

SYLLABUS AND INTRODUCTION

SI 661: Managing Health Informatics

Winter 2020, Tuesdays, 4:30-7:30 PM, 1225 North Quad

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DESCRIPTION AND LEARNING OBJECTIVES

SI 661: Introduction to leadership for health informatics. Includes cases on real-world decisions under ambiguity. Management and administration are synonyms for this class (it could be “Administering Health Informatics”). Learning through <reflective practice>: reading, theory, practitioner views, experience, and case study. Learning objectives: students can do project management and become effective at managerial awareness (how to work with managers) or managerial intent (being a manager) through knowledge of the Administrative Point of View (APOV).

DESIGN

Module 1. A brief introduction to management as profession and field of study applied to health professions and with respect to technology, followed by work on project management as the *minimum* management skill for MHI professionals and an introduction to APOV.

Module 2. Continued APOV; managers as stakeholders in health informatics and the role of APOV in that. Students choose between *managerial inclination* (being managers), or *managerial awareness* (working with managers to obtain agreement and/or support).

Previous Design. Earlier incarnations of 661 built around the special nature of health, leadership in health IT Implementation, redesigning care to take advantage of health IT, and innovating with health IT. These topics are woven into the modules above.

Conventions. Use an Internet search engine (e.g. Google or Bing) to search on the entire string between < and >, (see <reflective practice> above). Include quotation marks if there. Cut and paste works. Click on blue and underlined links and see what’s there. The University of Michigan provides on-line access to articles in collections like [JSTOR](#) (Journal Storage) and the [OED](#) (*Oxford English Dictionary*).

Look Things Up. Find out what terms mean and where they came from: (e.g., <[inheritance](#)>). Some terms (<[health](#)>, <[informatics](#)>, <[management](#)>) return many hits. These links are to Wikipedia. Wikipedia [says](#) it is “...not considered a credible source.” Really? This class uses Wikipedia all the time to <parameterize>.¹ Wikipedia doesn’t replace broader search or the *OED*, but it is fast. For example, find out if a term or concept is precise. Wikipedia calls “Informatics “...a branch of information engineering...” involving, “...information processing and the engineering of information systems...” It says informatics “...is an applied form of information science.” It says information science is “Not to be confused with information theory, information engineering, data science, library science, information systems (discipline), or informatics,” but encompasses “...computer science, information systems, information technology, and statistics.” Do people in those fields agree? Wikipedia mentions “...computational, mathematical, biological, cognitive and social, including social impact.” That’s a lot. Wikipedia wants to be precise; the term informatics is not.

APOV. Search <“administrative point of view”>. You’ll find [this](#) from 1974 (paraphrased to shorten and remove sexist language): a point of view that recognizes sentiments, re-evaluates and learns, understands others, and communicates ideas and attitudes. The materials include options for “administration:” The entry on [business administration](#) refers to “...the broader management function, including the associated finance, personnel and MIS services.” Money, people, and technology; that’s two out of three. Note the word “function.” Search <functionalism>. Look up the sociology theory [structural functionalism](#). “Macro” structural functionalism from the late 19th century declined the late 20th century and is not in SI 661. “Micro” structural functionalism is. This people skill joined organizational psychology to create [organizational behavior](#), and is now embedded in management education, favoring incumbent structure tied to APOV. Incumbent APOV usually wins. Change is risky.

Consciousness. “Consciousness” has spawned many shenanigans, often through <[ambiguity](#)>. Employers say they want people who have a high tolerance for ambiguity. Avoid [solipsism](#); things are seldom hopelessly ambiguous. APOV is a kind of consciousness that accepts ambiguity, but still gets the job done.

