and additions to the manuscript.

- Analogies with Other High Hazard Sectors
- Case Studies (10)
- Analyses of Anesthesia Coordinator Schedule Development (3)

## Analogies with Other High Hazard Sectors

It is attractive to compare surgical and critical care with other sectors that deal with high hazards and high stakes. Such comparisons are often taken as literal truth instead of ways to gain insight. Does the OR surgical team look like a cockpit crew? Surely crew resource management (CRM) can be used to train better health care teams? Perhaps not.

There are a few comparisons that can shed light on surgical and critical care. I offer a few here from aviation and my own experience in the wake of a 30-year career as an active duty and reserve officer on the U.S. Navy.

### Aviation

It has been popular recently to liken health care to aviation, another high-risk sector. Aviation and health care both involve sophisticated use of technology and can cause significant loss when adverse events occur. However, aviation involves systems that are in operation (otherwise they are down, and in maintenance). By contrast, health care work is always on broken systems (the patients). Patient anatomies and responses to treatment vary widely and are not predictable. For that reason, healthcare has developed work patterns that deal with the extraordinary in ordinary ways.

### U.S. Navy

A U.S. Navy ship that is underway provides a helpful analogy to understand the nature of the surgical and critical care unit. In the U.S. Navy, elaborate planning over a year or more anticipates requirements. This happens far enough in advance so that each ship is appropriately provisioned, fueled and outfitted with appropriate current equipment that is in good repair. It is manned with sufficient officers and crewmembers who have already

had extensive training in general shipboard activities. Midshipmen receive training underway and enlisted crewmembers get on the job training. Most have significant advanced training and experience in specific job skills and have received briefings on their mission what to expect. The command structure is hierarchical from the Commanding Officer through the Executive Officer to department heads, division officers, and non-commissioned petty officers to junior enlisted personnel. Watches are established in multiple departments: weapons (Sonar), engineering (propulsion and electrical power, after steering), operations (Combat Information Center, Radio) and the bridge (Conning Officer, Navigator, Officer of the Deck, lookouts and signal bridge). Ships often operate in groups such as task units or groups in order to accomplish a mission. Specialty teams may also be embarked to provide skills that the normal ship's crew does not have. All procedures are based on Navy-wide regulations, the Shipboard Organization and Regulation Manual (SORM), watch bills and individual initiative. A regular series of watches and procedures are employed to monitor and report on the condition of the ship and crew. Results are recorded in logs and reported to the Officer of the Deck. Activities such as training, laundry, maintenance, repair and food preparation occur routinely. Training is nearly continuous as the officers and crew routinely perform drills in a range of skills including fire fighting, ship handling, communication, damage control, engineering, weapons employment, and defense. Occasionally an issue may be so significant that the command will "stand down" (suspend routine operations) in order to ensure that all hands receive special training. Occasional procedures such as entering and leaving port, replenishment, flight quarters and refueling require special evolutions that modify normal operations. Emergency procedures and casualties to the ship or crew

such as flood, fire and combat bring the ship to general quarters. The continual presence of ordnance, fuel oil, and other hazards means that even routine operations always run the risk of an emergency.

Health care departments such as Anesthesia and Critical Care (DACC) function in ways that are similar to a Navy ship. Elaborate planning anticipates patient and procedure requirements far enough in advance so that each operating room is appropriately prepared and outfitted with the correct supplies and current equipment that is in good repair.

Health care staff members have received extensive training in general medicine as well as years in their own specialty area. Teaching hospitals have a cadre of residents who are in training. Daily cycles of lab tests and preoperative evaluations report on the readiness of patients to undergo procedures. The unit operates on shifts, starting labs at 0400, rounds at 0600, procedures at 0730. Most of the procedures conclude by 1500. The PM shift continues until roughly 1900. Overnight (call) rotation covers patient needs in the ICU and patient floors until 0600 the next morning.

Some specialty operating rooms and teams that are dedicated to perform neurology, transplants, pediatric, or cardiologic procedures go on independent of the other cases on the unit. During the procedures, nursing and anesthesiology coordinators monitor their progress and duration to ensure an optimal balance among unit resources and demand. Coordinators ensure that others who are responsible have correctly staged equipment in the correct location for use when needed.

Operations are performed according to individual initiative of the physician, informed by the practice guidelines of the hospital and each professional organization (e.g., the American College of Obstetrics and Gynecology). Emergencies such as time-critical

transplants, emergency cardiac surgery and accident victims frequently cause changes to staff, equipment and rooms in order to minimize trauma and save lives. The continual presence of gasses, biohazards, wound-causing instruments and other hazards means that even routine activities can be dangerous.

In addition to the similarities, there are also interesting differences between the Navy ship and health care. In acute care, departmental watches are maintained at various places in the flow of patients: upstream (in pre-operative care and on the floors), downstream (post-operative care) and by the nurse and anesthesiology coordinators. Plans for each day are contingent on a wide variety of factors (including personal staff preferences) that can change at any time. A wide variety of independently operating individuals attempt to influence the schedule to their benefit. Review of the schedule and OR board and conversations with colleagues enable staff to understand what is ahead for the work shift. The surgeon is responsible for each procedure, assisted by an anesthesiologist, OR nursing staff and residents. There is no central figure who acts in the role of commanding officer. Physicians often ignore clinical guidelines in favor of using best-informed judgment. Patients vary widely in their availability, illness, anatomy, cooperation and response to treatment.

Emergencies can only be managed by one OR team and that team must be qualified to perform the required procedure. The variety in patient load and kinds of procedures that are needed continually presses the critical care unit to perform at its limits.

There is no opportunity to “stand down” for training. Every day is a day at high op tempo.

## Case Studies

The following case studies were developed during the period of 1 June to 30 August 2002 during the author's internship as a Research Associate in the Department of Anesthesia and Critical Care at Pacifica Hospital.

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Case: June 14, 2002

cpn 6.23.02

## Ghost Patients

### 1. Summary

A patient has been scheduled into OR6 for the installation of a shunt, a comparatively simple neurological surgical procedure. The surgeon has cancelled that case and substituted a decompression craniotomy, a much more significant procedure. The shunt case was used to hold the space in the OR.

### 2. Background

On Thursday, June 13th, the hospital had to suspend admissions due to patient wards being at full capacity. There weren't enough beds to accommodate additional in-patients.

There are sixteen rooms in the IOR. However, many have dedicated equipment that is used for specific procedures. As a result of those sixteen only a few are available for general assignment. The process of scheduling time in the OR begins months earlier with block schedules. Various surgical departments (neurology, cardiac surgery, thoracic surgery, obstetrics/gynecology, oncology) reserve time for operating rooms in advance. As the planned day gets closer, surgeons specify which case will be performed. Reservations for cases arrive at the DACC scheduling office by fax, phone, e-mail, and voice mail. By the day before, assignments are printed out on a Preliminary Copy of the Master Schedule.

### 3. Scenario

The master Schedule for the day shows a line that has been drawn through a shunt insertion case for a 63-year-old female patient that was scheduled to start first in OR 6. In OR 6 an anesthesia resident performs life support on a 72-year old female patient. She is undergoing a decompression craniotomy to relieve cranial pressure due to the brain swelling within the skull. The case had been called in as an add-on at 0715 and declared an emergency.

"That shunt case that was scheduled for this room was never going to go. It was a ghost case. I went up to do a pre-op last night and the patient's son said that the surgeon had told him the surgery probably wouldn't occur."

At the NC station, the AC reviews stand-by and add-on cases in order to evaluate which cases to assign next to an available OR.

#### 4. Process

Surgeons and the hospital generate revenue by throughput. That is, the more cases the greater the throughput. It is in the surgeons' interests to "fence" resources to optimize the opportunity for generating revenue. As a result, surgeons have developed certain methods to hold onto resources.

*Overestimation*--A surgeon will schedule a procedure for a longer time than it should take. This is in the interest of occupying the OR with a certain team and set-up. In this event, it is likely that the surgeon has another case on the add-on list. The surgeon will then prevail on the AC to assign the case from the add-on list to that OR.

*Ghost patients*--The surgeon schedules a case for the OR. However, there is no intention to actually perform that procedure. Usually, sometime during the evening before 0700, the surgical resident who is responsible for pre-operative work-ups will call the scheduling department to cancel the procedure and replace the case with another.

Some departments and surgeons are known by the NC and the AC to schedule more ghost cases than others.

The AC is responsible for unit efficiency and performs certain roles to maintain it.

