



# HIMSS<sup>19</sup> CHAMPIONS OF HEALTH UNITE

Global Conference & Exhibition  
FEB 11–15, 2019 | ORLANDO

## Population Health as Ecosystem Engineering

Session 2, February 12, 2019

Richard Biehl

University of Central Florida

# Conflict of Interest

Richard E. Biehl, Ph.D.

Has no real or apparent conflicts of interest to report.

# Agenda

- Objectives (2 minutes)
- Systems Modeling (10 minutes)
- Ecosystem Elements (5 minutes)
- Inputs vs. Components (8 minutes)
- System-of-Systems vs. Ecosystems (5 minutes)
- Population Health (15 minutes)
- Q&A (15 minutes)



# Learning Objectives

- Define requirements for ecological systems modeling of healthcare
- Categorize ecosystem elements across societal and organismic system layers
- Differentiate patients as system inputs from populations as integral ecosystem components
- Contrast traditional system-of-system versus ecological system strengths and weaknesses
- Propose ecological system management as primary paradigm for population health

# Overarching Objective

- We are *not* here to try to master systems modeling or engineering – the details matter less than the overall story.
- We *are* here to adopt a slightly different mindset about health systems as we begin our HIMSS19 journey together – this story underpins many topics and sessions this week.



# Systems Modeling

- What different kinds of systems are there?
- Specifically, what are *ecological* systems?
- What determines the boundaries of a system?

*Function*

**Ecological  
System**

Function on a *grand* scale: rivers moving water, wind moving air, and biosphere supporting life.

Ecological systems tend to range from *complicated* to *chaotic*.

**Ecological System**



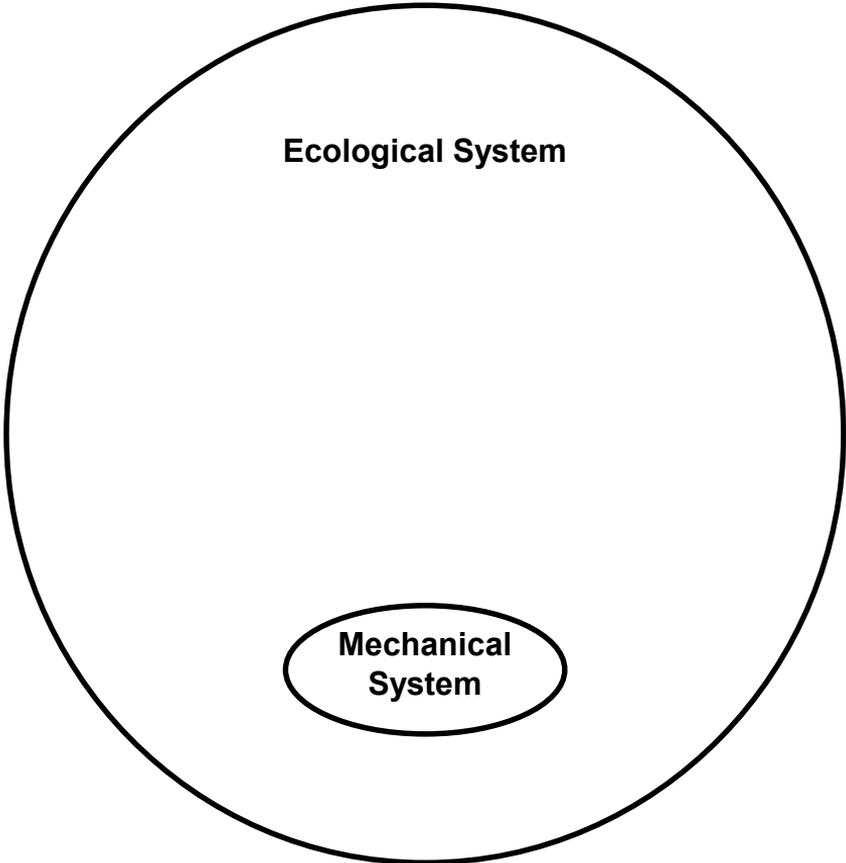
*Function*



*Sometimes intentionally designed.*

Mechanical systems tend to range from *simple to complicated*.

*Function*



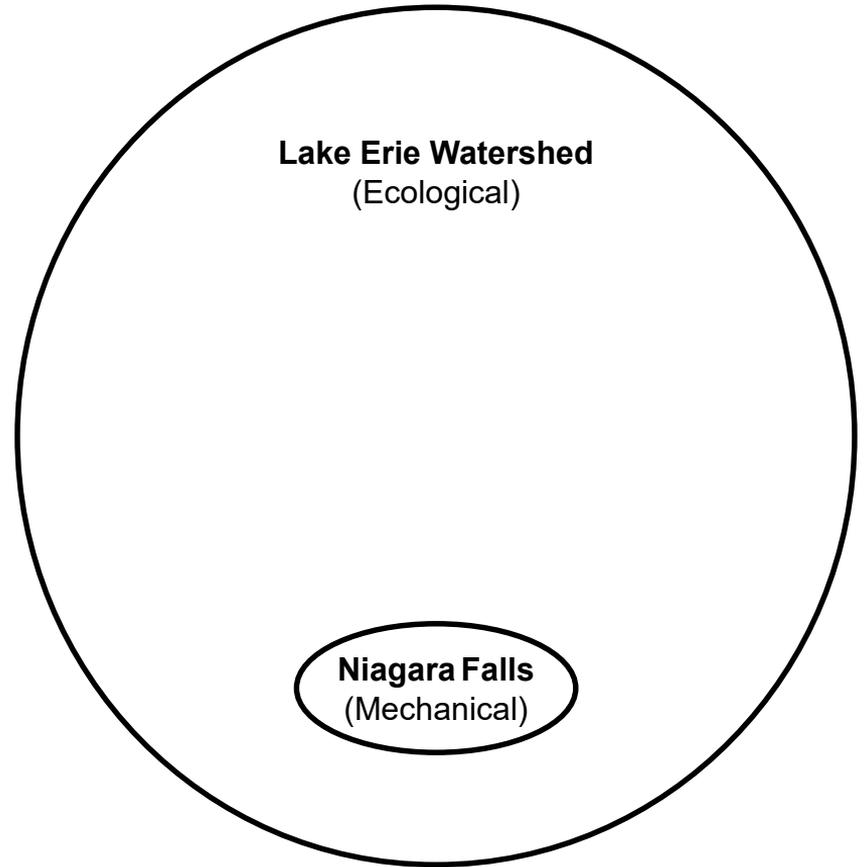
## Lake Erie Watershed (Ecological)

*Function:* Collect and consolidate rainfall and transfer it to the Atlantic Ocean via the Niagara River.