Canvas: an LMS: There is a set of cases from Harvard Business Publishing (details below). The rest of the materials are either on Canvas or available on-line from the U-M library, JSTOR, or similar. Canvas email is used for announcements and materials. Make sure it reaches you. Canvas is called a LMS (Learning Management System). That’s hyperbole: nobody understands learning well enough for systematic management. Health IT is often hyperbolic. Our use of the <[Gartner Hype Cycle](#)> addresses this. Canvas is an intellectual property management system (IPMS?). IP has important inheritance for education. Canvas is a secure file server, with most content in “Files.”

¹ <Parameter estimation> is as important to the scientific method as hypothesis testing

REQUIREMENTS

General: Students are required to participate, prepare case analyses, read, and write some things. Not all readings are discussed in class, but should be examined anyway to inform case analyses and written work. Cases might be short to read but still require much preparation. There are no in-class quizzes or exams.

Participation consists of in-class discussion and working on group work with others. For homework do cases and read material (see reading below). Come to class prepared for discussion. Random cold calls reinforce that everybody should be ready. Students will provide an evaluation of how others in their group did. This is part of participation. Ideally, all group members participate in group work, but having group members anonymously evaluate team members reduces free riders. You'll get instructions on how to submit peer evaluation. Failure to participate moves one toward the lower end of the grading scale. It is hard to participate if you do not come to class.

Case Analysis: Getting the Cases. Harvard Business School Publishing (HBSP) is part of a business school: they like getting paid. To get the cases, go to the website, register, and purchase the course-pack. Case studies provide opportunity to learn. They are increasingly used in job interviews. Students who took SI 661 earlier said the cases were very useful for recruiting. That's not why they are used this term (though it is a nice thing): cases are useful for APOV. Cases are often based on real organizations or places, but they can stretch the truth. (Full disclosure: the instructor has written Harvard Business School cases.) The course-pack is at <https://hbsp.harvard.edu/import/689941>. The cost for this course-pack of ten cases is \$40.87. You can read them as soon as you get them. The cases (the bullet items below in their clusters) are:

Electronic Health Records (EHR)

- *Stanford Medicine: Health IT Purchasing Decisions in a Complex Medical Organization*

Order Entry

- *Mount Auburn Hospital: Physician Order Entry*
- *Computerized Provider Order Entry at Emory Healthcare*

Disruption/Access

- *Weathering the Storm at NYU Langone Medical Center*
- *Improving Access at VA*

Research

- *Learning About Reducing Hospital Mortality at Kaiser Permanente*

Personal Health

- *PatientsLikeMe: Using Social Network Health Data to Improve Patient Care*
- *American Well: The Doctor Will E-See You Now*
- *GOQii: Envisioning a New Fitness Future (A)*
- *GOQii: Envisioning a New Fitness Future (B)*

Case Analysis: Doing the Cases: Cases are done by cluster. The first cluster, electronic health records, (the Stanford Medicine case) is done in plenary session, not by groups. This is to get acquainted with the case method of instruction. Nothing is graded for this discussion, but read the case and the materials on this cluster *before* you come to class so you are ready to participate. You need to get the hang of cases because you will be assigned to a group for work on the remaining clusters. For one of these your group must lead the discussion; for the others your group will have to participate. You will get instructions on how to do this.

Readings: Getting Them. Managing health informatics is large. A Google Internet search gives many hits (<health informatics management> 73 million; <"health informatics management"> 16 thousand; <health information management> 4 billion; <"health information management"> 8 million; <health information> 9 billion; <"health information"> 48 million). Cut it down by calling it different things, using quotes, eliminating redundancy, irrelevance, mislabeling, etc.; there are still too many hits to look at. At the end of this document there is a list of 36 readings from Professor Pierce that she deployed across her modules. There were typically two or three readings per week; a fraction of what a "well-read" person in health informatics should read. Nearly all are available on-line. Those without URLs are in the folder Pierce-Readings under Readings in Files on Canvas.