*Evaluate*--Determine whether the new case should be assigned to the same OR or placed on the add-on list

*Direct*--Assign a case to the add-on list and inform the surgeon that the case will be taken when other space becomes available.

#### 5. Comment

Scheduling is a continual process. The Preliminary and Master Copy versions of the schedule are efforts that the institution makes to capture and channel the flow of demand so that resources can be allocated to meet them. The schedule serves as a narrowing in the river, making it possible to more accurately meter the amount of flow and speed. However, it does not change the demand. As a result, participants have developed a variety of tactics to relieve the stress that this narrowing brings about. The struggle for control over limited resources is a daily aspect of the IOR. The struggle occurs as various groups attempt to redraw the boundaries of what constitutes reality for that day, that morning or afternoon, or that hour.

Patients can be ghosts for three different reasons.

A patient that might get better has a procedure postponed

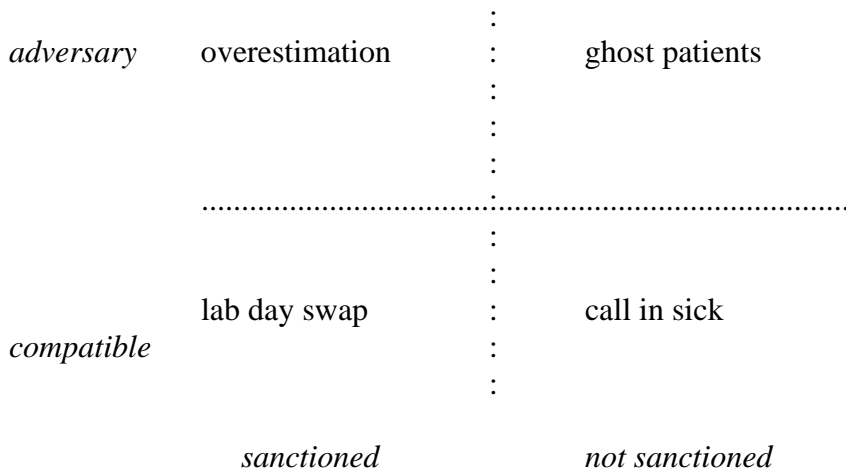
A patient that does get better has a procedure cancelled

No patient at all

The AC may not be able to move a case up from the Add-On List because there are certain conditions that need to be met such as an available patient, prepared patient, available staff, and correct type of room and equipment for the procedure. The telling sign when a ghost patient was used to hold a place in the queue comes when a substitution occurs. That is, a surgeon swaps one patient in for another without allowing the AC to substitute an available patient from the Add-On List. The longer the Add-On List is, the greater a penalty ghost patients impose on those who are waiting for a procedure to be performed.

Methods of influence may or may not be sanctioned. Sanctioned methods include participation in programs such as residency and fellowship, application for vacation or swapping lab days. Methods that are not sanctioned include scheduling ghost patients and calling in sick when healthy.

Methods may be compatible or adversary. Compatible methods involve efforts to collaborate through invitation and request. Their initiation is intended to achieve a personal agenda within what is allowable by the individual who is responsible for resource allocation. The resident who stops by on the way out of the unit at the end of the day and asks for a particular assignment because of his program requirements is compatible. Adversary methods seek to benefit the individual at the expense of the consensus. Because the unit is a public collaboration, a direct attempt to subvert the consensus is obvious and vulnerable to being quashed by the anesthesia coordinator. Instead, overestimating procedure times and scheduling ghost patients takes advantage of what the schedule will allow in a covert manner. This puts the burden on the AC and NC to minimize such abuses.



## Close Out

### 1. Summary

On a Monday afternoon, as the evening shift takes over from the day shift the Anesthesia Coordinator (AC) and Nursing Coordinator (NC) confer on what will and will not be done after 1500. During the turnover, the day AC refuses to allow a procedure to proceed.

### 2. Background

The day shift is scheduled to finish work at 1500. At 1430, the current AC starts the transition with the evening AC. Both rely on the Master Schedule and the OR Board to decide what will and what will not be done after the day shift leaves.

Vacations and departing residents at the end of the term leave the available staff to assign shorter than normal. The AC has had to stop the flow of patients into the IOR because the Post Anesthesia Care Unit (PACU) is full. There is nowhere to put patients whose procedures are completed.

An anesthesia resident [Resident 1] stands near the OR board and shakes his head slowly back and forth. "Patient flow is just like the human body. You have input and output, but if the output gets backed up..." "We just has a patient waiting in the OR for 20 minutes. Two nurses. An anesthesiologist." He rubs his thumb and fingers together. "That's a lot of money to just sit there and recover."

Patients can get backed up for any number of reasons. If they come from a floor then they have a room and they can go back. But these folks came from home. It can be that transporters were called for but haven't come yet. Might be that they just need to be in the PACU longer to recover. At the moment we have three OR's on hold.

This is the first day of the new year-long cycle for surgical residents.

### 3. Sequence

At 1430, the evening AC [Anesthesiologist 1] gets turnover information from the day AC [the respected senior AC]. Standing at the OR Board, [Anesthesiologist 1] points to each OR room number and [the respected senior AC] describes each case. [Anesthesiologist 1] jots finish times in marker on the board to the left of the OR room number. "4:30," "5:00" and so on. Reviews what procedure is scheduled for each room, where the patient for each procedure is located.

[The respected senior AC] runs down which attendings and residents will perform anesthesia. "He was here on Saturday and Sunday doing livers. So if you can, get him out early."

[The respected senior AC] then turns to the cases that remain on the schedule for the day. "P4-2 is a debridement skin case. Two hours. Should be out by 5:00." He checks his pager for a message he has stored on it. "The tracheostomy in P4-3 should be out by 3:30."

The NC runs down the cases on the add-on list out loud across the passageway. [Anesthesiologist 1] writes a tally on the OR board in marker. At the same time [the respected senior AC] checks on patients that are still in pre-op.

[Anesthesiologist 1]'s list on the board reads:

- To Start
1. (B) TKR
  2. Transthoracic Myotomy
  3. STSG back (10)
  4. Colostomy (15)
  5. Skin graft #1
  6. Skin graft #2
  7. Skin graft #3
  8. EGD

Item 8 is later revised to another procedure "DL/Blonch."

[The respected senior AC] refers to one of the procedures listed on the OR Board. "I'm getting tired of that." (to the NC) "[NC], don't call that case. They should have done that nephrostomy tube by now." [the respected senior AC] calls on the phone. "Don't send for the case in 15. We've been waiting for an hour for that case." [Anesthesiologist 1] and [the respected senior AC] continue to confer over the schedule on the OR Board for a minute and the phone rings. [The respected senior AC] picks up the call. "Yeah, you can either cancel it, hold and reschedule it or wait until later. Why didn't they do it earlier?" "No. I'm closing the room. My staff leaves at 3:00. We've been waiting for 45 minutes. I'm not blaming you. I know you move fast. I'm trying to help you out as much as I can. We've been waiting for an hour. When did the patient show up? Did anyone page [Anesthesiologist 2]?"

A nurse stops by and holds out a piece of note paper with writing on it. "Can we start this next case?" [The respected senior AC] shakes his head "No. I have nowhere to put patients. They're backed up in the PACU." The nurse responds "If we start now we'll be done in four hours." "I have patients who are waiting in the rooms now with no beds."

A code goes down in P4-3 calling for a vascular surgeon and vascular clamps. The NC takes a call and says to the AC "They need a vascular tech in P4-3. They think they hit the carotid."

[Anesthesiologist 1] adds a few T.S. [to start] notations next to OR numbers. [the respected senior AC] draws a bracket to enclose the skin grafts. "You may not do these." "If you can do one do this. He's fast" (referring to surgeon)

[Anesthesiologist 1] writes in 7PM and 5PM attending and resident names on the board. He changes the projected end time for the procedure in P4-3 from 3:30 to "?" As this is the case that just coded and the finish time is now unknown.

[The respected senior AC] points to the list of procedures in marker, starting with the three skin grafts. "I won't do any of these." Points to the Brain BX. "And I won't do this one either." [Anesthesiologist 1] points to the myotomy. "How about this?" [The respected senior AC] comments "If we don't have any beds we can't." "If you want to use [Anesthesiologist 3] you can." He places [Anesthesiologist 3]'s name plaque diagonally next to the name of an attending, then slides it into place.

Updating her copy of the master schedule, the OR desk clerk mutters "Good heavens. If we keep addin' on, we *never* gonna finish."