*While not definitional, an expectation that ecological systems will exhibit some form of emergent chaos, and that mechanical systems won't, is helpful when modeling functional systems.*

## Niagara Falls (Mechanical)

*Function:* Increase the linear momentum of water in the Niagara River by allowing it to fall in the gravitational field of its ecosystem



*Function*

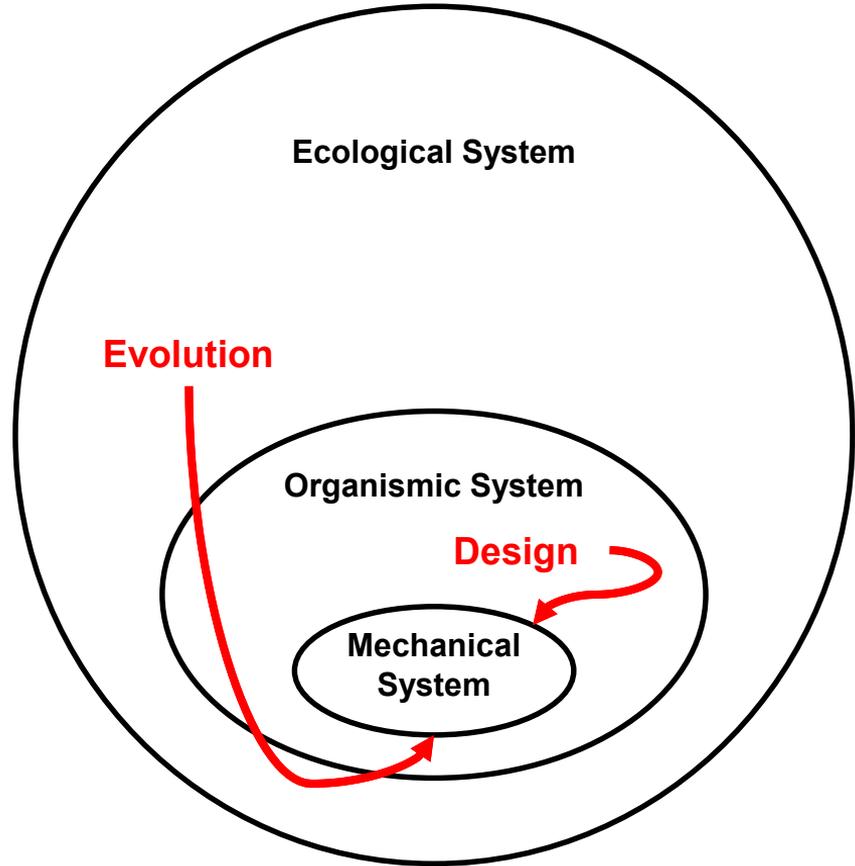


*Organismic systems are any distinct biological individuals that are capable of varying their behaviors in multiple ways in response to information or environmental stimuli.*

*Purpose*



*Function*



*Function*

**Ecological System**

*Purpose*

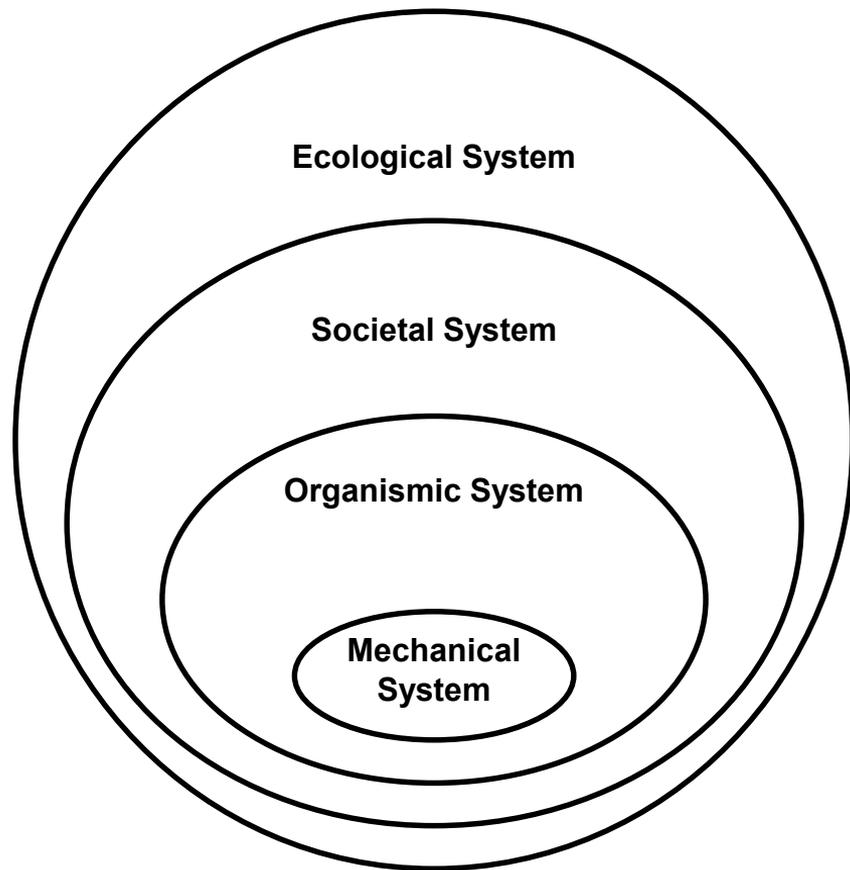
**Societal System**

*Purpose*

**Organismic System**

*Function*

**Mechanical System**



Ecology  
Meteorology  
Geology



*Function*

Anthropology  
Sociology  
Economics



*Purpose*

Psychology  
Ergonomics

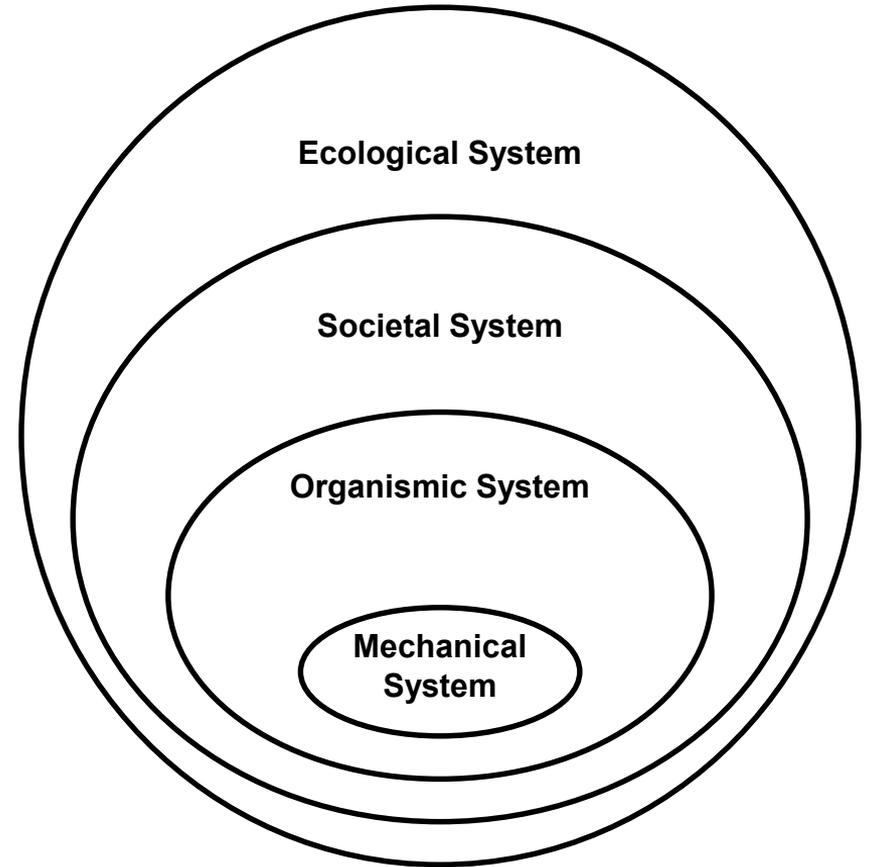


*Purpose*

Biology  
Mechanics  
Electronics  
Chemistry



*Function*



## Lake Erie Watershed (Ecological)

*Function:* Collect and consolidate rainfall and transfer it to the Atlantic Ocean via the Niagara River.

