

Comparing and Contrasting Health and Transportation as Complex Sociotechnical Systems

Sociotechnical Systems Research Center (SSRC) Series
Conversations on Sociotechnical Systems
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Ideas about Complex Sociotechnical Systems

- April 2012- *Miller Lecture*– Complex Sociotechnical Systems: The Case for a New Field of Study
- February 2013 – *Inaugural SSRC Distinguished Lecture*: Developing Processes for Understanding Complex Sociotechnical Systems: Are We There Yet?
- September 2013 – *SSRC Series – Conversations about Sociotechnical System*: Comparing and Contrasting Health and Transportation as Complex Sociotechnical Systems

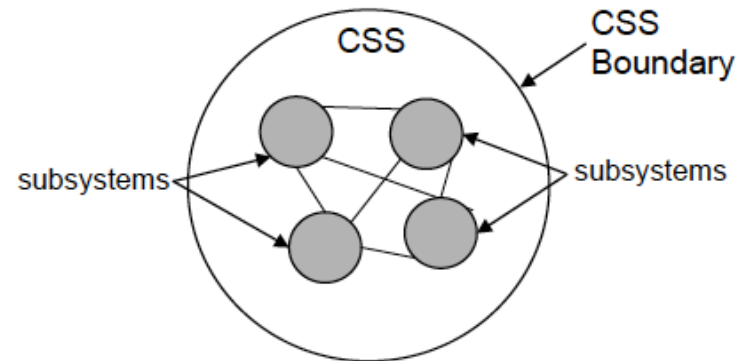
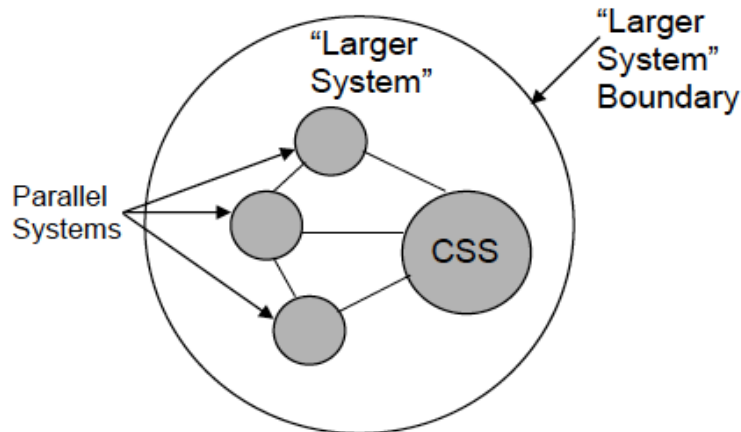
Two Linked Concepts

CRITICAL CONTEMPORARY ISSUES
and
COMPLEX SOCIOTECHNICAL SYSTEMS



Systems

- Composed of interconnected components and subsystems
- Often structured in a hierarchical manner
- Usually Interacts with the environment external to it