As the evening shift progresses, further notation in marker will refine the information that is related to each case. By 7PM, the night shift will have taken over and only two rooms will be in operation.

#### 4. Process

The transfer of responsibility involves three participants in the exchange of information: day AC, evening AC and day NC. All three rely on the master schedule and the OR board to perform multiple roles that benefit each other.

*Report*--The NC accounts for the status of cases that are in rooms and remain to be performed

*Mentor*--As the senior of the two anesthesiologists, the day AC makes recommendations on which procedures for the evening AC to act on.

*Direct*--The day AC acts to stop a case from further burdening the scarce resources he has to manage.

*Evaluate*--AC compares cases that remain to be started against the staff and rooms that will remain after 1500. He also reallocates resources according to: case urgency, which cases can be performed using the staff that will be on hand after 1500, and which surgeon can be relied upon to perform a procedure quickly.

*Summarize*--The evening AC notes the cases that remain to be performed and collects them into a list for discussion with the day AC.

#### 5. Comment

Both the schedule and the OR board come into play as the coordinators plan for the remainder of the day. This is the most active period for OR board use during the day. During this period, evening AC [Anesthesiologist 1] uses the board as a means to map out the current state and to summarize the expectations for the evening shift.

Knowing that he is taking on responsibility for the work to be done, [Anesthesiologist 1] is thorough in accounting for the expected length and complexity of each procedure. The day AC assists him, using the temporary marker list, the roster of attending and resident name plaques to add information that the evening AC would not have.

The attending and resident name plaques serve as a physical device to manage the assignment of anesthesia staff. The day AC places plaques off to the right of the roster when contemplating which resident to assign to which attending. Cocking the plaque at a 45-degree angle places it apart from other information that is more certain. As he makes a decision, the day AC straightens the plaque and slides it into the row aligned with the name of the attending who will be responsible for supervision.

They collaborate in building a list of procedures that remain to be done. Both deliberate over whether this list will work. A few phone calls and some reflection by the senior AC bring about changes. This results in a new list. Both consider the likelihood that the set of procedures will be feasible during the four hours and the staff that remains in the IOR.

This has implications for the case study on *Anticipation*.

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Case: June 23, 2002

cpn 6.25.02

## Knowledge "On Hold"

### 1. Summary

Knowledge about the DACC and what is to be done occurs on multiple levels. At the least formal level, it is information that is held on scraps of paper or in the memory of individuals such as the NC or AC. Even though it is not written down, it still influences the way the unit works.

### 2. Background

The Nurse Coordinator (NC) serves as the main point of contact for activities that occur on the Inpatient Operating Rooms (IOR). The NC station is an assembly of phones, a two-way radio, items posted to a bulletin board located over a countertop in the passageway that services each of sixteen operating rooms. As the day evolves, staff, departments and family members contact the NC station to provide or to learn information having to do with surgical and critical care procedures. The NC works closely with the Anesthesiology Coordinator (AC) who is an MD responsible for the assignment of anesthesiologists, anesthesiology residents and Certified Registered Nurse Anesthetists (CRNA).

Both [Nurse Coordinator 1] and [Nurse Coordinator 2] have been asked to serve in the NC role for a few days of the week. This follows the recent retirement of [the respected senior NC] who served as NC for many years and whose knowledge of what was

occurring on the unit was considered by those on the DACC to be as encyclopedic as [the respected senior AC]'s.

### 3. Sequence

[Nurse Coordinator 1] is the NC for the day shift. She walks away for a brief time. During that period, the phone at the NC station rings. Another nurse who is passing by stops and, in an effort to be helpful, picks up the phone. She tries to answer a question the caller has regarding patient status and can't locate the information on the Master Schedule. After looking over the schedule and looking around for the NC, she says "I can't find the charge person. Can I have her call you?" and takes a name and phone number. NC returns to the NC station. "Oh, the Std Op DKA on female patient will go to Room 11. [the respected senior AC] had told me."

On June 24th, [Nurse Coordinator 2] is the day shift NC. Around 0730 the AC is away from the station and the phone rings. She writes a patient name, procedure and phone number onto a scrap of paper. "I don't know if [the AC] wants to put them into the room. They may think they can just put this new case into the same OR. But that's not up to me. I'm only here two days a week, so..." She holds the scrap of paper under the hospital paging directory booklet while she waits for [the AC] to return. "I think they assume they can bump their own room. Sometimes they can, but...." The AC returns a few minutes later and has her put the case onto the add-on list. The case will have to wait for an available OR.

### 4. Process

The NC serves in a number of roles at the same time throughout the shift.

*Recorder*--Takes frequent phone calls, spoken requests for information from nurses, anesthesiologists and surgeons in person as well as from surgeons, pre- and post-op, other departmental staff, and even patient family members over the phone.

*Dispatcher, Expediter*--Contacts various departments in order to move along the processes that occur on the IOR. Calls pre-op to transport patients to the IOR. Calls for specialized equipment or supplies to be delivered. Calls to have maintenance (EVS) staff clean an OR. When necessary, will push for faster performance by more frequent calls or more insistent requests.

*Reporter*--Responds to in person queries from AC and IOR staff and phone requests regarding what has occurred, is occurring or is planned to occur on the IOR.

*Supervisor*--The NC performs in a director role, but carries it out in a more collegial manner by comparison with the AC, who is an MD. Will add elements of negotiation while discussing nursing assignments and who will take them.

### 5. Comment

A certain amount of knowledge regarding what is to be done is never committed to paper. In some cases, this is an occasion of brief information bits that can be held in short term

memory. However, it is only held in the mind of the NC. As a result, it becomes cognition that is not actually distributed.

In another example of cognition that remains undistributed, some types of information are written onto scraps of paper. The practice suspends commitment to a formal course of action pending receipt of more information. The information in this case is what the AC chooses to do with a case that has been phoned to the NC by a surgical resident. The NC notes the case but the resident asks for the case to be assigned to a room. The NC is uncertain which course to take, as it is the AC's prerogative how to assign the case. It is a default decision whether she writes it onto the add-on list, or if writes it into an IOR row on the schedule. Instead, she creates a third option for herself by writing the information on a scrap of paper. In so doing, she avoids having to make a commitment that she wants to avoid. She effectively puts the action "on hold" until the AC returns and can make a decision. That also frees her from having to defend herself from challenges by the surgical resident who wanted the case assigned directly to a room.

The rapid rate of activity on the DACC requires information to be used in a variety of different ways. The practice of putting knowledge "on hold" is a short term solution that serves a number of purposes. Extra effort is economized by the NC keeping the AC's preference in her head until it is necessary. Writing on the schedule suggests commitment and jotting information on a note saves the NC from uncertainty and potential embarrassment.

The practice has interesting implications for computer support.

Knowledge that is on hold is unavailable to other humans for good reason. Entering information into a computer-supported system requires a level of confidence, a level of certainty and a need to commit. Neither of the cases described here had those elements. Even so, they were essential to the distributed cognition on the IOR.

This also implies that means to convey this kind of information using computers will remain a partial representation of what is actually occurring.

Workplace studies is embodied in the work of authors such as Luff and Hindmarsh [Luff, P., Hindmarsh, J. and Heath, C., eds. (2000) *Workplace Studies: Recovering Work Practice and Informing System Design*. Cambridge University Press. New York] and Heath and Luff [Heath, C. and Luff, P. (2000) *Technology in Action*. Cambridge University Press. New York]. These authors make the assumption that information in the workplace is necessarily distributed by those who work actively sharing it. This case illustrates how that assumption is not consistently true. Workers make choices whether to withhold, reframe or pass along information based on a number of considerations such as uncertainty, concern over perceptions by others, unwillingness to commit and tentativeness. How they make that choice to segregate information from sharing to keeping it "on hold" is an interesting issue.

## Likes and Dislikes

### 1. Summary

Whose name appears on the Master Schedule and who actually performs certain activities in a procedure are not necessarily the same. Individuals will be added, changed and dropped for a number of reasons including personal preference.

### 2. Background

Among the roughly 50 anesthesiology staff and 50 nursing staff present in the IOR each day, there is talent and need and motivation. Preferences play a role in terms of who does what. Long term, preferences spell out who performs in certain roles. For example, anesthesiologists who prefer to work with children can pursue certification in pediatric anesthesia. Their certification links them to pediatric cases. That becomes a requirement that the Anesthesia Coordinator observes as schedules are made out. Nurses who enjoy working with children seek assignment to pediatric procedures. They develop a reputation for skill in dealing with children. Nurses who prefer not to work with children seek other kinds of assignments. The Nursing Coordinator tries to make such assignments when possible. However, nurse shortages can make it difficult to consistently assign a nurse to one kind of procedure.