## Erie Utilities (Societal)

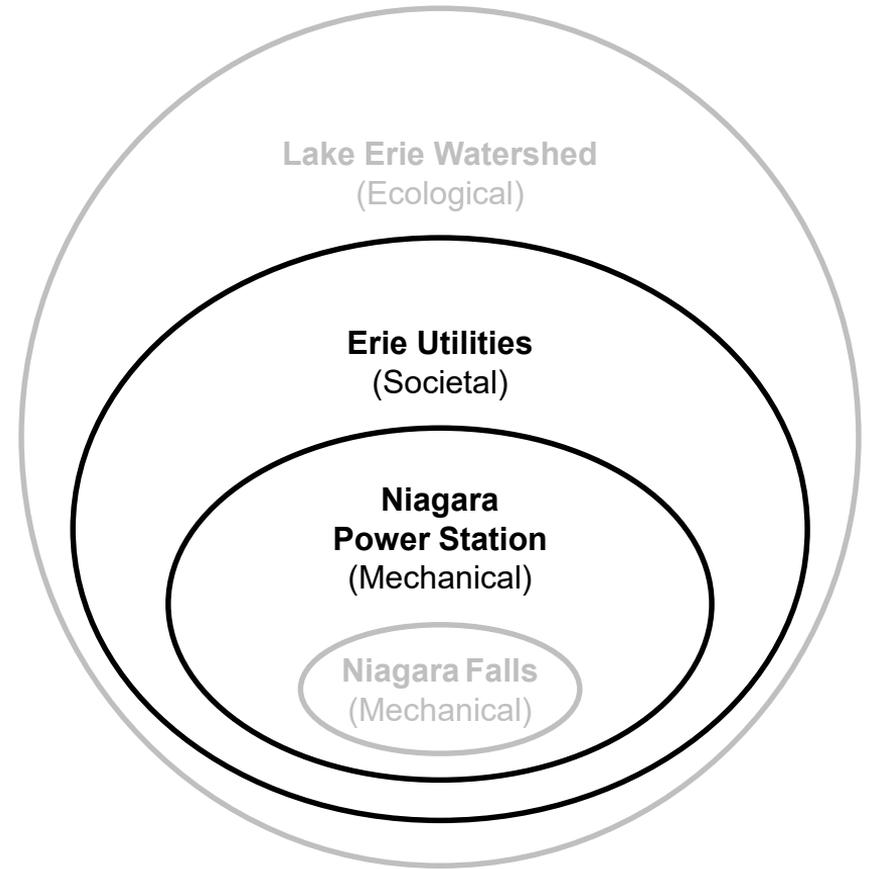
*Purpose:* Generate shareholder profits by exploiting the resources of Niagara Falls to generate and distribute hydroelectric power.

## Niagara Power Station (Mechanical)

*Function:* Convert the linear momentum of water in the Niagara River into hydroelectric power.

## Niagara Falls (Mechanical)

*Function:* Increase the linear momentum of water in the Niagara River by allowing it to fall in the gravitational field of its ecosystem