Sociotechnical

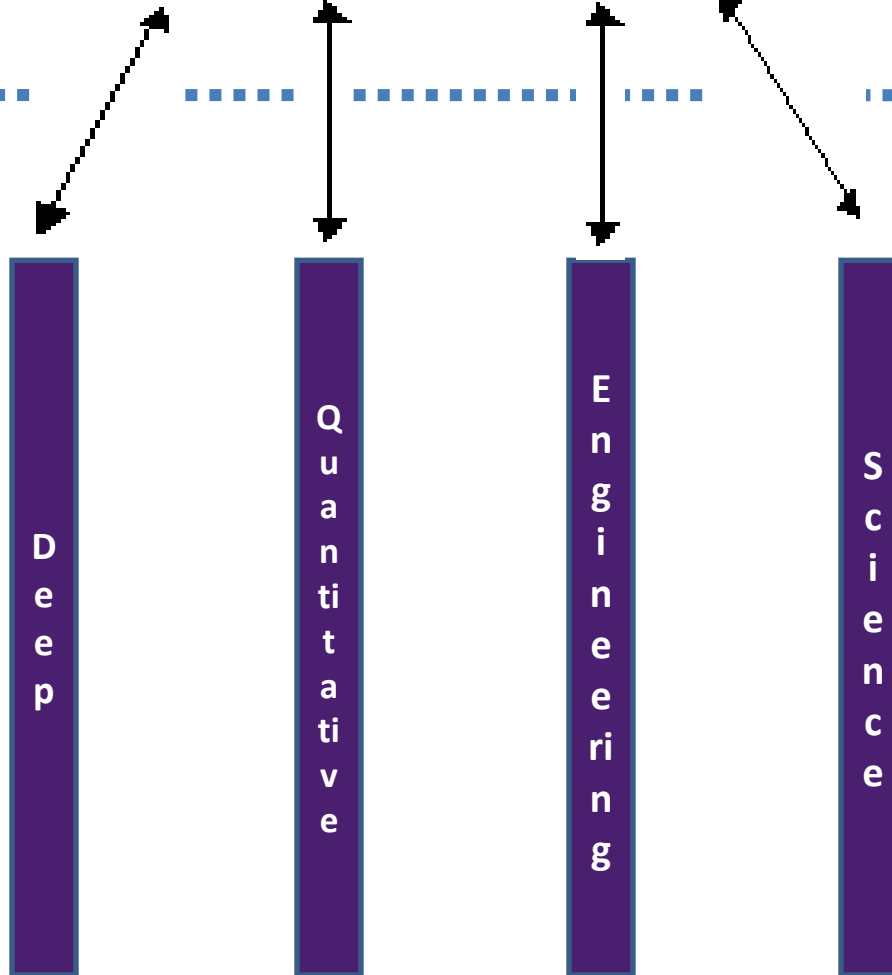
- Containing technology subsystems and components central to its performance
- and*
- Having societal/political/economic relevance and impact

An Approach to the *Design* of Complex Sociotechnical Systems

*Systems-Oriented Methods

Integrative Domain Knowledge

**Social Sciences, Management & Planning



Integrative View of the Field

- Transportation
 - Economic Development, Energy, Environment, Land Use, Urban and Regional Structure, Public Health
- Health
 - Economic Development, Social Equity, Geopolitics, Transportation (Accessibility)

Where the Fields Connect

- Transportation impacts the environment (e.g., air quality) which in turn causes health issues, especially for the elderly and infants.
- Transportation is the means for accessing health services, conventionally and in emergencies.
- Highway safety is a major public health issue in both the “rich” world (death toll in U.S. of 35,000 annually) and the developing world (e.g., see statistics on pedestrian fatalities).

Uncertainty

In Transportation:

- Economy
- Energy Constraints
- Environmental Constraints
- Political Environment

In Health:

- Technology
- Political Environment
- Public Attitudes
- Epidemics

Networks

In Transportation:

- The physical network is central to transportation—infrastructure: highways, railroads, airports...
- Vehicles – cars, buses trucks, locomotives, aircraft move on the network carrying people, freight.

In Health:

- The network is often virtual
- “Patients”, information flow
- A redefinition: care coming to the patient

Institutional Change

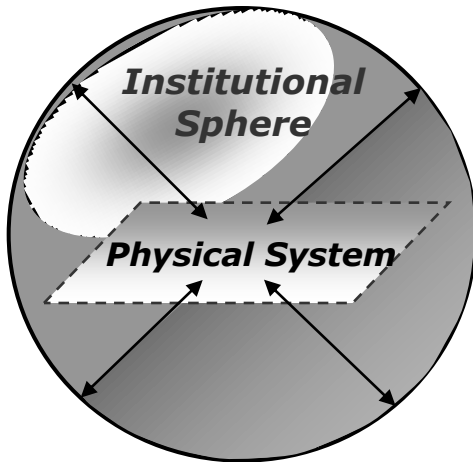
In Transportation:

- Intelligent Transportation Systems (ITS) – changed the focus from low-tech infrastructure to high-tech infrastructure, smart vehicles and **operations**
- The “death” of the Highway Trust Fund and the need for new funding mechanisms like road pricing
- The public/ private partnership

In Health:

- The Affordable Care Act (ACA)
- The recognition that you don't need a doctor for everything!
- A variety of forms of care delivery

Nested Complexity



- > Physical system
 - More quantitative principles
 - Engineering & economic models
- > Institutional “sphere”
 - More qualitative in nature and often more participatory
 - Stakeholder evaluation and organizational analysis
- > Different methodologies are required
 - within the physical system
 - between the institutional sphere and the physical system
 - within the institutional sphere

System of Systems (SoS)

In Transportation:

- An example is the PhD dissertation of Nirav Shah, September 2012.
- The component systems are railroads and truckers competing and yet cooperating to move intermodal containers.