Inevitably, there is harmony and discord. Some anesthesiology and nursing staff work well together and look for opportunities to collaborate on procedures. It may be from professional appreciation; one knows the other is reliable and knowledgeable. It may be from personality. The obverse is also true. Some do not get along. Some find surgeons difficult to work with. The Anesthesia Coordinator and the Nursing Coordinator both know these undercurrents and do their best to account for these considerations in their assignments.

It can happen that a surgeon and anesthesiologist disagree. This happens on the average of three to four times a year. For example, a surgeon may direct an anesthesiologist to give a patient general anesthetic. In such a case, the anesthesiologist will need to assert the right to choose how to proceed. The matter will eventually be brought to the attention senior team leaders in order to restore proportion and balance to the team. Left unresolved, such conflicts could undermine the integrity of patient safety.

Some surgeons have no contact with their patient prior to a procedure. Some want to speak with the patient in Pre-Op. Others want to speak with the patient before the procedure. Only the NC and AC recall all of that collective information.

### 3. Sequence

At 0700, ten to twelve nurses at a time cluster around the nursing assignment roster to see what IOR room assignment the Nursing Coordinator has given them. They then move to the Master Schedule to see what the procedure is and which surgeon and anesthesiologist

will be on hand.

One nurse cranes her head forward to scan the Master Schedule, and her eyes land on her assigned procedure. She frowns and crinkles up her nose in a mock scowl. "Oooh, a bowel resection," she mutters. "Ooooh, poopie poopie" another mutters in empathy. Abdominal work involving the bowel is considered to be unpleasant by some of the staff.

A few days earlier, an anesthesiologist and nurse bumped into each other in an OR resulting in the anesthesiologist being charged with battery.

#### 4. Process

The Anesthesia Coordinator performs in the following roles having to do with likes and dislikes.

*Matchmaker*--Creates a pair by teaming surgeon with anesthesiologist. Success in making such matches relies on understanding who works well with whom. Not everyone in the surgical and anesthesia services has equal social skills.

*Mentor*--Promotes the career development by looking out for the development of residents and fellows.

*Tactician*--Places certain anesthesiologists with certain surgeons in order to minimize conflict. Some surgeons are difficult to work for and other members of the DACC know it. The AC imposes certain attendings into certain OR's in order to protect more junior staff.

#### 5. Comment

Scheduling implies that participants will develop and enact a consensus about what the future will be. The basis for that consensus is complex particularly among highly skilled individuals in a high hazard system

The least tractable aspects have to do with requirements. Education and certification enable individuals to perform certain services. They are not negotiable and are among the first considerations that the coordinator takes into account when developing a schedule.

The most tractable aspects of the work environment involve daily work preferences. What procedure will be assigned? Who will be one's co-workers? Each individual knows that success relies on the success of the team that arrives in each OR. Can I trust myself to manage the task at hand? Can I trust others in the OR to perform their work to realize success?

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Case: 7.11.02

cpn 7.15.02

## Mark Makers

### 1. Summary

Who makes marks on the Master Schedule and the OR board varies according to role and artifact. That reflects the nature of team interaction in order to share cognition. It also reflects who limits and directs how resources will be allocated in the IOR.

### 2. Background

The Master schedule is formatted as a table to include information regarding procedures that are scheduled for each day. Among the information provided, two columns are located between the anesthetist and procedure description: FC and Anesth. Type. "FC" refers to [M D S B P I NA]. "Anesth. Type" indicates whether a general or particular choice has been made regarding the anesthesia that will be administered for the procedure.

Vertical lines are drawn to set off the "FC" and "Anesthesia Type" columns, making a box for each procedure. The Nursing Coordinator will use those columns for a second purpose. Through the day, each procedure status is updated by making certain marks in that column using a broad nib purple marker. The only individuals who have the purple marker to annotate the Master Schedule are the NC and AC.

Addition of a dot indicates that the Nursing Coordinator (NC) has asked for a patient to be transported to the IOR. Drawing a diagonal line from upper right to lower left shows that the patient is in the Pre-Operative unit.

When an anesthesiologist and nursing team wheel a patient to the assigned operating room, they pass the nursing station. As they do, one of the team calls out the room number for which they are destined. The NC fills in the upper portion of the box to form a right triangle. When the team escorts the patient from the IOR to the Post-Anesthesia Care Unit (PACU) they again pass the NC station and call the room number. The NC fills in the remaining half of the box. The filled-in box indicates that the procedure has been completed.

Other marks are also made. Either the NC or AC will draw a squiggly line across the entire line to indicate cases that are cancelled.

"Do you ever make a mistake?" "Yes, [the respected retiring Nurse Coordinator] giggles, "That's why I have my white out."

### 3. Sequence

The [new Nurse Coordinator] is at the NC station and has recently made a diagonal mark on a particular procedure indicating that the patient is in Pre-Op. As she does, the AC [the respected senior AC] steps up after having been away from the station for a few minutes.

AC "So that patient has arrived in Pre-Op?"

NC "No, I just called for them and they will be here in a few minutes."

AC "Then you shouldn't be making a mark there yet if the patient hasn't actually arrived."

#### 4. Comment

Restrictions on who makes a mark on the Master Schedule demonstrates the importance of the artifact as a reliable reflection of the actual status of what is occurring on the IOR. Because the NC and AC are the coordinators, it is their role to monitor the flow of events.

*"We try to reduce variability and independent behavior in order to enhance credibility."*  
(Cutter)

The Anesthesia Coordinator reinforces norms regarding the use of the Master Schedule to show IOR status. Inaccurate information, such as indicating that a patient has arrived in Pre-Op when only called for, erodes the schedule's reliability. The AC knows that an accurate picture is important to making and anticipating accurate decisions. He relies on the schedule for accurate, current information. In addition, the credibility of his leadership relies on the faith that others have in his grasp of what is occurring and what will occur.

The schedule is annotated in color for a reason. The purple ink identifies the only version of the schedule that can be relied on as the accurate account of what went on. This matters, because the annotated schedule goes on to serve additional needs after the IOR workday is finished. The NC takes down the previous day's annotated schedule, which is then forwarded to the DACC Billing Department. The schedule, along with time sheets from the individual OR's, are used to produce a completed "OR Graph." The OR Graph shows time lines for each OR through 12 hours, labeled with the name of each attending anesthesiologist and resident/CRNA who performed procedures.

The permanence of the master schedule and its use demonstrates the use of order to manage what would otherwise be chaotic. Reserving mark making for the coordinators alone forces widely varying parallel activities to be filtered serially for a moment through a reliable element in this complex system. That enables the AC to monitor what is being conveyed. That monitoring role is intended to filter out poor or erroneous information. Information that the coordinators view with confidence receives the imprimatur of purple ink on one master schedule.

Marks are unambiguous because norms have been agreed upon and are adhered to. This strict management of mark authorship and execution indicates how the schedule can break down if not managed well. Clarity about distinct states is important because it accounts for certain states and transitions between states (*e.g.*, in Pre-Op, in OR6, or having been called for). By reserving mark making for the NC and the AC, both generate a representation of the world for others to use. The moment-by-moment condition of the schedule is a way to fix what the state of the world is in the coordinator's mind.

## Mistiming

### 1. Summary

The Master Schedule shows start and end times for every procedure that is scheduled throughout the day. Less than a third of the times are correct. The inaccuracy hides a broader part of the tension between economic reality and resource utilization.

### 2. Background

Capitation is the managed care practice of paying a flat fee for a procedure. All surgeons vary in the time that they take to perform a procedure. However, the less time a surgeon takes to perform a given procedure the higher the compensation will be. That serves as an inducement to increase the number of procedures performed. The bulk of nursing resources are scheduled from 0730 to 1500, setting limits on the length of the available workday. Shortening the length of procedures makes it possible to accommodate more procedures in a standard day. It also allows for more procedures to be billed. Because of the norms at this teaching institution, it is not acceptable to perform a procedure faster than ability will allow. However, the more capable surgeons do operate quickly.

Some surgeons have a reputation in the OR for procedure time underestimation. The AC knows who they are and will set other actions in motion during the day to offset the ripple effects of procedures that run longer than scheduled. For example, some members of the anesthesia service will complete their activities off site at locations such as the outpatient clinic. The AC will stash staff by sending them on a break so that they will be available when the need for their services actually occurs.