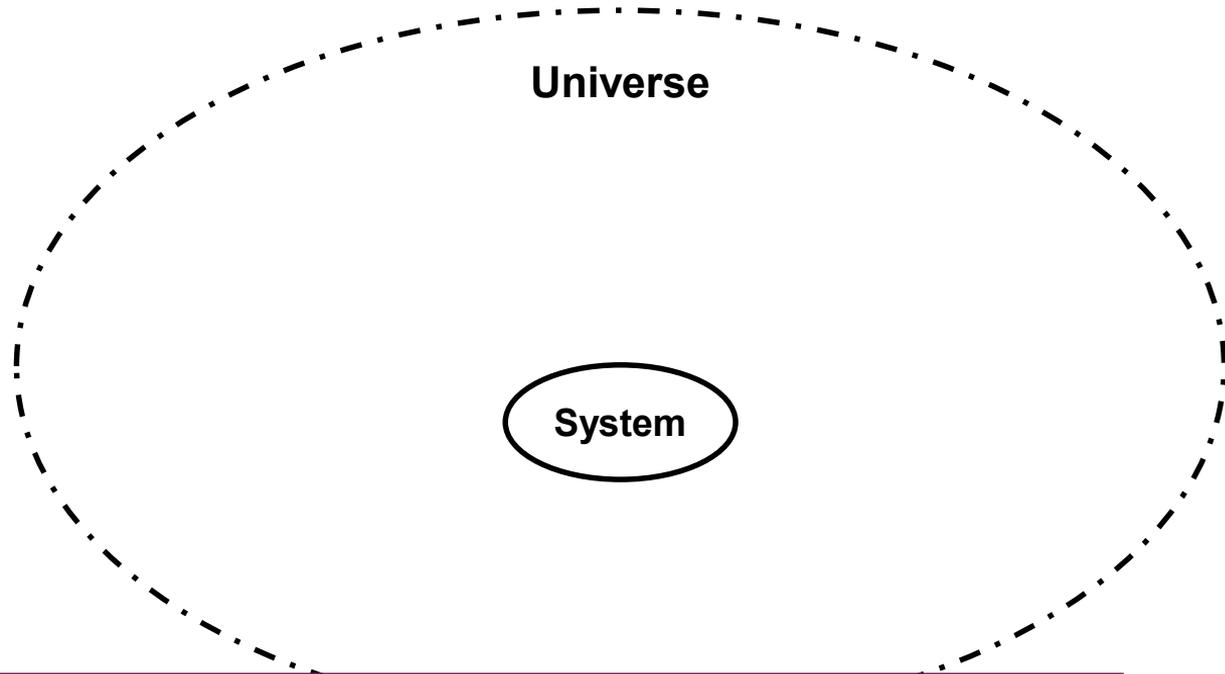


## Universe

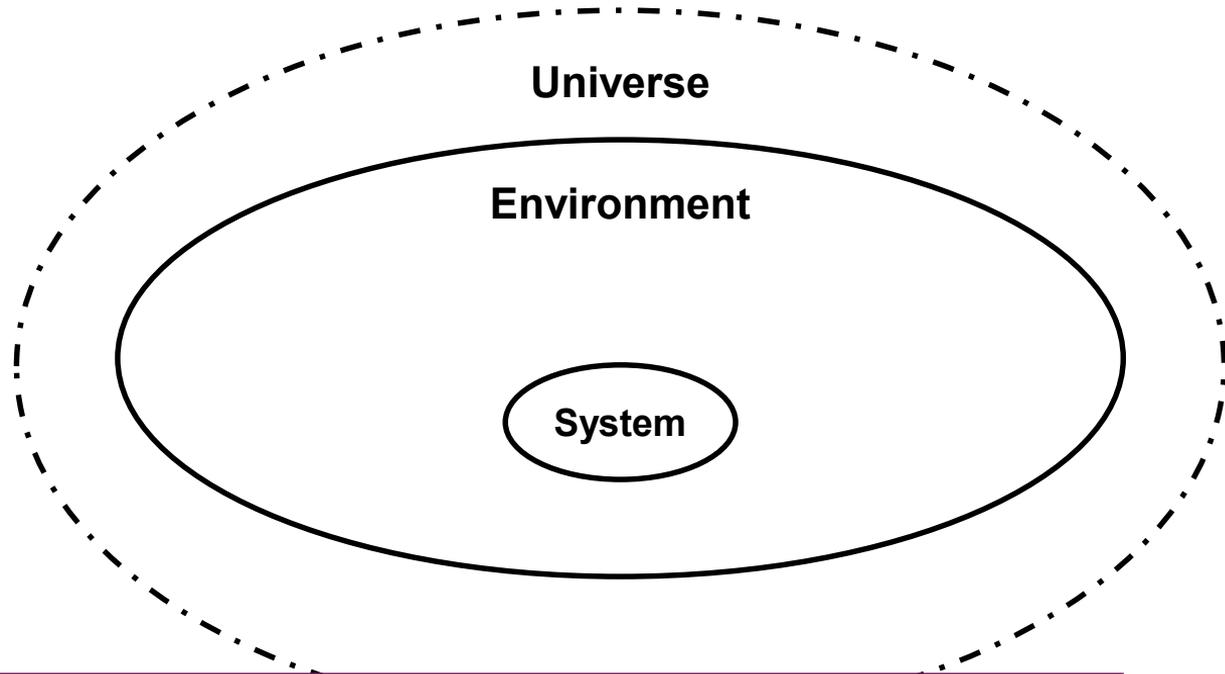


Universe

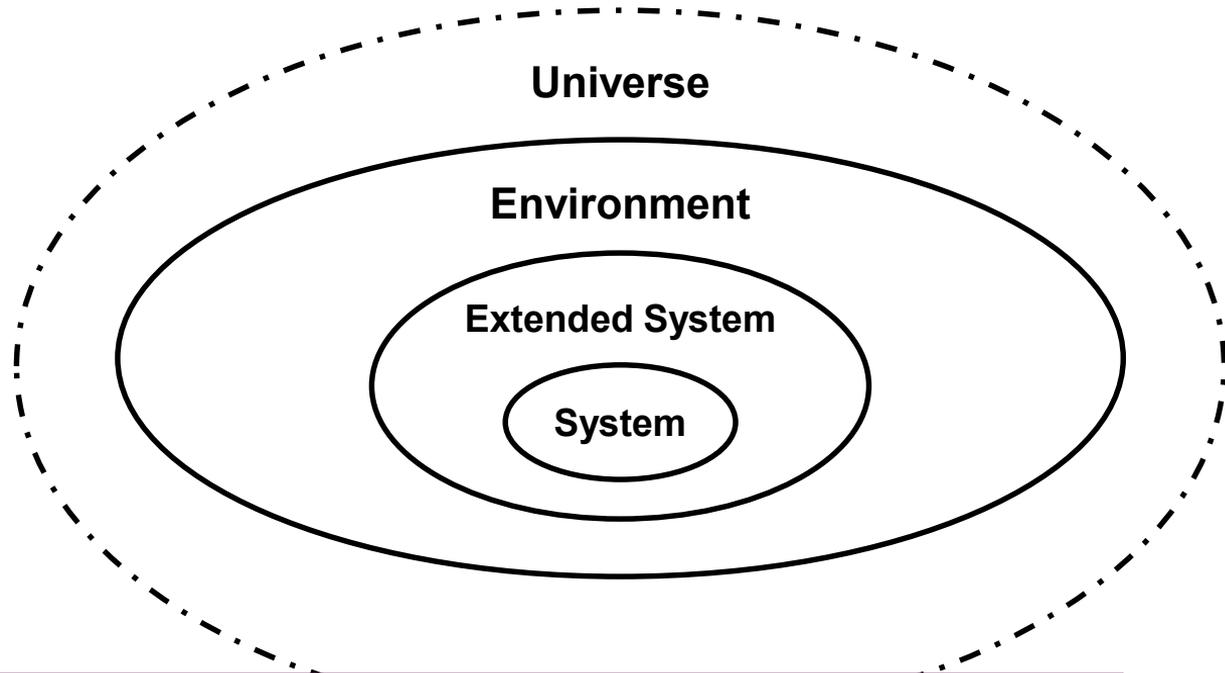




While much of our interest in modeling any *system* is in the internal structure and interactions of components, we also need to consider the interaction of the system with the universe within which it resides.



The *environment* includes those non-system aspects of the universe of interest to the systems engineer, the scope and scale of which will vary based on the system of interest and the purpose or intent of the modeler.



The *extended system* allows aspects of what would otherwise be viewed as the environment to be treated as part of the system for modeling purposes, even if only *temporarily*.