Readings: Using Them. I list the readings alphabetically. Some are about management generally, some about management of IT, some about IT, some about health, some about health IT, etc. Professor Pierce said they were required but listed some as "skim." If they were "required" in 2019, why wouldn't they be "required" in 2020? It depends on what "required" means. At least look at each, but rather than memorize the facts (you'll probably forget almost immediately) think about the points of view they reflect. Knowledgeable people <curated> this list. It is a *good* sample for this class. As the term proceeds, some of these readings will be mentioned. Some will help you. You will get other things to consider via links, searches, or things posted on Canvas. You can be unhappy, or consider that knowledgeable people curated *these readings* for SI 661. <Parse> the words in the titles: what subjects does this list cover, and what does that tell you about points of view?

Writing: To encourage writing that is *good* and *short*, I usually put upper bounds on the number of words to use. The first assignment is to turn in a short (200 word upper bound) statement of project. This illustrates writing for the class. The short things to be turned in might require substantial background work. There are three things we'll cover:

getting project management under control; explaining your inclination vs. awareness perspective, and a final paper to address the APOV issue and managers as stakeholders.

GRADING

Grading: General. Grading is complicated. Statistically, grades in UMSI masters classes tend to be B, B+, A- and A. Some prestigious professional masters programs make it impossible to get a failing grade in a class. Grades matter: I always preferred higher grades. However, most professional students are not pleasing UMSI instructors, but getting ready to obtain employment and succeed as practitioners. People should see me if aspiring for a PhD or have other reasons for which grades are particularly important. We can discuss my APOV regarding grading in class.

Grading, Individual: About 66% of final grade consists of participation and writing, as discussed above. Participation will be discussed as we go: each writing assignment will have a rubric discussion.

Grading, Group: About 33% of final consists of work in groups on the cases. The instructors will be looking for evidence that a student read the materials for the case and came ready to discuss. Once again, the cases are particularly important at developing the APOV.

Grading, Final: This class does not use A+ except in unusual circumstances. As noted above, people who do the work can expect at least a B. Spreadsheets are used to keep track of grades. Canvas grade tools are not used in this class. Do not trust anything on Canvas to tell you what your grade will be. You should talk with the instructors.

POLICIES AND EXPECTATIONS

General: The instructors care about accuracy and gaps in understanding. Follow-up if you find errors or don't understand. Use office hours or make appointments. The class is for you, not for the instructors. You will receive instructions for submitting work. Instructions will include a reminder to put your name (UMID optional) on whatever you hand in. It is unprofessional to be late. If extenuating circumstances require you to be late, if possible tell the instructors *before* the assignment is due. Arrive for class on time. Class will begin no later than 4:35pm and end no later than 7:20pm. Missing multiple classes makes it hard to get a high grade in the class. Again, let the Instructors know if you can't make it to class. Bring devices to class as learning tools. Refrain from e-mail, IM, chat, games, or other off-task things. Don't display things that might be offensive. Mute the volume on your device, close it, put it face down, etc. to avoid distraction. With only a few legal exceptions, instructors will hold communications in confidence.

Academic Integrity and collaboration:² Some SI 661 assignments need collaboration. Follow instructions and ask. Be careful about plagiarism. Assume all written submissions must be your own, original work, not mere paraphrasing of someone else's work. It is safest to not share final written answers with other students. Excerpts, statements, or phrases from the work of others must be clearly identified, and proper citation provided. Copy-editing assistance is OK. Student handbooks (*e.g.*, on the UMSI intranet) define plagiarism, set standards for academic and professional integrity, and point to resources to help you avoid the consequences if caught doing bad things. Consequences impacting assignment or course grades are determined by the instructor; additional sanctions may be imposed by the assistant dean for academic and student affairs. Ask if in doubt.

Accommodations For Students With Disabilities: If you think you need an accommodation for a disability, please let the instructors know at your earliest convenience. Some aspects of this course, the assignments, the in-class activities, and the way we [instructor] teach may be modified to facilitate your participation and progress. As soon as you make the instructor aware of your needs, instructors and student can work with the Office of Services for Students with Disabilities (SSD – 734-763-3000; ssd.umich.edu/) to help instructor and student determine appropriate accommodations. SSD typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. The instructors will treat any information that students provide in as confidential a manner as possible.