### 3. Sequence

The a senior manager of the hospital arrives at the Nursing Coordinator station giving another of the hospital's senior manager a tour of the IOR. Gesturing to the Master Schedule, he asks the Anesthesia Coordinator [the senior respected AC]:

Mgr. "Doctor [respected senior AC] how many of these times are inaccurate?"

AC "About 70 percent."

Mgr. "And how many cases are cancelled?"

AC "Not too many. You can see a few here." (gesturing to lines drawn through cases listed on the schedule). "And the ones that are get replaced by cases from the add-on list. The add-on list is only a page today but sometimes it can get up to three pages."

After they continue the tour the AC comments.

AC "Those times only account for the surgeon's estimate of how long the procedure

will last, and the surgeons underestimate the procedure times."

"The times don't allow for room set-up and patient preparation. It takes a half an hour to forty-five minutes to get a room set up and to start patient anesthesia. Sometimes it takes a half an hour to get the patient out of the room and to clean up. That's an hour and a half."

"I've told them about this for twenty years and they say 'Well, it's entered into the computer and it'll all balance out.' Computer entry has nothing to do with it."

[Respected senior AC] comments April 1st:

*"People don't like the truth. They live in a dream world. So that results in cases running late." The more cases the more money there is for the facility and the surgeons."*

*"Nobody's interested in improving OR efficiency. They want it but they don't care." We can have a case scheduled to start but the surgeon is in a meeting. Or the patient consent has not been done yet." "There are no penalties here for failure to take care of such oversights. Penalties for that are standard in community hospitals."*

#### 4. Comment

Few items on the Master Schedule are as specific and significant as the start and end times, yet none are as variable. The times that are shown on the schedule are provided by the surgeons who book the OR. Their estimates do not include preparation and retrograde. As a result, the schedule times are only a vague indication of what will occur.

Knowledge regarding what is to be done and how long the procedure will take is located in other areas. Because of this, the master schedule can only reflect what exists elsewhere. Timing information is meaningful, even though it may not be accurate. That is because meaning is conditional upon interpretation.

The members of the DACC have a whimsical response that they use when dealing with such issues. The comment "Oh, this is a *surgical* thirty minutes" implies that there will be more time required than stated and that the underestimation is chronic.

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Case: Friday, June 14, 2002

cpn 6.18.02

## Soft Emergency

### 1. Summary

A surgeon called to declare an emergency in order to have his skin graft case (which was an add-on procedure) assigned to an operating room when none were open. Opening a

room would require a scheduled case to be bumped (postponed). The Anesthesia Coordinator negotiated an arrangement in which the surgeon accepted a 45-minute delay until a room became available. The arrangement avoided bumping a procedure.

## 2. Background

The Coordinator station is located at the entryway of a 16-operating room Surgical and Critical Care Unit at a major urban teaching hospital. There, the Anesthesiology Coordinator (AC) and Nurse Coordinator (NC) monitor the status and progress of activity on the unit as the day progresses. Interactions are in person with other staff members and by pager/phone conversations. It is Friday at mid-day and surgeons attempt to clear out cases before the weekend. The master schedule add-on list is 2.5 pages long. 1 page is more routine. The chief anesthesiology resident speculated that there may be a backlog because admitting was suspended on Thursday due to no available beds. At around 11:30 the Anesthesiology Coordinator fields a phone call to the AC (Dr. Livingston).

### 2.1 The inpatient operating rooms (IOR)

The Department of Anesthesia and Critical Care (DACC) is responsible for management of the Surgical and Critical Care unit (SACC) which includes six activities in the hospital complex that require anesthesia services.

Cases are scheduled for the outpatient clinic (SurgiCenter), the inpatient operating rooms (IOR) or four other services such as radiology. The most acute cases are treated in the IOR. Cases vary from cardiology to neurology to orthopedics, transplants and general surgery. In each case, staff, equipment and supplies must be matched to meet patient needs and surgeon requirements.

Conflicts are embedded in the process.

*Demand*--The type and number of demands varies. A patient experiences a heart attack. An organ becomes available for transplant. Each occurs in its own time.

*Economics*--The greatest number of procedures performed generates the greatest amount of revenue for the surgeon and the hospital. Each surgeon schedules cases according to specialty and patient population.

*Efficiency*--The DACC is responsible for managing the use of resources and the cost of providing services in the IOR. Resource management keeps staff and equipment working at optimum--neither under nor over-employed. There are only sixteen rooms in the IOR. Some are dedicated for specific uses and cannot be given over to general assignment.

*Teaching*--As this is a teaching institution, the DACC trains residents to perform as physicians in a variety of medical fields.

Cases are either scheduled procedures or emergencies. Each surgeon estimates case severity as either routine, urgent and emergency. Officially, the potential loss of a patient's life or patient organ would be an emergency. Declaration of an emergency requires that resources be freed up and made available for that case. In reality, there are very fine gradations of what constitutes an emergency. Because of that ambiguity, it is

possible for a surgeon to declare a case emergent in order to free up resources for his or her case. In the instance of cases that are declared emergent, it is up to the AC to evaluate the case. Anesthesia and nursing staff call "soft" those emergencies that are declared yet have no apparent high risk. Through an effective evaluation, the AC ensures that there is a match between demand and resource.

## 2.2 The booking process

Surgeons reserve OR rooms by phone, fax, e-mail, in-person at the NC station. This flow of bookings is continuous, varying according to patient needs and surgeon demands. The department employs a Master Schedule to funnel cases into a manageable set of arrangements. Completed each day by the next day's AC, the schedule lists each case along with all needed information. Some are listed as standby. These cases are elective and could not be fit into the available rooms. The finished master schedule, which is distributed throughout the organization at 1530 each day, is the department's best match between demand and available resources. Because the flow of demand is on-going, surgeons continue to add cases. These are hand written onto an "add-on list."

Both the AC and NC serve as controllers in the flow of services, equipment, supplies and information. Phone, pager, and in-person communication are used in order to manage that flow. Information tools, or cognitive artifacts, provide a plan and log to track the intentions, status and accomplishments on the in the DACC as a whole and the SACC in particular.

## 2.3 The Coordinator role

a. Anesthesiology Coordinator. The AC role continually moves among the activities of planning, action and evaluation through the day. In so doing the AC reconciles wide variations in demand with finite resources. The main cognitive artifacts that the AC relies on are the Master Schedule and the OR Board.

### b. Nursing Coordinator

The NC responds to the AC's lead by expediting nursing staff and equipment to their correct locations. The main cognitive artifacts that the NC uses are the Master Schedule, the nursing assignment sheet and the IOR schedule.

## 2.4 Coping strategies

Both AC and NC employ strategies in order to reconcile demand and supply.

### a. Demand

*Evaluation*--Probe to determine a demand's actual nature: type, length, arrival on IOR, special needs for equipment, supplies, staff

b. Resources--The AC and NC manage the availability and positioning of staff and equipment through a number of techniques.

*Anticipation*--Use available staff to satisfy unique or dedicated requirements. Send for staff and equipment in ahead of need.

*Stashing*--Send staff members on temporary assignment such as a break or lunch to return within a predictable time

*Resource husbanding*--AC adjusts availability of staff through lab day assignments

*Bumping*--Designate a room on regular rotation in which a procedure will be postponed so that an emergency can be accommodated

### 3. Sequence

The sequence of events occurs over about ten minutes from 1130 to 1140. Portions of the dialog that occur at the Coordinator station provide a sense of what is occurring.

AC (on phone) I don't think we can do it today.  
We can book it and see if we can fit it in.

AC (on phone) You're in the bump room, Number 1.

AC (on phone) He wants to do it

AC: (on phone) I don't make those decisions

*Why am I being bumped? Is this really an emergency?*

AC You'll have to talk to him.

CRNA Are we being bumped?

AC Yes, you're being bumped.

CRNA How do they decide which rooms get bumped?

AC The bump list.

CRNA Doesn't it make sense to bump by the severity of the case?

AC: It depends on the surgeons to make those decisions.

AC: (to nurse coordinator) Clean it up and let's set it up.

AC Ask the person bumping to talk to the surgeon who is being bumped.

NC Six is coming out.

AC: (to nurse coordinator) We can put [Surgeon 1] in there. (Calls, no answer.)

(to nurse coordinator) We can put [Surgeon 2] in 4 and [Surgeon 1] in 6.

Let me page [Surgeon 1].

(to nurse coordinator) You're planning to put something in 6.