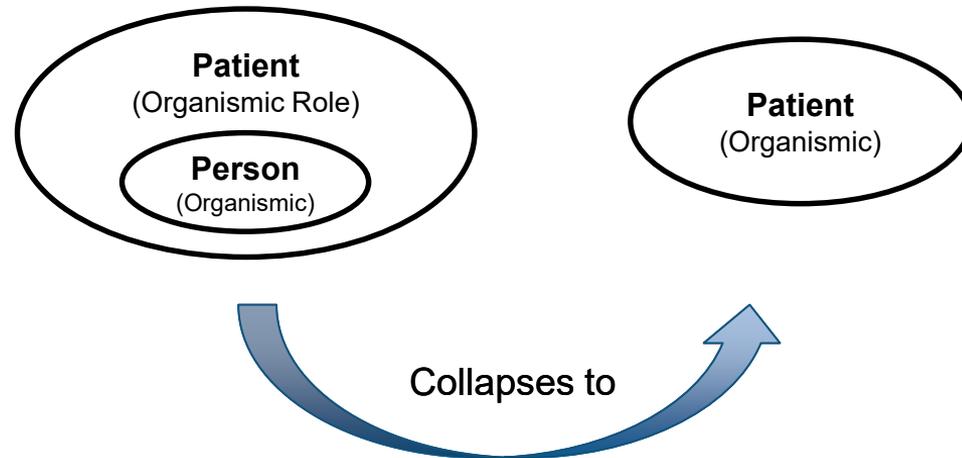


# Ecosystems Elements

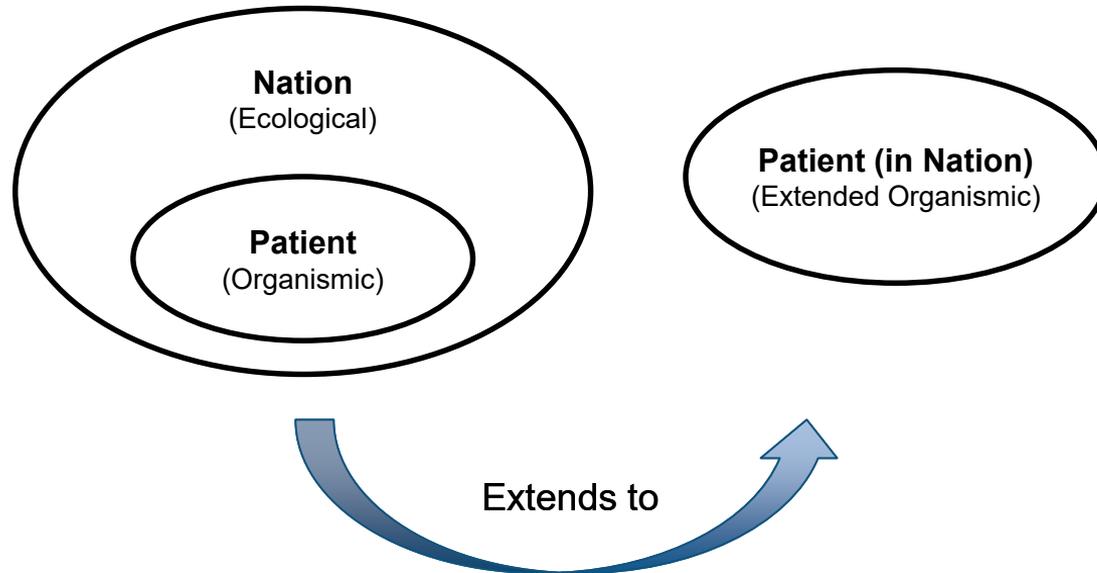
- The boundary problem puts modelers up against the environment, both inwardly and outwardly.
- We extend toward the environment – into the ecosystem.
- We collapse toward mechanisms – into the organisms.
- The context provided by the ecology often remains unexamined.

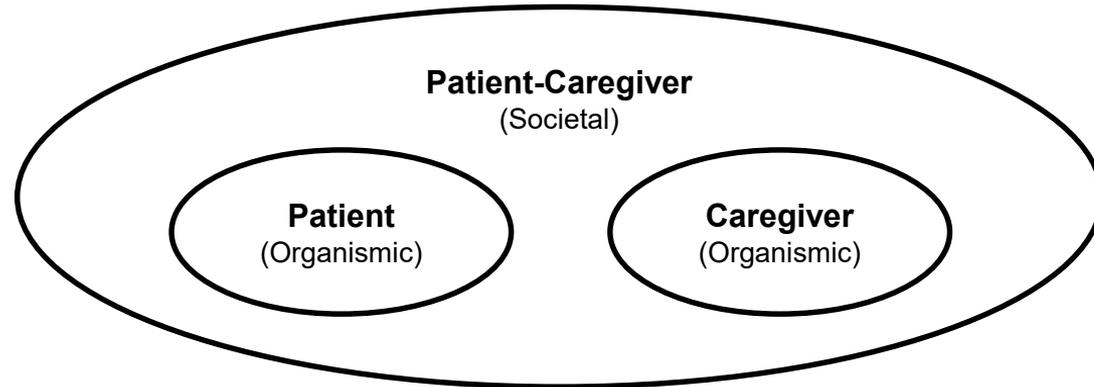


Much of what we know about a patient is actually limited to what we see during her or his *role* as patient.



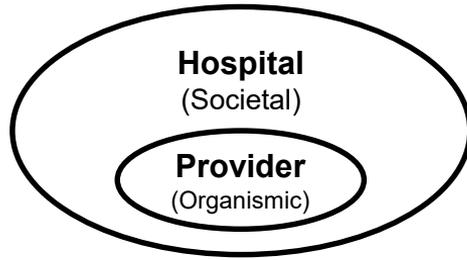
Much of what we know about a patient is actually what we know about the *ecological* systems in which the patient lives and works.

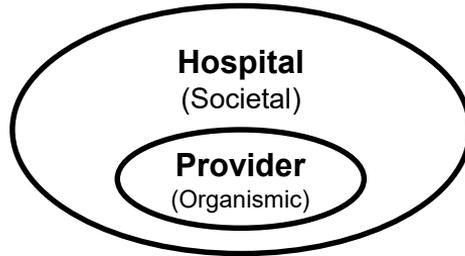




**We combine *organismic* systems into *societal* systems.**

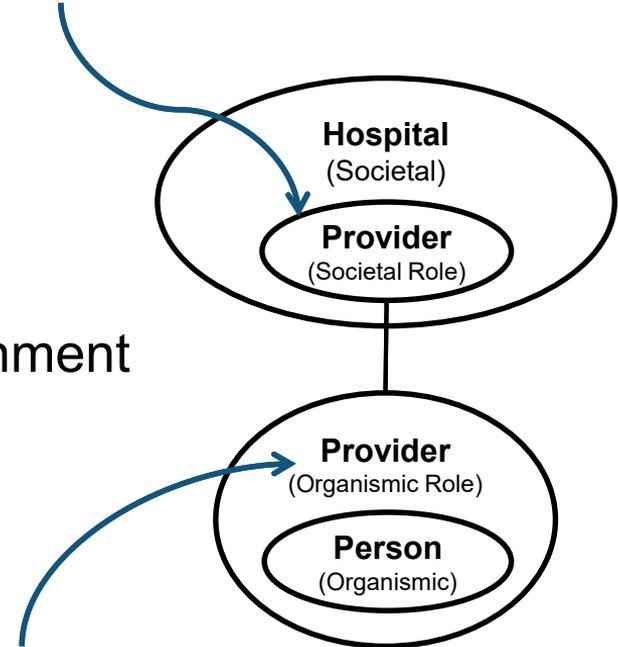




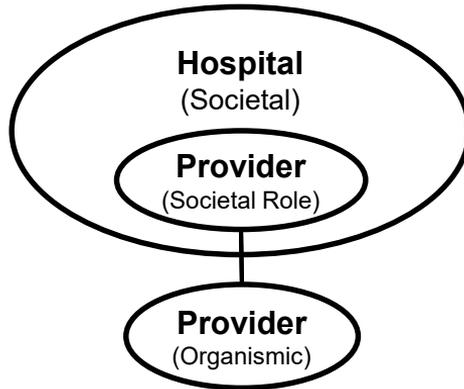
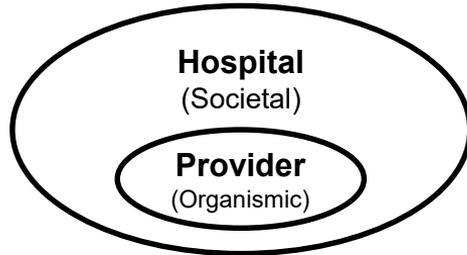


A societal role can be unfilled or vacant.

## Role Alignment

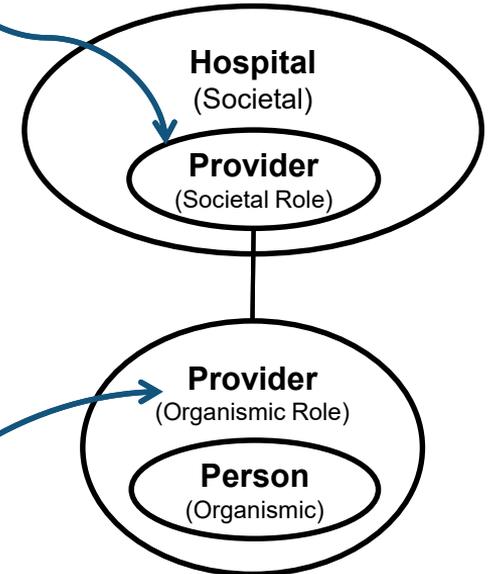


An organismic role can be unfulfilled or unrealized.