Student Mental Health and Wellbeing: The University of Michigan is committed to advancing the mental health and wellbeing of its students. If you [student] or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, contact Counseling and Psychological Services (CAPS) at (734) 764-8312 and <https://caps.umich.edu/> during and after hours, on weekends and holidays, or through its counselors physically located in schools on both North and Central Campus. You may also consult University Health Service (UHS) at (734) 764-8320 and <https://www.uhs.umich.edu/mentalhealthsvcs>, or for alcohol or drug concerns, see www.uhs.umich.edu/aodresources. For a listing of other mental health resources available on and off campus, visit: <http://umich.edu/~mhealth/>

² See [this](#).

INTRODUCTION TO MANAGEMENT

The discussion that follows corresponds to the first lectures. It <foreshadows> what the class covers and frames elements of SI 661 by starting broad and narrowing. It is a <parameterization> to provide context. It is especially important those who haven't had training or experience in management. This class cannot prepare people to be managers. It sensitizes people to what management schools prepare managers to care about. This introduction to management is followed by an introduction to health management. This is a huge area. It cannot be covered in one semester, much less one document. An introduction to health informatics follows that. It provides the working philosophy for the class. Health informatics is nested in health management, which is nested in the broad management context. The topics are bigger than the things nested. We are basically reducing the search space. We begin by discussing value, precision in language, and decision-making.

Managers ultimately care about <value>, as in <value chain>, <value proposition> and <value-added> (or added value). You must understand value, so look it up. A lot of this comes down to something called the <theory of the firm> that prioritizes owner value. Since shareholders are usually the owners, maximizing shareholder value is usually the primary – maybe the *only* – goal of the organization. You can begin to see why health is a strange critter in this space.

For precision in terminology consider that “management” and “administration” are not synonyms but they are often used *as* synonyms. Many “management” schools give only “administration” degrees (e.g., the BBA and MBA). For SI 661 “management” and “administration” are synonymous. This is part of the ambiguity, and is not limited to these topics. UMSI 661 doesn't exist; only SI 661 does. “Branding” replaced SI with UMSI, but the Registrar's systems didn't keep up. Terminological imprecision is intentional. The International Air Transport Association (IATA) no longer changes its codes when airport change their names because it was so expensive to recode New York's Idlewild International Airport from IDL to JFK when it changed its name to John F. Kennedy International Airport. IATA no longer issues new codes. Orange County California renamed its airport John Wayne Orange County International airport, but still uses the IATA code SNA, after the City of Santa Ana where it is located.

Many think management is “decision-making.” Some places built their reputation on this. Research shows that most management time goes to building and managing relationships (this is tied to decision-making – can you see why?). Insights about decision making help show how strange management is. The [Garbage Can Theory](#) created by the late Michael Cohen of UMSI and colleagues says that decisions happen because of problems looking for solutions, solutions looking for problems, and decision-makers looking for work. Decisions “win” because of truth, power or process, but since

power and process claim the truth, it is hard to tell. “Power wins” can be despotic, but isn’t always. What economists call “decision rights” confer “legitimate” power, essential to management. Plato liked risky monarchy (the philosopher king). Lord Acton said power tends to corrupt and absolute power corrupts absolutely. Process is often created to rein-in power (cf. “separation of powers” and “due process”). Truth and process are both invoked by scientific method and jurisprudence. Decision-making might not be management but it kinda is. Why decisions are made and why they win is a rabbit hole you can go down and get lost in. It’s a lot simpler to think of money and people leading to the concepts of stakeholder and APOV. There might be more to it, but in SI 661 we start with money and people.