(points to a case on the add-on list)(pages [Surgeon 2])(calls [Surgeon 2])

Nurse (while walking past station) Are we being bumped?  
Is this for sure now?

AC (to nurse) Do the scheduled case

AC (to [Surgeon 1]) [Surgeon 1], Room 6 is coming out.  
(to [Surgeon 2]) [Surgeon 2], [AC]. I just talked to [Surgeon 1] and he doesn't  
mind waiting 45 minutes.

AC When they declare emergency I don't have anything to do with it. We let  
them work it out.

AC I struck a deal by getting [Surgeon 1] to wait 45 minutes and was able to put  
him into a room that was coming open. That avoided having to bump a  
procedure.

#### 4. Process

*Inject*--Surgeon calls and changes the nature of an add-on case to "emergency status."

*Evaluate*--AC notes the kind of procedure. As a skin graft with no extenuating  
indications, he knows as an MD that this is not a life threatening circumstance that would  
warrant bumping another procedure. He has been on the unit long enough to know these  
particular surgeons. That understanding provides him with a sense of how flexible they  
are.

*Notify*--AC contacts the surgeon in the operating room that is scheduled as that day's  
primary bump room. AC also responds to a flurry of queries from nursing level staff who  
are quickly attempting to anticipate how their work assignments and related preparations  
will need to be changed.

The AC's response changes through the ten or so minutes as the scenario plays out and  
new options and information become known to him.

*Verify*--Captured the NC notification that Room 6 was closing and would become  
available as an opportunity to solve the issue.

*Determine*--Checked to see when the room would become available and learned that it  
could be ready for use 45 minutes later.

*Propose*-- As the skin graft procedure was a general surgical procedure, he took the  
option to propose assignment to Room 6, a general surgical room.

*Direct*--AC directs those who are junior to him on the unit, as in "Do your assigned procedure."

*Arbitrate*--Multiple times during the sequence, he reminded staff on the unit that the decision was the surgeons' to make. As Coordinator, he knows that he is in the best position to make good use of unit resources. He checked first with the surgeon and asked if the 45-minute delay would be acceptable. Because of his experience on the unit, he was proposing a solution that he knew was tenable.

*Confirm*--Upon the surgeon's acceptance, he confirmed the assignment and notified the surgeon in the bump room that he would not be pre-empted. He also had the staff proceed with plans to prepare the room for the procedure when it became available.

## 5. Comment

This particular AC has a reputation on the unit for many abilities including a powerful ability to plan and well as to diplomatically evaluate demands and resources. This AC's value to the entire team is that he does not create an official plan and then try to enforce it. Instead, he will be open to change but keeps his work manageable by only attending to solutions that have the prospect of success. To accomplish that, he deals with what can be known and managed on the fly. Rather than trying to control the process, he sees possibilities and presents them for consideration. In this way, this AC comes to be known as one who will bring good news such as a feasible solution.

He redefines boundaries of responsibilities by reminding the bumping surgeon, the surgeon to be bumped, and staff of who is responsible for decisions, how agreements have been worked out in advance (i.e., the bump rotation). Through such reminders he reestablishes unit work process norms as a leader. He also avoids confrontation by avoiding a controlling role. Instead, he invites surgeons to work out the resource conflict between themselves. By offering the bumping surgeon a viable alternative and inviting him to accept it, he relieves the tension between resource and demand.

He averted a confrontation and made use of available resources.

Understood the two surgeons' personalities. For example, some surgeons keep track of who gave and who got while others have no such issues.

Evaluated the skin graft as a "soft emergency"

Conceived a solution that would get the surgeon's case into an operating room without having to pre-empt a procedure

The evolution of responses that the AC gives through the brief period indicates how elastic the boundaries are between what exists and what might exist. Circumstances change from a demand for unavailable resources to the potential for an arrangement to the reality of an arrangement. As he sees that evolution, he adjusts his responses to set

actions in motion so that resources ready for use when needed (e.g., "Clean it up and let's set it up," and "Do the scheduled case").

This case also illustrates how the AC and NC keep information in suspense and do not commit it to the schedule or OR Board as in the *Information "On Hold"* case study.

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Case: June 24, 2002

cpn 6.25.02

## Start Up

### 1. Summary

Surgical and critical care procedures are scheduled to start at 0730 weekdays on the IOR. That point is the culmination of many activities that began months before and have brought staff, equipment, facilities and patient together at a single place in time.

### 2. Background

Start-up represents the beginning of the workday in the Inpatient Operating Room (IOR) and the outpatient clinic (SurgiCenter). At 0630, the Nursing Coordinator (NC) posts the Master Schedule for the day. Ten to fifteen cases have been written onto the add-on list as surgeons schedule additional procedures for the day. Next to it, the Nursing Assignments form bears the names of all nursing staff and the rooms to which they are assigned. By 0645, the Anesthesia Coordinator has placed name plaques for the anesthesiologists and anesthesia residents and Certified Registered Nurse Anesthetists (CRNA) in place according to operating room numbers.

At 0700, nurses arrive at the NC station, scan the nursing assignment list to find out where they will work. They then scan the Master Schedule to see what procedure, surgeon and anesthetist they will assist.

Ideally, each anesthesiologist is in Pre-Op providing medications to prepare their patient. Many events intervene to impede the preparations and throw off the carefully laid plans. Patients get sick. Patients fail to show up. Surgeons fail to obtain consent or to complete the necessary history and physical (H&P). Patients, confused by conflicting directions, eat a meal when they should have fasted. Because the AC and NC know that such changes will occur, allowances are made to make the schedule flexible. Cancellations are noted on the Master along with the reason and time it was learned.

Others in the hospital (Pre-Operative Care, Post-Anesthesia Care Unit, OR Desk) align their expectations in order to anticipate what will be expected of them. They also use the schedule to negotiate new arrangements in case they cannot comply.

### 3. Sequence

At 0700 on a Tuesday morning, NC calls to verify the location and intentions of a nurse who should be on hand already according to the nurse assignment form. "The mom is with the patient and the surgery is scheduled to start at 0730. They're in M400."

A nurse approaches the NC. "[NC], do you have three people? Can they help? Here, come with me." She leads the NC off to another part of the IOR.

Nurse asks "Are they going to do that?" referring to a procedure listed on the Master Schedule. The NC replies "No, they're not sure they're going to do it. They're going to call me back."

A nurse points to the nursing assignment roster and asks the NC "Is that somebody who *knows* what to do?" The NC replies "Yes." The nurse continues "Somebody who *knows* how to *scrub* so I don't have to *teach* them?"

Nurse to NC "Do you have any neuro people free?" NC responds "Yes." The nurse continues "Send one back there. We have a lot of neuro...."

The AC [Anesthesiologist 1] returns to the station and places his hand on the NC's shoulder as he peers at the Master Schedule. "So have we put everything to bed already? You've done your usual *superrrrrlative* job. You've got them in the rooms? Or assigned? Or can't go? Excellent."

At 7:15, a general surgery resident (who started the previous day) arrives at the station and says to the AC "We asked for a 7:30 start."

AC            When?

Resident      Yesterday. Pat called yesterday.

AC            Who did he talk to?

Resident      Scheduling, at extension.....[gives the phone number]

AC            (pointing to the Master Schedule) "This is what I see."

Resident      Can you open 15?

AC            No, I've sent people away

Resident      (*referring to the attending surgeon the resident represents*)  
He's gonna freak. I wish you would have paged me.

AC            We can't page everybody. Hang on. (Checks the OR board.)  
I'm going to open up Room 2. (to the NC) Let's open Room 2 for a parathyroidectomy.

(scanning the OR board again) "Let's see....who am I gonna screw...?  
[Anesthesiologist 2]!"

Okay, I'm going to put [Anesthesiologist 2] and [Resident 1] in there. (to the anesthesiologists who by now are standing at the board) "Sorry to yank you."

Attending      Okay, I'm going to set it up.

AC                Great

Surgeon        ([Surgeon 1], who has arrived on the IOR and scanned the Master Schedule)

Room 2! (joking in his Afrikaans-inflected English ) It's HUGE. I'm agoraphobic! I'll get swallowed up in there.

AC                (to surgical resident "We do the schedule a week in advance, just so you know."

Resident        "It was all kind of last minute."

Anesthes        "Was it an add-on?"

AC                "It was a stand-by case. They thought it was on the schedule."

#### 4. Process

Many activities take place at the same time in the entryway to the IOR. The AC demonstrated three that made it possible to quickly respond to a change in demand without having to disrupt the workflow. His ability to do so with such a high level of good humor demonstrates why he has been assigned AC duties.