A societal role can be unfilled or vacant.

## Role Alignment



An organismic role can be unfulfilled or unrealized.

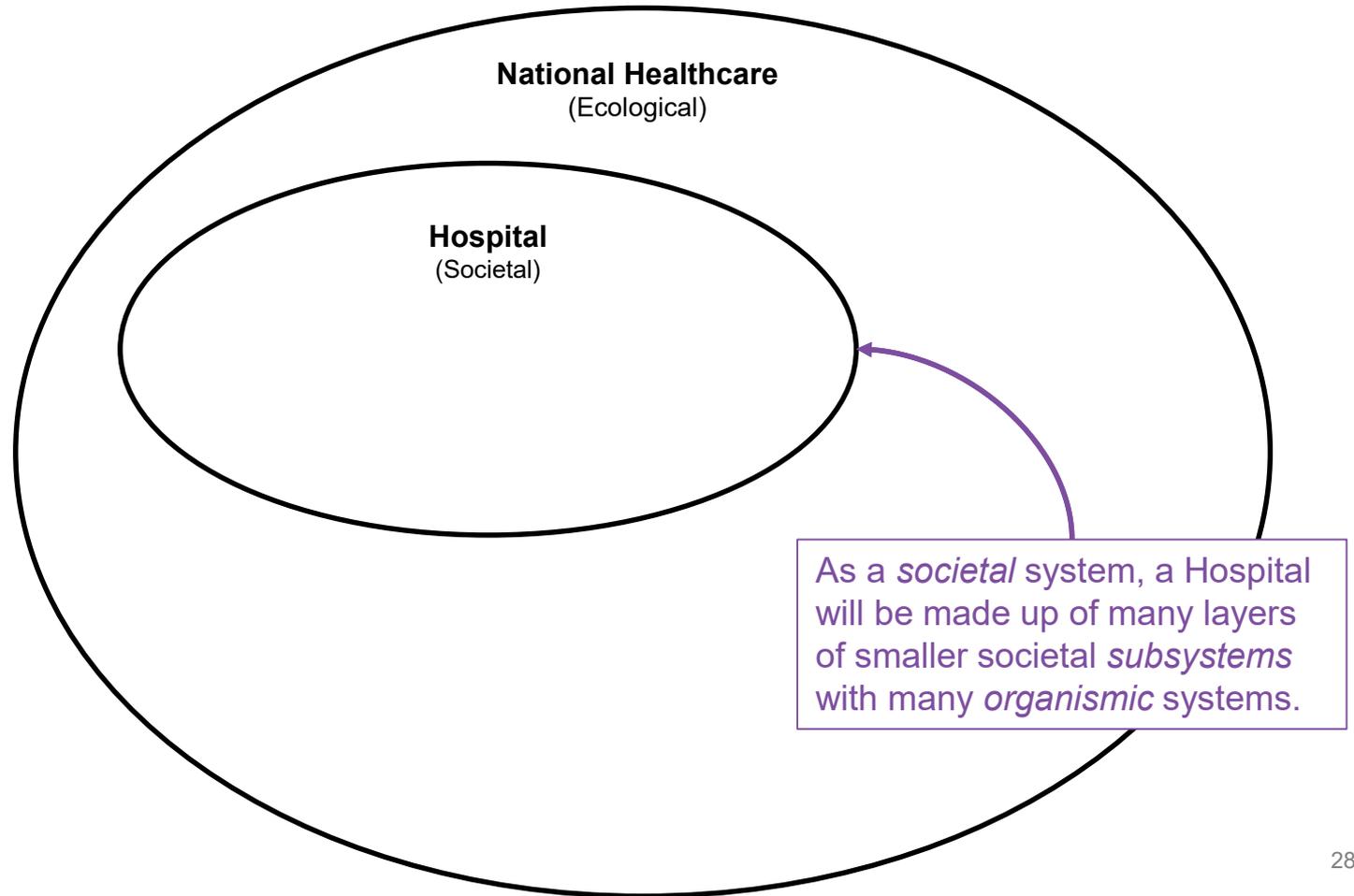


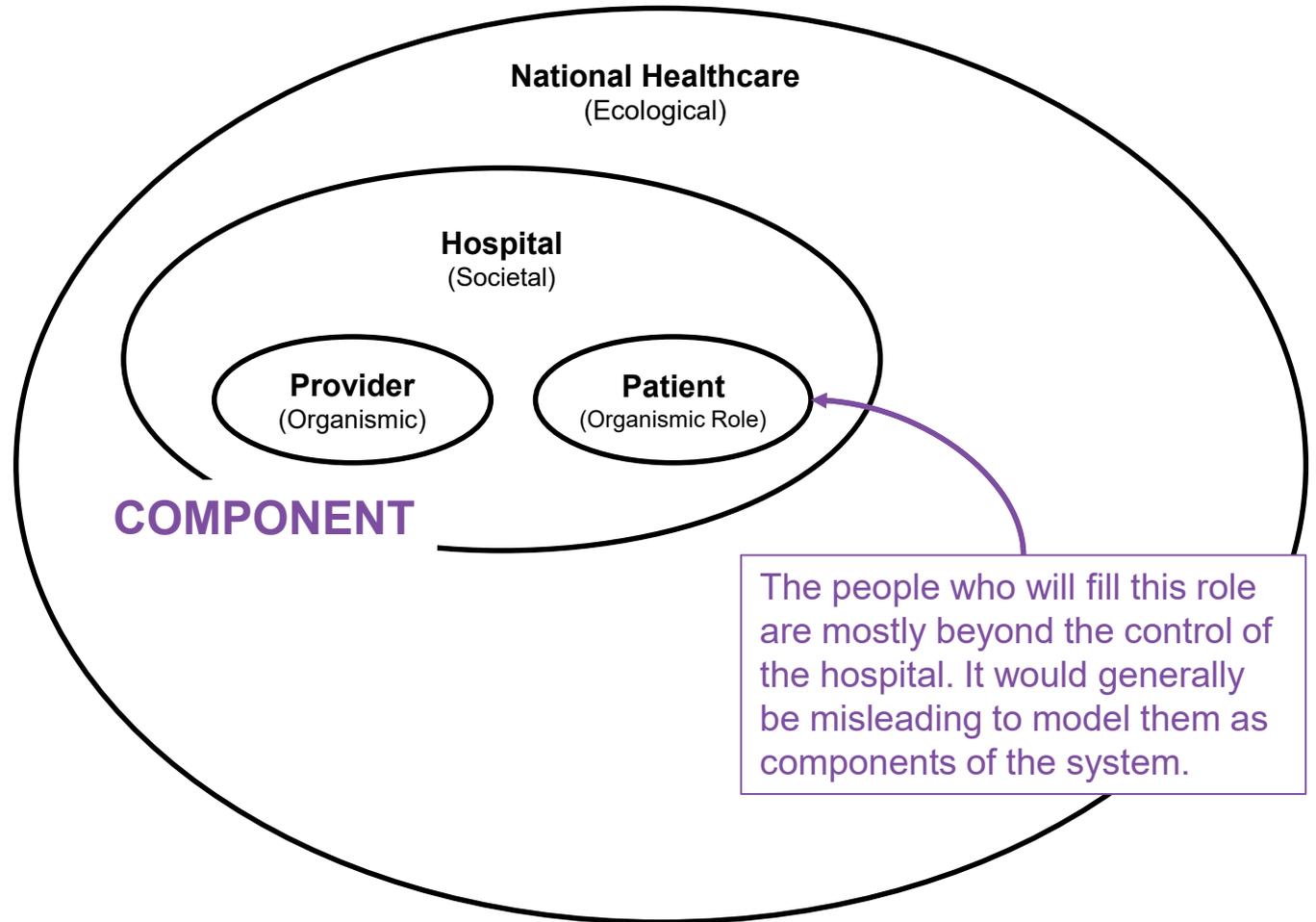
# Inputs vs. Components

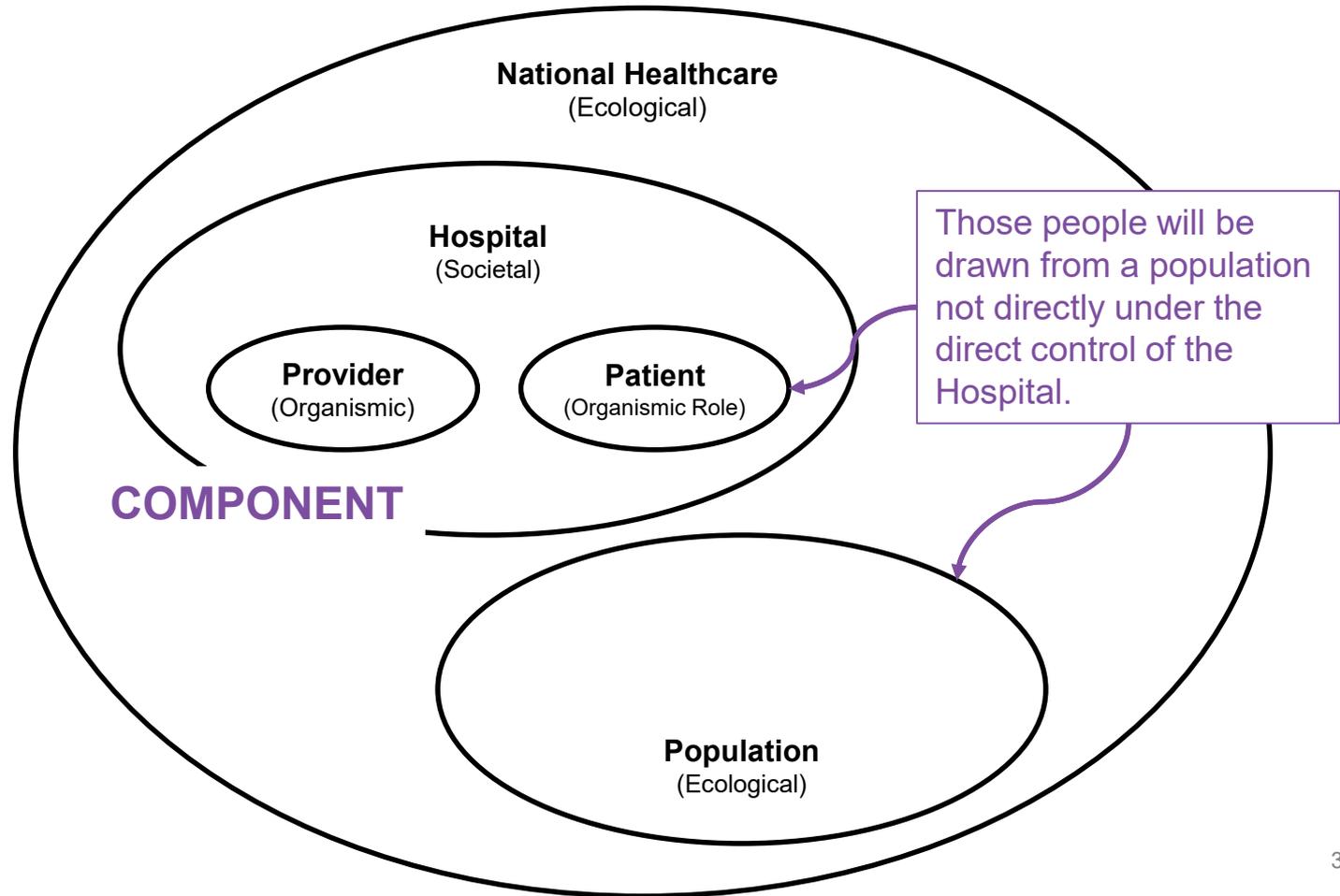
- Inputs represent noise to our systems, sources of variability and lack of control.
- Components lend themselves to control in some circumstances, at least more so than inputs.
- The characteristics of inputs is largely driven by the ecological system from which they are drawn.