Money is an <abstraction>, a <representation>, and a <proxy> for other things. Money can proxy people (a welder at a going rate of so much per hour), land (square units like hectares at so much per unit), or materials (so much per quantity). Chunks of money (a <budget>) start projects that are then evaluated: are they “on budget,” “on time,” “on track,” etc. Things go ahead with money and stop without it. Money is a control mechanism, and paying in increments allows ongoing control. Money has a language from accounting, finance, etc. People who wish to communicate with managers must know this language and have “money skills.”

“People skills” get people to work, buy, and say OK. Managers use people to get stuff done. Managers <organize> and <control>. <Division of labor> and <specialization> lead to the structure of hierarchy. For purposes of SI 661, forget about anything that challenges hierarchy – that is a highly specialized discussion. In management schools these subjects are part of organization behavior, theory, development, etc. Some places call them strategy or management. The canonical representation of organizing is <structure> to fulfill a <function> (the objectives). Hence structural functionalism and the role of hierarchy as in Exodus 18. Structural functionalism is both influential and salient. Don’t underestimate structural functionalism, and most structure is hierarchy.

Sustainability (keeping what original structure enabled) requires control, particularly social control. Traditionally this means getting people to do things, but it increasingly means control of machines or hybrid combinations of machines and people. JoAnne Yates says control is essentially management as it is now thought of.³ The inheritance is important: managers who used financial and accounting mechanisms were historically called “controllers.” Information technology in organizations, especially information systems, grew out of control and is still tied to control. APOV is about use of money and people to organize and control activities for some purpose (function).

³ Yates, JoAnne, (1989), *Control Through Communication: The Rise of System in American Management*. Baltimore: Johns Hopkins University, page XIV.

Business administration considers health an *area* or sub-field. Yet health is unusual. It is *highly institutionalized*, making it relevant to <institutional theory>. Activities like getting paid or keeping track of what's been done occupy health managers. Distinguish between broad field (health) vs. narrow activities (e.g., getting paid). <Stakeholders> are groups united by shared interests. Health managers are interested in value, function, money, and people with respect to health.

INTRODUCTION TO HEALTH MANAGEMENT

“Health” is a <service industry> within business administration. It has commonalities with public administration, but don't get hung up between public and private, non-profit and for-profit. Health is so peculiar that such terms are moot. Inheritance brought us to where we are. The following discussion could be located earlier, functionalism in the introduction to management. It shows why health is peculiar.

Adam Smith in the 18th century characterized the “invisible hand” of the market. Management was the “visible hand” that guides organizations toward functional ends. This was the functionalist view of management, It began in the late 19th century with U.S. business education (Wharton was first in 1881). Government administrative education was already there. 19th century ideas by Prussian sociologist Max Weber (who coined the term “bureaucracy”) joined 19th century scientific management gurus like Frederick Winslow Taylor.⁴ Scientific management guru Luther Gulick built on the work of French government theorist Henri Fayol to create the acronym POSDCORB for Planning, Organizing, Staffing, Directing, Co-Ordinating, Reporting, and Budgeting, to (Gulick, 1937).⁵ Chester Barnard's 1938 book, *The Functions of the Executive* made functionalism the bedrock of professional management.⁶

Health as a service industry (cf. <product industry>) means doing things for or to people rather than making/selling things. The functionalism of health is inherently conflicted: it fights against sickness, injury and death, but almost everyone gets sick or injured. Everyone dies. The service has been politically disputed in the U.S. for decades. Some think access to health service should be predicated on ability to pay like most other services. Others see access to health service is a fundamental right. Large health service enterprises cost a lot. Health is regulated: control is placed on who can do what.

⁴ Scientific management contributed a lot, not just to the foundations of administrative theory. Gulick helped create the sport of *basketball*, and with his wife Charlotte, started the *Camp Fire Girls*. With his co-author Lyndall Urwick, who first applied to management, Gulick created the journal *Administrative Science Quarterly*. The book (and later movies) *Cheaper by the Dozen* was about husband and wife scientific management team Fred and Lillian Gilbreth and their 12 children. Lillian Gilbreth and Mary Parker Follett are considered the pioneering women in management theory.