Verify            The AC used the master schedule and the OR board to determine the facility and staff opportunities that could be reallocated to assist the surgical resident. He was able to make a quick, decisive choice because he knew the information on the two artifacts was accurate and current.

Redirect         The AC could have refused to assist. The AC toyed with her briefly to reinforce the fact that resources are not easily able to be reallocated.

Set norms        The surgical resident attempted to direct the flow of work to benefit her attending surgeon. Instead, he used the occasion to help the resident understand how the scheduling process works.

## 5. Comment

The Master Schedule serves as the physical representation of the goals, aspirations, preferences, requirements and expectations of all who collaborate in the IOR and related services. If a procedure is not listed, it is not brought to the attention of the healthcare team. If it is listed, it serves as a vehicle to perform a variety of functions.

There are many levels of function that the schedule serves.

- The Anesthesia Coordinator and the Nursing Coordinator propose what the future will be and invite others to respond by estimating how to best participate in it and to determine what their contribution to it will be.
- Anesthesiologists seek opportunities to employ their skills. Residents strive to get the qualifications that will be necessary to satisfy the requirements of their rotations.
- Nurses seek assignments that match their skills, their interest (such as working with children). Some look for the opportunity to do different kinds of procedures while others prefer consistent assignments.

If a procedure is on the schedule, individuals are joined in collaboration for better or worse. Not all assignments are welcome, as some staff members dislike each other.

All of this culminates in the shared intention of the DACC that the master schedule represents. The AC's oversight of the schedule is the physical enactment of that consensus. How well the day begins relies on the ability of the AC and NC to ensure processes are in motion to bring staff, equipment, facilities and patients together within a short window of time to begin the day's procedures.

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Case: June 20, 2002

cpn 6.21.02

## Transient Marks

### 1. Summary

The official Master Schedule is printed out in word processor formatted columns and rows of typed characters. Updates to the Schedule are made in purple marker to show case status and disposition. However, there is a third level of notation that coordinators and staff use: transient marks. Transient marks reflect a level of information sharing that is as useful yet is less sanctioned than printed characters or marker annotation.

### 2. Background

On June 20, resident rotations have nearly completed. Vacation days and a reduction in the resident population at the end of the academic year have drawn anesthesiologist resources down to only 20. This is to service all anesthesia needs in both the IOR and five other services. During routine staffing, the AC can assign a resident or CRNA to an operating room and an attending to supervise their work. This short staff now requires the

AC to assign one attending per room in four separate OR's. The AC will try to do this in an OR that has multiple shorter cases. That will make the work load more tolerable.

### 3. Sequence

At 0645 on Thursday June 20th, the AC arranges name plaques on the OR Board to reflect assignments for the day. The Master Schedule was pinned to the bulletin board at the Nurse Coordinator station at 0630. It already shows changes made in pen that have occurred since the schedule was distributed the previous afternoon at 1530. The NC takes a phone call and after she hangs up the AC asks "What did he say?" The NC points to a case on the add-on list (perineal protectomy reconstruction for a 31-year old female). Referring to the surgeon she just spoke to "This is the one he'll want to do."

Small notes are written in pencil in the right "urgency" column on the same row as the protectomy case: "jackknife." As AC reviews cases and room availabilities, he jots down additional items: "Case from 6/19/02." After he determines OR 12 will be suitable for the procedure he assigns it and the NC call for the patient to be transported to the unit. When she does, she marks "655" next to the AC notes to indicate she called for the transport at 0655. "P" is written to the right of the column in pencil.

An attending anesthesiologist is "floating" on the unit. Available to cover for other anesthesiologists, he pays particular attention to the four OR's that have only one attending anesthesiologist assigned. As he stops in he asks if they need a break or additional supplies. After each stop he walks back to the OR Board, picks up a marker and writes "OK" to the right of the anesthesiologist's name. After visiting the four OR's, four OK marks on the board will let the AC know the next time that he passes by the Board that his solo attending anesthesiologists are fine. Having seen the AC view the Board, O'Connor removes the marks and heads back down the corridor to see who might need a break.

On the 21st, the Nursing Coordinator (NC) writes the time that she called for a patient to be brought to the IOR. Writes "to be done at 4PM." Comment in urgency column reads "Mostly Urgent" on a case of a 23-year-old female with nasal and orbital fractures. There is no such classification, but that is what was meant. "Not here as of 9:00" is written on a scheduled case that was cancelled.

### 4. Comment

Most of the marks indicate states such as the state of a patient who is in Pre-Op, the state of staff who are working solo in OR's or the expected end time for a procedure. The states can be fleeting. Occasionally there is a need to have some other representation than those a state diagram can provide. That is because a state diagram captures what is intended or sanctioned. Transient marks lie outside of that domain, As a result, the state diagram is not a good fit to capture this type of instance.

Both the AC and the NC add pencil marks to the Master Schedule. All of the marks made in pencil are for the benefit of the Coordinators. They are temporary or transient in importance, made as memory aids in case the need for them appears at a later time. For

example, the AC asks at 0710 where a particular patient is. The NC checks her pencil note, verifies that she had requested at 0655 that a patient be brought to the OR. Within minutes, the surgeon for the case calls her from the OR asking for her to check with Pre-Op to find out what is causing the delay. The note is again helpful for her to inform the surgeon that the patient is en route, saving an additional set of calls (to Pre-Op and back to the OR).

The marks that are made on the OR Board by O'Connor are for the benefit of the Coordinator. They are on the Board for no longer than 20 to 25 minutes. Even in that short span, they are a way for one colleague to indicate to another that the solo anesthesiologists are managing well, that concern on the AC's part over how they are doing is unnecessary, and that O'Connor is looking out for them (thereby relieving the AC of a task he would otherwise feel obliged to perform).

On July 11, there are short marker symbols are written along the left margin of the OR board: "C," "self," "later." These are the AC's notes to himself regarding who is an coffee break (C), which anesthesiologist attendings can decide for themselves when to take a break (self) and who has said they would like to delay taking a break (later).

There are multiple levels of function in the way the information about the DACC is obtained, shared among staff and transmitted to others outside of the DACC. It reflects the uncertainties over what will happen or how it should happen. It reflects the continual changes that occur throughout the 24-hour cycle.

There is an issue with anticipated computer support for scheduling. One concern has to do with attention to the DACC and its unique character. The AC is skeptical about the implementation of the OpTime system, which is planned for October (this is June). "They all have flaws. Programmers are different. They don't know about us. They haven't talked with us." Another concern has to do with levels of control, reference and indication. In computer-supported systems, information is either in or out of the system. In this analog artifact, however, there are multiple kinds of permanence and purpose.

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Case: 6.10.02

cpn 7.12.02

## Writing the Master Schedule

### 1. Summary

The Master Schedule is the primary artifact that the IOR team uses to coordinate their work each day. Writing it requires a grasp of many levels of knowledge about the IOR and other departments and what is likely and unlikely to occur.

### 2. Background

The Department of Anesthesia and Critical Care (DACC) is responsible to provide anesthesia services throughout the University of Chicago Hospital. DACC services around forty cases a day through the general operating room (IOR), while about thirty-five cases are handled at the outpatient clinic (SurgiCenter). Four other services are also scheduled each day: radiology, pain clinic, Post-Anesthesia Recovery Unit (PACU), labor/delivery, and burn unit.

Advance planning is managed on a yearly cycle. The department calendar is posted in the hallway outside the DACC administrative offices. It shows all DACC staff along with vacations, courses and other time commitments that will remove them from availability for assignment.

Each staff member is required to serve a certain number of days in the OR. The more senior attendings have earned the opportunity for fewer IOR days and more days allocated to research (lab days). Members will use the annual calendar to make their own plans and negotiate with other staff of similar rank regarding when to be in the IOR.

IOR procedures are scheduled to start each day at 0730. Most activity is expected to be completed around 1500. At that time, nurses that started at 0700 complete their shift and leave. Some staff are scheduled to cover the rooms in which procedures continue to be performed. No procedures are scheduled to be performed after 1900. However, a small group of staff members need to be available to cover emergency surgery, transplant surgery and airway management. Staff who cover such after hours requirements remain at the hospital to be summoned when a need arises. Staff who have completed their overnight on call shift are post-call the can take the next day to recuperate.

Residents perform pre-operative calls to assess patient needs before surgery the evening before a procedure. On call staff perform pre-operative visits for staff who are post-call.