In Health:

- Work by Fradinho, Nightingale and Fradinho – studying a hospital as an SoS – comparing a hospital in the U.S. with one in the U.K.
- Another idea: consider multiple hospitals in the same city as a SoS.

Mitigation vs. Avoidance

In Transportation:

Mitigation

- Crashworthy cars.
- Good emergency response – get people to the hospital fast to an ED that is ready for them – Horan’s work on CrashHelp

Avoidance

- V2V communication– avoid crashes in the first place

In Health:

Mitigation

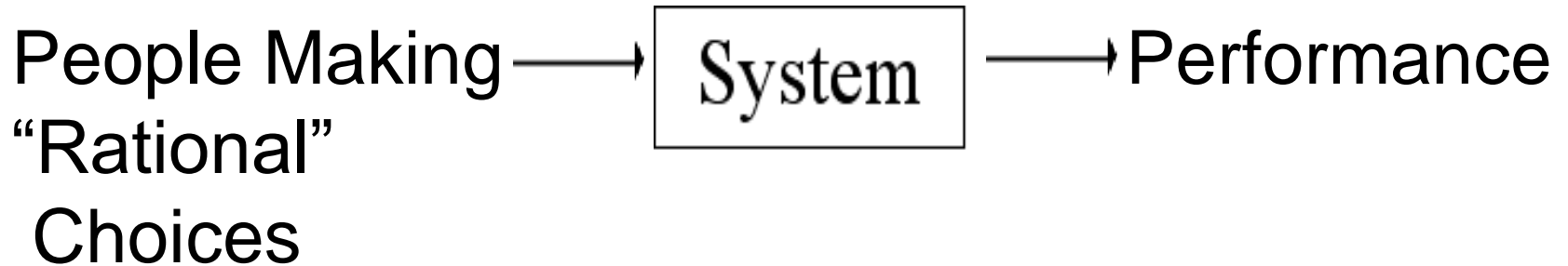
- Get people better

Avoidance

- Wellness – keep people healthy
- Vaccinations

Herbert A. Simon

H.A. Simon, 'Rational choice and the structure of the environment', *Psychological Review*, vol. 63 (1956), pp. 129-38



Predicting Demand

In Transportation:

Demand is a function of multi-dimensional service quality; it is driven by economic factors – no job, less travel; multiple trip purposes; multiple mode choices; driven by land use, which changes slowly; relates to supply chain management (for freight).

In Health:

- Demand is a function of demographics, community health, access to care.
- Social Attitudes
- Public Health Initiatives
 - Smoking
 - Obesity