⁵ Gulick, Luther (1937). *Notes on the Theory of Organization*. In Gulick, Luther; Urwick, Lyndall (eds.). *Papers on the science of Administration*. New York: Institute of Public Administration. p. 13.

⁶ Barnard, C.I. (1938). *The Functions of the Executive*. Harvard University Press.

Patients technically *own* their health data, but are seldom custodians of those data due to moral hazard (insurance). Health might be *the* most complicated service industry.

Health is nonetheless subject to management expectations. Health management is dependent on using money skills and people skills to get health stuff done. Shelves of books and countless papers have been written about health management. Instructional programs (like the MHI) take months or years to complete. SI 661 scratches the surface of a big topic. Theory can help one be tolerant of ambiguity and still get the work done. Take, for example, isomorphism. Confidence in professionalism is a big part of health management. Without such confidence, patients won't come, programs will not be accredited, etc. Sometimes it is easier to mimic success than to invent it. Health (like most institutionalized endeavors) exhibits *mimetic isomorphism* where organizations mimic (imitate) the structures and/or control mechanisms of the successful.⁷ ("Best practice" is an isomorphism play.) Contrast with two other kinds of isomorphism seen in health: *coercive isomorphism* (external actors force conformance), and *normative isomorphism* (standards and conventions influence change).

Calls for health to be more "businesslike" are serious. Everyone wants important and expensive health to be managed well. Yet, health has *never* been easy to manage. A high tolerance for ambiguity is essential to any hope at health management. There *has* been progress. People keep trying. But health is nonetheless confusing. Health is kind of like the weather: everyone talks about it, but no one does anything about it. Health management is a bit like <Whac-a-Mole>; whack it here and it pops out there. Health management remains hard. Managers have "stakes;" they are stakeholders. They have the APOV. To work with them or to be one of them requires understanding the APOV.

INTRODUCTION TO MANAGING HEALTH INFORMATICS

Professionals should engage health informatics with a skeptical embrace. Technology can make things better and deserves the embrace, but many claims (especially around IT) are so hyperbolic that skepticism is warranted. Much depends on the kind of health informatics being considered. To most people health informatics means information systems that are big, expensive, and tied to general management functions. The management school field of Information Systems is trying to envelop Health Information Systems. It was once called Management Information Systems. Health informatics often focuses too much on particular kinds of information systems and not enough at other issues.

Information Systems

⁷ DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147–160.

There are two broad classes of information systems: one found mostly within health care providers and one mostly outside. Many health professionals who *knowingly* interact with IT use information systems run by health care providers ostensibly to control “workflow” (visits or appointments, procedure scheduling, getting paid directly by patients or by third-parties such as insurance or Medicare, health records, drug prescription, clinical trial enrollment, etc.). These sometimes involve patients through “portals” and such. These systems are visible because they are big and expensive.

A common measure of big is “lines of code” in a software program.⁸ Keep three things in mind about lines of code:

- Most code grows – adds lines – over time to exploit price/performance improvements in processors, storage, and networking, and to provide greater functionality. And don’t forget coders looking for work.
- Code bases can grow beyond poorly understood thresholds. Bases that cross these thresholds can become difficult or impossible to modify because no one has the source code or the it has grown so complicated that each “fix” introduces more errors. This leads to, “If it ain’t broke, don’t fix it,” where the base is frozen. Some common systems (e.g., for airline reservations) have kernels that run today on one-off variants of IBM OS 360 assembly code from the 1960s under emulation. Software can last a long time (the Y2K problem came from this). Once small systems grow as new code is built on top of old code, or that calls functionality from old code libraries (primitive reuse).
- The <cloud> is a return of an old thing called “timesharing.” The cloud and SaaS (software as a service) have allowed software consolidation and increased software size.

