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

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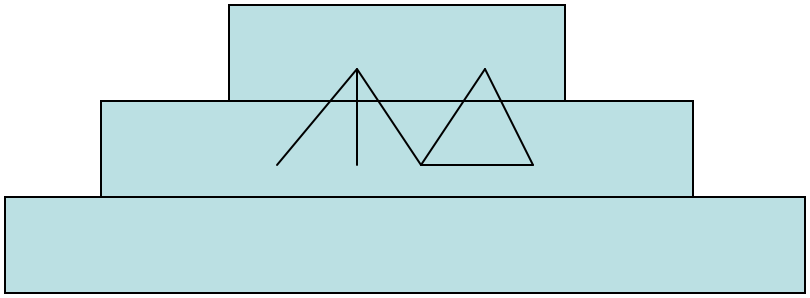
Why Revisit the Anatomy Paper?

- 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?