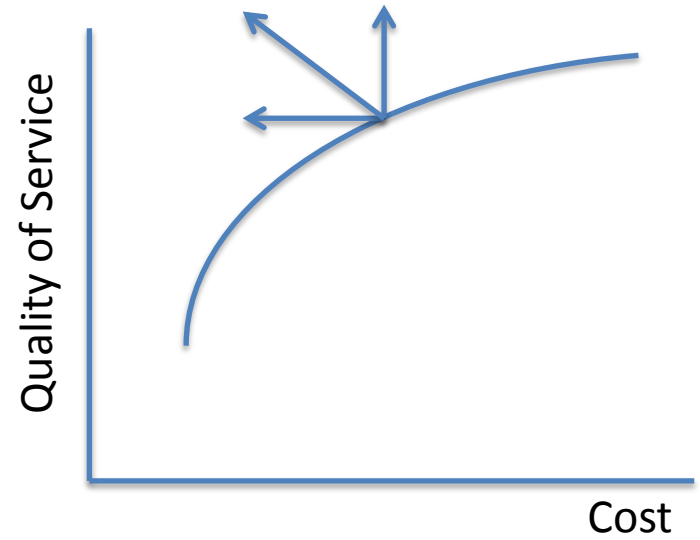
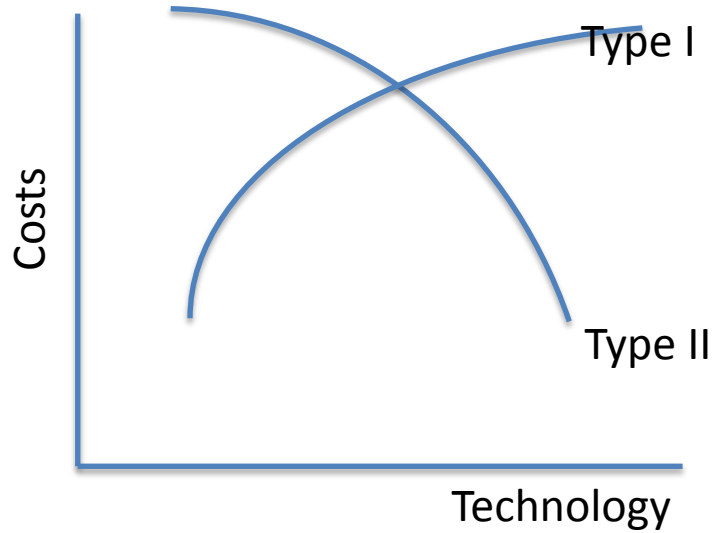
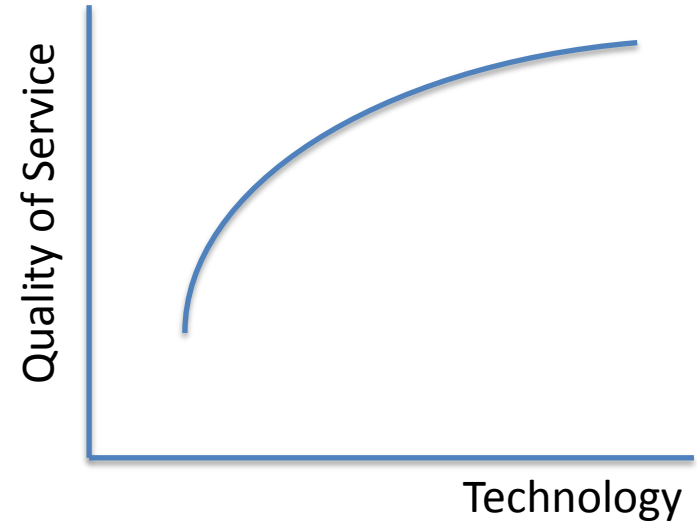
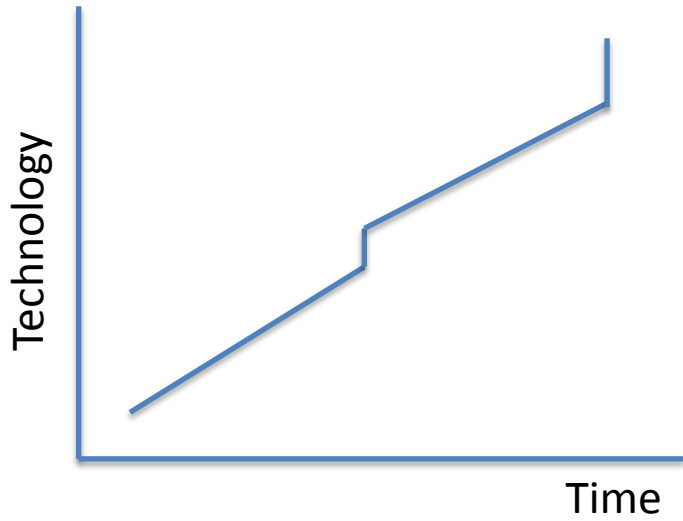
Congestion

- In transportation we know that the quality of service on a link is a function of the volume/ capacity ratio – the well-known hockey stick – as volume approaches capacity, travel time increases in a non-linear fashion.

In health, the same occurs – e.g., *Stress on the Ward: Evidence of Safety Tipping Points in Hospitals*, Kuntz, et al.– “Do hospitals experience safety tipping points as utilization increases? What are the implications for hospital operations?”

Cost vs. Service Quality: The Imperative to Lower Costs Without Service Degradation

Technology, Quality of Service and Cost



Costs vs. Service Quality

In Transportation:

The BMW is “the ultimate driving machine” – that doesn’t mean we think it is inequitable if everyone doesn’t have access to one.