The Google code base is estimated at 2 billion lines of code. SAP, the Enterprise Resource Planning (ERP) system, is about 250 million lines of code. Large health-related information systems can be millions of lines of code. Big code bases can be customized in principle by setting “switches” to fit organizational conditions. But a 1000 switches (not uncommon) creates billions of possible configurations. (1000! is an integer with 249 0s after it.). Most big systems are installed by “value-added remarketers” (usually big consulting organizations) that have perhaps 20 templates they choose from to configure implementation for any organization.⁹ Big health-related systems are similar – too big and complicated to allow for serious customization.

⁸ Lines of code is a problematic measure of software size. There are disagreements about what counts as “a line” (do comments count?). Some languages contain multiple instructions per line and others contain only one. There are disagreements about the importance of specific instructions. Alternative measures like <function points> have been suggested. This fight has been going for seven decades, since the advent of the “stored program.” It became heated four decades ago.

⁹ A full-blown ERP system can cost many millions of dollars. The University of Michigan’s 1990s PeopleSoft system (locally called M-Pathways that drives Wolverine Access and other systems) was supposed to cost \$30 million. The actual cost was closer to \$100 million.

Health-related information systems for large hospitals cost hundreds of millions of dollars. Electronic Health Records (EHR) systems for small, stand-alone health offices can be in the thousands, but can range from about \$1 million for a small hospital to billions for large systems like Kaiser Permanente (\$4 billion) or the Veterans Administration (\$10 billion). Such systems often require additional investments in database management, other infrastructure, and implementation services. Since the people managers report to care about money, such systems draw attention. There can be additional problems besides expense, as when influential users dislike the systems. Search <problems with health information systems>. Big problems also draw attention. Adoption is a one-way street when an organization cannot pull back.

Another class of information systems exists outside health care providers. Sometimes services are provided by other companies (genetic history, fitness, laboratory testing, immune system profiles). Sometimes they are provided in concert with monitoring devices. Sometimes provision or exchange of information is part of these services (medical information sites, pharmaceutical sites, patient discussion fora). They might be tied to print, radio, and television coverage or advertising. They are among the fastest growing information systems but because they are not part of health care providers they are hard to spot. They can bypass health practitioners or change power relationships. (See Barley's work on CT Scanners changing the relationship between radiologists and radiological technicians,¹⁰ and the medical device manufacturers who collect health data and keep it from practitioners.)

Organizations acquire or produce such systems for good reasons. Still, they can be huge, unmanageable by the organizations that buy them, expensive, disliked by their users, hidden from view, and disruptive to the existing health care ecology.

Research Systems

Information systems have long been used to manage research projects to manage human subjects, perform RCR (responsible conduct of research), and provide other aspects of research administration. Research advances and evidence-based practices are important for all health organizations. Increasingly, publication in journals requires making data and software for reanalysis available. Any research-related endeavor in health should incorporate a careful assessment of the role of information technology. Health research is increasingly grounded in data analysis. Machine learning, deep learning, and other aspects of "data science" are predicated on the assumption that data are available from information systems (e.g., electronic health records), and data

¹⁰ Barley Stephen R. (1986). Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments. *Administrative Science Quarterly*. Vol. 31, No. 1 (Mar., 1986), pp. 78-108

collected “automatically” from devices like CPAP machines, Fit-Bits, etc. is rapidly-evolving. Research systems often bridge information systems and embedded systems.

Embedded Systems

Embedded systems are hardware (processors, storage, data communications capability, and controllers) plus the software to control them, collect data, perform needed computation, etc. Programmable or not is an option, depending on application. Embedded systems are often invisible to users. Software often supervises functionality and watches for availability of processor speed, system memory and power. Many embedded systems are of high speed, small size, low power use, high reliability, high accuracy, and adaptability (e.g., if they can be re-programed). Embedded systems process inputs into outputs, sometimes interacting with other systems or humans or working by themselves. They can control connected devices (e.g., mp3 players, video game consoles, smart thermostats, appliances like microwave ovens, automobile systems, avionics and “fire and forget” weapons control). Some operate in real time. Some use wired or wireless networks (e.g., the Internet) as when a home security system links sensors via TCP/IP, or SCADA (Supervisory Control and Data Acquisition) applications control utilities.

