The Anatomy of Large Scale Systems Revisited: Restructuring US Health Care

Joel Moses
MIT
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Why Revisit the Anatomy Paper?

- I gave a talk at the “Internal ESD Symposium” in 2002 and also one at the first ESD Symposium in 2004.
- My points relative to the importance in complex systems of “ilities” such as flexibility, robustness, and maintainability were generally well understood.
- My points relative to how to structure or architect large scale complex systems were not that well understood.
- Hence I am giving it another try to explain a type of structures called layered hierarchies.
Layered Hierarchies

Pyramidal organizational structures

– Each layer can be viewed as an abstraction of the prior layer
  • Examples: polynomials–integers, databases–a single record, physicians–nurses, captains–privates
  • Physicians can, in principle, do what nurses do as well as perform additional analyses and procedures

– A key goal of hierarchies, in particular layered hierarchies, is to control overall complexity
  • Hierarchies also permit “breaking of ties” in decision making
A layered system with three layers.

Elements in one layer connect to one or more elements in a higher layer.

Often members of one layer cooperate with other members of that layer, forming a team.
The Magic Number 3

- Historically the number of layers in layered human systems has been 3. It is possible to have 5 or 7 layers. More layers than that is unusual in human organizations but quite common in software.
- Flat systems (e.g., networks) have one layer, with little or no payoff in the use of hierarchy to control complexity and be reasonably assured of a desired result.
- Systems with just two layers have some payoff, but not as much as three layers.
- Examples:
  - cardinals, bishops, priests
  - full professors, associate professors, assistant professors
  - strategy, operations, tactics
- One can get a higher number of layers than 3 by splitting one layer into three layers.
Layered systems are not Trees or Networks

- **Tree structures** tend to emphasize competition between different branches (silo mentality)
- **Layered systems** tend to emphasize lateral cooperation at each level
- **Networks** are usually flat organizational structures and not hierarchies
- Each of these generic architectural forms has advantages and disadvantages – there is no ideal organizational form for every situation
Why Health Care?

• Not an obvious situation for looking for an architecture
• Health care delivery is of great interest these days
• My analysis deals with only a piece of the puzzle
  – No discussion of IT
  – No discussion of the need to avoid needless procedures (e.g., Dartmouth studies)
  – …
Triaging Healthcare

• In the US we basically have a two-layered system – primary care and specialists/hospitals.
• As a result, primary care can be frustrating to physicians in part since most visits involve relatively routine issues, such as an ear ache in an infant
• As a result as well, emergency rooms in hospitals are full during hours when primary care offices are closed and when individuals do not have medical insurance
• The cost of primary care is high (about 40 percent of all US health care costs or $1 trillion per year)
• In many European countries there are three layers: community clinics, primary care and specialists/hospitals
First Triage

• Emphasize a three-layer system:
  – community clinics staffed by nurse practitioners
  – primary care physicians
  – specialists and hospitals

• 80/20 rule (Pareto) applied twice
  – Assumes that most of the interactions with healthcare system can be treated well and safely by nurse practitioners under a physician’s guidance
  – Assumes that most of the remaining visits can be handled by primary care physicians
  – Leaves fewer cases than at present to be handled by specialists and hospitals

We can argue about the percentages, but I believe the basic idea of a Pareto rule taken twice still holds
Advantages of the First Triage

• Community-based clinics can be open many more hours than primary care offices, may be closer to patients, permit visits to the home, encourage wellness
• Less pressure on primary care physicians, less boring primary care practices, consistent with relative lack of interest in primary care by young US physicians
• Less pressure on emergency rooms
• Over 1000 such clinics currently exist (lately associated with major hospitals, viewed as providing advertising for the hospitals)
• Should result in major savings (tens to hundreds of billions annually) in the long run
Concerns with First Triage

• Cultural change
  – US public expects to see physicians all the time
  – Physicians are concerned over their income level: follow the money
• Safety concerns (even with physicians’ oversight)
• Not enough nurses, not enough teachers of nurses
• May require major upfront investments in nurse education and creation of clinics
Second Triage - Hospitals

- Hospital system is often composed of three layers itself: community hospitals, regional hospitals, tertiary hospitals
- Community hospitals – ERs, relatively simple diagnoses and procedures, send more complex cases to regional hospitals or tertiary ones
- Regional hospitals – more complex cases than community hospitals, broader set of specialists, send the most complex cases to tertiary hospitals
- Tertiary hospitals – handle cases that have been difficult to diagnose, have sophisticated intensive care units, several sub-specialties, specialized equipment, teaching
Specialty hospitals

- Some parts of the US have specialized hospitals in areas such as cancer, children’s diseases, diabetes and heart diseases
- Advantage of specialty hospitals is that experience gained in seeing many similar cases can lead to medical teams that will have higher quality outcomes
- A possible advantage is that with higher quality (and thus fewer complications) and a large number of similar cases (leading to continuous improvement) costs can be reduced markedly
Proposed Tertiary Hospitals

• Proposed structure of tertiary hospitals would have three layers
• The top layer in tertiary hospitals will handle cases that are difficult to diagnose and/or require innovative procedures that are not yet ready for the rest of the system
• Diagnosticians in such top layers are masters of their craft (think of TV’s House minus his personality)
• Top layer of a tertiary hospitals would share specialists and services from the rest of the hospital
Lower Layers of Proposed Tertiary Hospital Structure

• The **middle** layer in the tertiary hospitals would have several specialty subhospitals – they could share some medical specialties (e.g., anesthesiology)

• The **lowest** layer would have an ER and some general medical services, but less than present tertiary hospitals which duplicate services available in regional or community hospitals
Advantages of Second Triage

• Reduced cost of the community hospitals without loss of effectiveness (assumes that more people will go to them first)
• Higher quality and reduced cost of the specialty subhospitals
• Reduction of complexity (and hence overhead costs) that arises from proper separation of the nature of services in a tertiary hospital
• Greater effectiveness (due to clearer emphasis on masters in the diagnostic craft) of the top layer of a true tertiary hospitals, albeit at relatively high cost per patient
Issues with the Second Triage

• Change in culture – greater reliance on community hospitals

• Change in payment structure – master diagnosticians in tertiary hospitals should be paid by the hour as do professionals in many fields other than medicine

• Surgeons and other specialists in specialized hospitals or subhospitals should be paid a fixed price for the overall procedure - competition between such specialized subhospitals is via quality and cost (see Clay Christensen’s latest book, *The Innovators Prescription*)
Other Examples of Layered Systems

- Consumer Industries: women’s clothing, automobiles
- Government centered services: higher education (K-12 educational structure is usually too biased by national culture), military (with lateral alignment)
- Technical systems: many large software or communication systems
- The human brain – 6 layers in the cortex
Questions?