In Health:

Everyone deserves access to the best available and deployed technology. That is what social equity means.

Costs vs. Service Quality

In Transportation:

If a high-technology, high-performance and expensive alternative is available – say, high-speed rail – we may choose *not* to deploy it—say, in the U.S.

In Health:

If a high-technology, high-performance and expensive alternative is available – say, a better chemotherapy treatment for cancer – there is a moral imperative to deploy it..... *{let me get this straight. We are not going to give our patients this life-saving new treatment because it is too expensive?!}*

System Safety as an Emergent Property

In Transportation:

- It is not always “pilot error”
- Prince William Sound

In Health:

- Gawande– The Checklist Manifesto
- Hierarchy

Economic Development

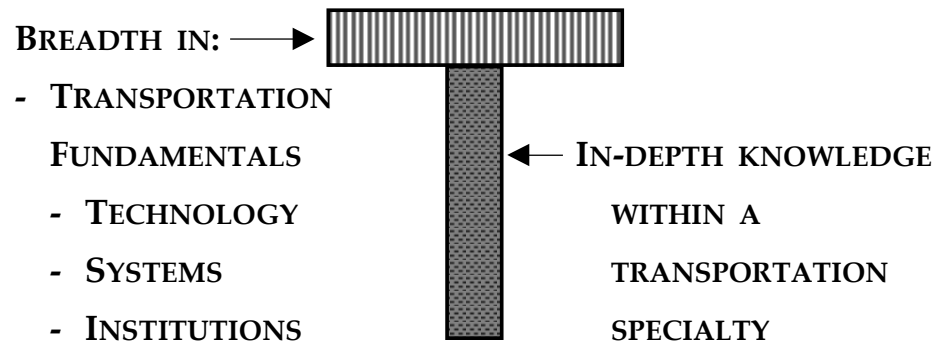
In Transportation:

Mobility as a plus but congestion as a minus; enabling the global economy through efficient freight movements; creating an economic drag because of environmental impacts.

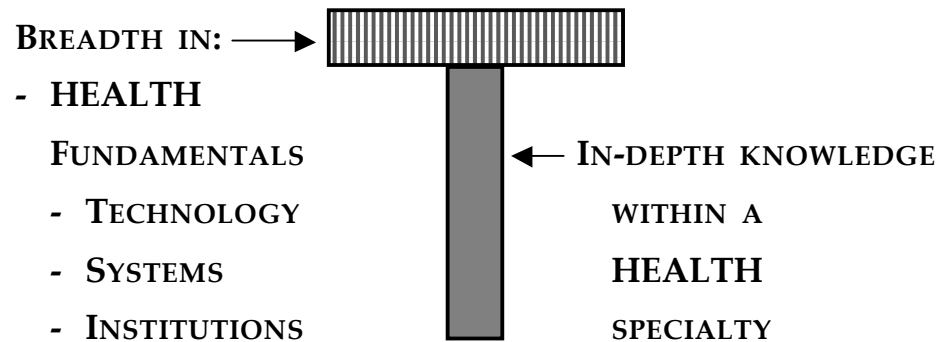
In Health:

Costs of care; lost productivity because of illness but creating a longer, more productive “life-cycle” for many individuals; a recession-proof source of jobs – the “Louisville” story.