Embedded systems can run on a small (4-8 bit) processors with primitive software development environments, mid-sized (16-32 bit) processors and software development in compiled languages, or on large (32-64 bit) processors using advanced software and hardware/software co-design. Embedded systems are becoming common (appliances, automobiles, consumer electronics, and anything part of the Internet of Things, or IoT). They are often invisible to users. They are of growing importance in health informatics, operating diagnostic and therapeutic medical devices or collecting data that go to information systems (e.g., automatic reporting of test results or images to health records). They also connect to research systems to report data to researchers.

Embedded systems can be large. Smart phones can carry as many as 15 million lines of code, up from a couple of million just five years ago. Some cars are estimated to carry up to 100 million lines of code, up from a few million not long ago. The line between non-embedded and embedded blurs as network connectivity improves. Google’s huge code base is largely available through Internet connectivity. Applications increasingly act like embedded systems, always “on,” waiting to interact with users. As stand-alone, “on premise” software moves to the cloud and SaaS, most IT becomes like embedded systems. The connections between embedded systems, information systems and research systems can facilitate or impede decisions about health informatics. It is important to look closely for these connections.

People who work in health informatics should pay attention to embedded systems. They can be hard to spot, but are of growing importance. Some embedded systems have long been implanted in bodies (pacemakers, for example. More will be.

RECAP AND CONCLUSION

Management involves ambiguity. It is about value, focusing on money and people tied to functions. Budgeted money starts projects; lack of money stops them. Managers use money as a control mechanism. Managers need “money skills.” They need “people skills” to organize into a structure to fulfill functions – structural functionalism. Control enforces structure. Control is management. Information systems grew out of control.

Health organizations want to get paid, keep track of what’s been done, assign people to shifts and tasks, etc. This makes health management fit with business administration, but it doesn’t matter much for SI 661 whether it is or not. The functional tradition captured by ideas like POSDCORB and Barnard’s *The Functions of the Executive* fits with what health management comes down to: money and/or people. Health might be *highly institutionalized*, a peculiar service, and perhaps the most complicated service industry. But it still must be organized and controlled. Health managers are stakeholders – what are their interests? Use APOV to get at this.

Health informatics includes more than health care organization information systems. It includes as well systems that serve patients directly, in some cases outside health provider organizations, as well as research systems and embedded systems. Software size and expense draw attention. Infrastructure can become unmanageable though the mandate to manage remains. User Experience, machine learning, deep learning, and other aspects of “data science” are creating new challenges. Health informatics is rapidly-evolving. Of special importance are embedded systems “invisible” to users but that interact with other systems using wired or wireless networks. The line between non-embedded and embedded is blurring.

Like the IT world, SI 661 has many details. Be ready to drill in on the details – they can matter. But most of the time, remember the big picture. Managers are stakeholders with interests. Stakeholders can have competing or even antithetical interests. Find each manager’s interests. For any system, whose interests are served? What APOV is a given manager likely to hold? There might be more than one point of view. If you know where managers are coming from and where they are going, you probably understand their APOV well enough to be a manager or work with managers.

Lectures, readings, cases, and things people bring in for discussion are seeds for reflective learning. A typical class meeting will have elements of all four. Lectures provide grounding and tie the materials together. Readings and cases establish understanding of APOV. Things brought in by members of the class or visitors shape real-time consciousness. Two modules establish project management and APOV. Project management is a need for almost everyone. Understanding perspectives of *managerial inclination* or *managerial awareness* make this work professionally relevant.

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