Certain rooms are dedicated to certain uses, primarily due to the equipment that is staged there. Cardiac procedures are scheduled into OR1. Transplants and orthopedic procedures are scheduled for their own dedicated OR's. That will make it necessary to assign anesthesia staff with specific skills (such as cardiac anesthesia or pediatric anesthesia) to those rooms.

These items have prepared the way for two artifacts that provide the information that is necessary to write the Master Schedule: the Availability Sheet and the Preliminary Copy of the Master Schedule.

*Availability Sheet* --Lists all anesthesia staff according to who will and will not be available for assignment. Those who will may be reserved because of practice specialty (e.g., pediatric or cardiac certification), qualification (attending, resident or CRNA) or time (on call, post-call). Special requests are written on the back of the form.

*Preliminary Copy*--Shows room and surgeon assignments that have already been made by the Executive Committee (chairs of surgery and anesthesia departments). It also shows outpatient clinic assignments that are made by the SurgiCenter anesthesia coordinator.

The Preliminary Copy lists each case assigned to a IOR or SurgiCenter room. It also lists "stand-by" cases that do not have a room assignment and are often left over from the previous day's add-on list. The AC's task is to allocate each of the anesthesia staff on the Availability Sheet to the cases on the Preliminary Copy. Doing so requires the AC to reconcile many requirements.

At 1130 on most days, the Anesthesia Coordinator (AC) for the next day composes the Master Schedule for that day's procedures.

### 3. Sequence

The AC follows a path to draft the Master Schedule each day. The path that the AC takes in making assignments strives to reduce the degree of uncertainty to a manageable set.

He typically begins by looking for an anesthesia attending who is qualified to perform procedures such as cardiac and pediatric cases that require specialized anesthesia knowledge. Assigning them removes them from the pool of candidates.

For example, on June 10th, the AC assigns an attending and resident who have training in transplant cases to Room 10 (the transplant room). Assigns the attending on call for cardiac procedures to Room 2, where heart procedures are performed. Assigns third year resident to an interesting lumbar pediatric case in Room 11. Assigns a PACU resident to handle recovery room/codes responsibilities. Urology procedures in Room Nine need an attending and resident. *"I'll give [Anesthesiologist 1] one room. He called in sick today. So he may call in sick tomorrow and it will be easier to replace him if he only has one room."* [the respected senior AC] Goes back and assigns attendings to the second of the two OR's they will cover as they supervise experienced residents. (In July, the pattern will change as new residents that other residents refer to as "fresh meat" will spend their first month in a 1:1 relationship with an attending). Assigns a new attending, [Anesthesiologist 2], to one room in order to allow her less of a burden as she settles in. If [Anesthesiologist 1] does actually call in sick, then the AC can add another room to her workload. Assigns a particular anesthesiologist to a case in which a patient who is a surgeon on staff has made a special request. Assigns remaining staff to cover cases listed as "stand-by." The schedule is now complete. Makes pre-operative assignments for residents to perform, also writing in the name of their attending. *"I try to even out the load of pre-ops over time. But it may be more for one resident one day, and less another day."* (Livingston)

When he is finished, he writes in names of attendings and residents on the Preliminary Copy, and passes it to the OR secretary who forwards it to Scheduling (in the SurgiCenter). The finished schedule is normally distributed around 1530. The AC also records a voice mail message summarizing assignments. Anesthesia staff can then know their assignment without having to obtain a physical copy of the Master Schedule.

On June 14th, he plans for Monday the 17th by checking the Bump Room rotation, then transcribes SurgiCenter assignments from the Preliminary Copy to the Availabilities List. He checks a special request on the back of the Availabilities Sheet.

Assigns a cardiac resident to the cardiac room (OR1). Assigns a thoracic resident to the thoracic room (OR2). Assigns a radiology specialist to cardiac catheterization. Updates/specifies CRNA note that said 3PM but he knows that she will be at the hospital 24 hours so he annotates "cc" next to her name to indicate she is on call. Assigns senior pediatric anesthesia resident to pediatric case in OR11. Assigns a general anesthesiologist to a general surgery case scheduled for OR5. *"I will put people on call into longer procedures so they will not have to switch later."* [the respected senior AC]

Reviews cases for Room 12, 13. *"She's not on call..."* he says to himself as he looks over assignment candidates. A case is slated for OR3 (the orthopedic room) but there is no orthopedic resident in the department at this time, so he assigns a CRNA. Got to the point where he had one room left. That would have required him to assign an attending to a room alone. He stopped and reshuffled the assignments.

*"I preferred to put sole attending in a room with more cases but shorter in duration. So, it will be easier on one person to handle compared with a single long procedure."* [the respected senior AC]

*"I would normally give lab days but I can't in order to make sure they're covered."* That will save him from having to call staff in from a lab day in order to cover IOR needs.

#### 4. Process

The AC performs a variety of activities during the process of master schedule development.

*Anticipate*--Foresee what is likely to occur. By knowing who had called in sick, knowing the individual and knowing what other resources were available, he foresaw what problem may have occurred and avoided it by limiting the anesthesiologist's commitment for the next day.

*Negotiate*--Solicit the cooperation of others to defer, accelerate cases

*Direct*--Assign anesthesia staff to locations, cases

*Balance*--Reach an equilibrium between what is expected and resources that are allocated. Maintaining the balance will remain part of the AC role through the afternoon, evening and the following day when the schedule is enacted. Demand volume may dip or increase, demand type may change or resources may become available or vanish.

#### 5. Comment

Not every anesthesiologist performs in the coordinator role. One anesthesiologist [the respected senior AC] is held in high regard for his ability to deftly compose a schedule that meets many conflicting needs. The knowledge about the institution and those who work in it are specific to this particular location. The schedule and the knowledge to develop it are highly meaningful within these walls but irrelevant outside of them. Types of knowledge that the AC needs to know about includes:

Procedure

Type: requirements

Location: IOR/room, SurgiCenter, outlying service

Time: planned, likely

Duration: planned, likely

Surgeon

Preferences

Anesthesiologist

Availability: on service, on call, post call, vacation

Qualifications: rank, certification

Experience: in anesthesia, at hospital, with procedure, with surgeon

Talent: negotiator, mentor

Preferences

Scheduling can be particularly difficult in June when vacations and resident departures draw down available staff. On June 28, [the respected senior AC] sat in the lounge fingering a bagel. "I am stuck," he muttered to himself. "I should have left this place a long time ago." Taking a bite of the bagel, he smiled wanly. "I don't know what to do. That's why I am eating."

As he composes the schedule, the AC will follow the assignment path, making room assignment notes on the Availability Sheet. He continues until he comes to an assignment that cannot be made. At that point, he will review those whom he has assigned who might be reassigned (e.g., an attending who is responsible to supervise one resident and could be assigned two residents). When he finds a better sort, he will cover previous room notation using white out fluid and write in the new room numbers. By unraveling a portion of what he has woven together, he can maintain most assignments and yet resolve the conflicts that might compromise its success.

The AC will set tighter constraints in order to keep staff available. Staff dissatisfaction will be lower if called in and allowed to leave early. Staff dissatisfaction will be higher if he sets constraints too loose, allows staff to have lab days, and is then forced by an individual calling in sick or an increase in patient load to call staff in from labs.

Managing the activity of the IOR would be chaotic without the schedule. Its complexity reflects the complex activity that occurs on the unit. Its widespread interest among all members of the unit attests to the value it provides.

## Anesthesia Coordinator Schedule Development Analyses

Chapter Five described the strategies that anesthesia coordinators follow as they develop daily schedules. The following three analyses describe the coordinator sessions in terms of verbal protocols, as well as analyses of artifact and cognition. Coordinator summaries (Figures 5.2 through 5.4) show how subjects vary in their approaches to schedule writing. Even though coordinators vary in their strategies, no schedule that they write is wrong. One reason for this is that the year-long development cycle (Figure 4.1) has groomed arrangements so that they contain the least amount of uncertainty on the day before procedures. Another reason is that the coordinators anticipate the day that they are scheduling and will ultimately manage. Rather than make assignments blindly, coordinators tend to evaluate assignments as they make them in terms of feasibility (will this work tomorrow?). Any assignment is changed the moment it becomes suspect. If it remains on the schedule, the team and the coordinator will have to live with it through the next day of procedures.

The patterns in the analyses that follow show how the variety in strategies plays out in the schedule writing process. As Chapter Five and Six indicate, any scheduling software will need to account for the processes that coordinators employ,