THE “T-SHAPED” NEW TRANSPORTATION PROFESSIONAL



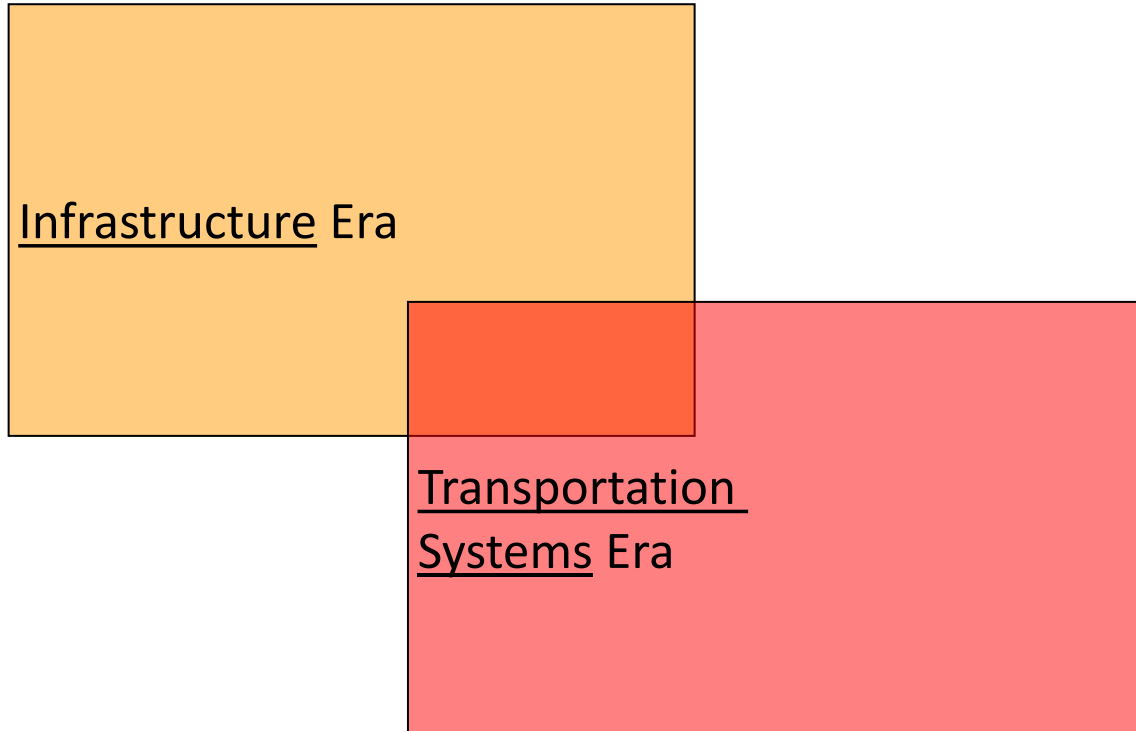
THE “T-SHAPED” NEW HEALTHCARE PROFESSIONAL



What does the “T-shaped” professional have?

- Breadth for an integrative “systems” view
- Depth for professional confidence
- An open and curious mind
- Ability to communicate
 - In writing
 - In oral presentations
- Ability to work as a member of a team
- Ability to lead a team (or perhaps an enterprise)
- An ethical sense

Transportation Eras



“Infrastructure” Era

- Build What “They” Want
- Focus on Physical Facilities
- Focus on Mobility
- Focus on Economic Growth
- Largely a Modal Perspective

“Transportation Systems” Era

- Economics-Based Framework
 - Supply
 - Demand
 - Equilibrium
 - Networks
- Focus on Economic Development and Environmental Concerns
- Focus on Both Mobility and Accessibility
- Recognition of Unpriced Externalities as Causing Problems – Congestion, Air Quality, Sprawl
- Intermodal Perspective (Largely Limited to Freight)

“Infrastructure” Era – What’s the Equivalent in Health

- ?

“Transportation Systems” Era

–What is the Equivalent in Health

- ?

PRINCIPLES FOR PROCESS FORMATION FOR COMPLEX SOCIOTECHNICAL SYSTEMS

Principles for Process Formation for Complex Sociotechnical Systems

- Keep institutional changes on the agenda (recognizing the difficulties).
- Optimization is a will-o'-the-wisp
 - Too hard to find an optimum
 - Oft-times, not even sure what we are optimizing
- Uncertainty dominates
 - Known unknowns
 - Unknown unknowns

Principles for Process Formation for Complex Sociotechnical Systems

- Understanding structure is vital
 - Don't rush to quantify
 - There is no silver bullet
 - Bundles of strategies alternatives
- Retain flexibility:
 - *“The essence of project leadership is to selectively commit as needed to move projects forward, but to delay costly and irreversible commitments until dominant uncertainties are resolved”.* (Lessard and Miller)

Questions and Comments

References

- Sussman, Introduction to Transportation Systems
- Sussman, T-Shaped Professional
- Kuntz, et al. *Stress on the Ward: Evidence of Safety Tipping Points in Hospitals,*
- de Weck et al.
- Donofrio, et al. T-Shaped Professional
- Fradinho, Nightingale and Fradinho
- Lessard, et al.