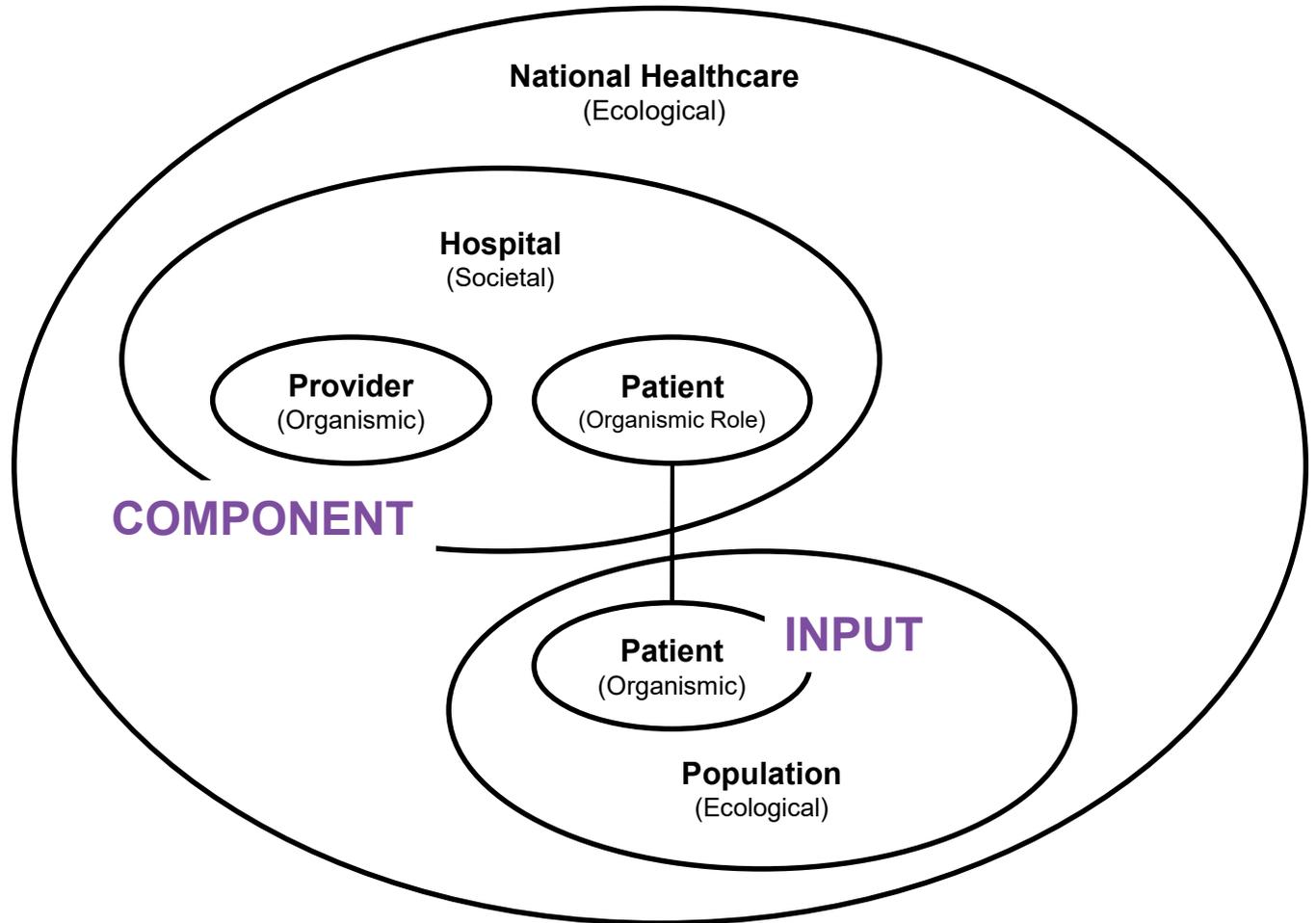


**National Healthcare**  
(Ecological)







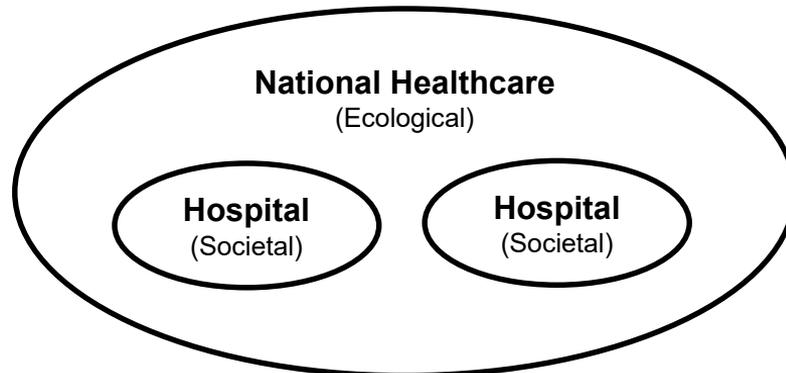


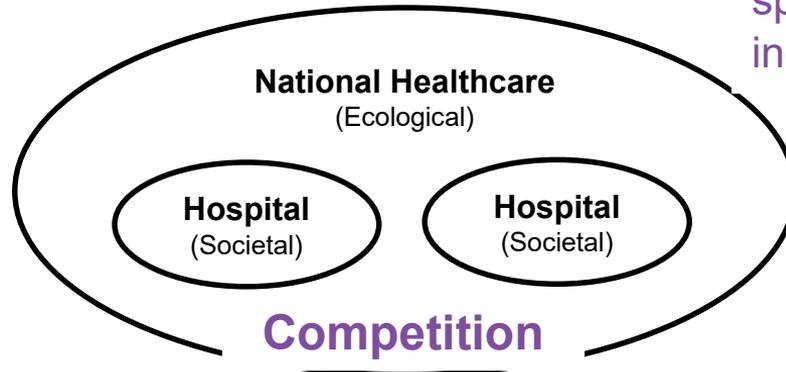
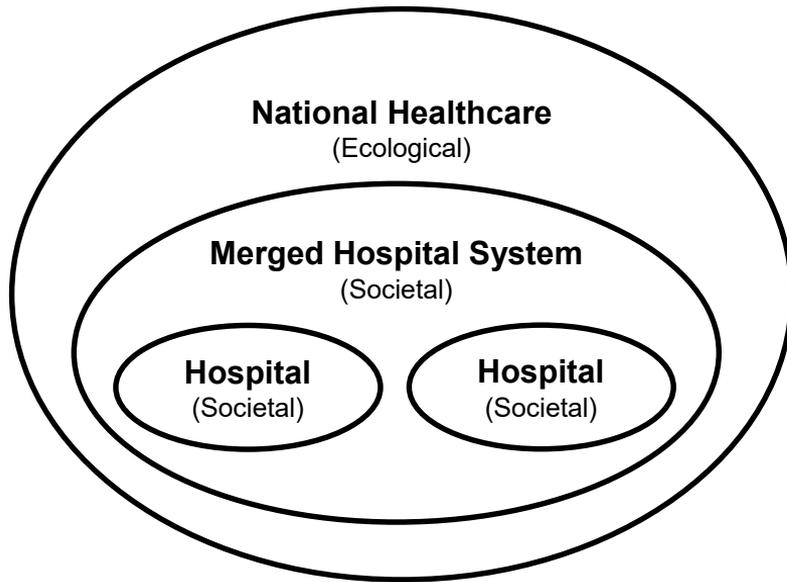
# System-of-Systems vs. Ecosystems

- A system-of-systems combines otherwise separate systems, but in predictable or standard ways.
- SoS component systems exhibit forms of autonomy.
- Emergence tends to occur at the system level.
- Ecosystems include many other systems.
- Characterized by competition for resources and outcomes.
- Ecosystems behave like unplanned systems of systems.

## Competition

Two hospitals in the same ecological system will typically compete with each other, sometimes to the detriment of both.

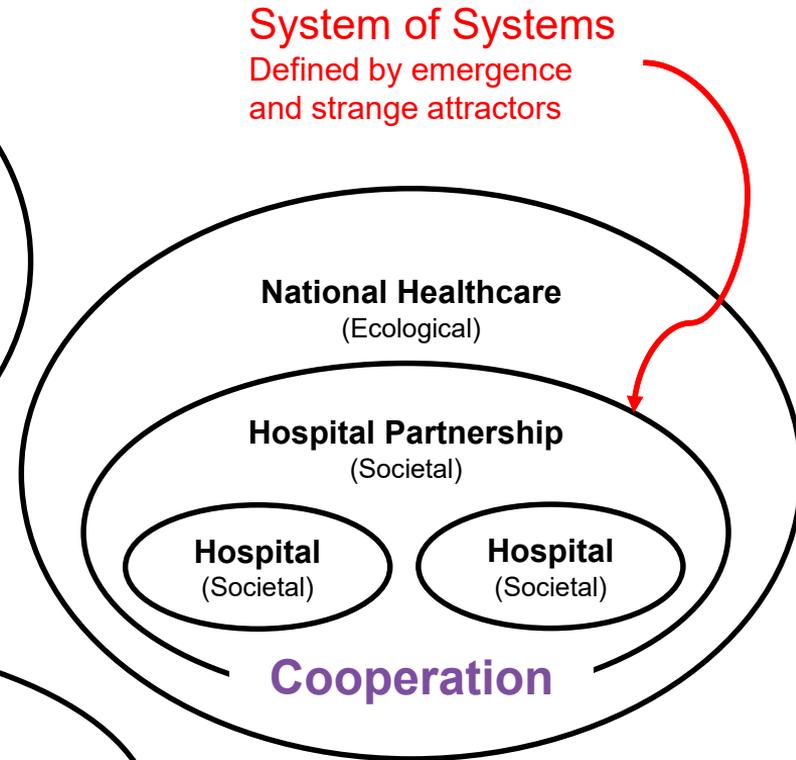
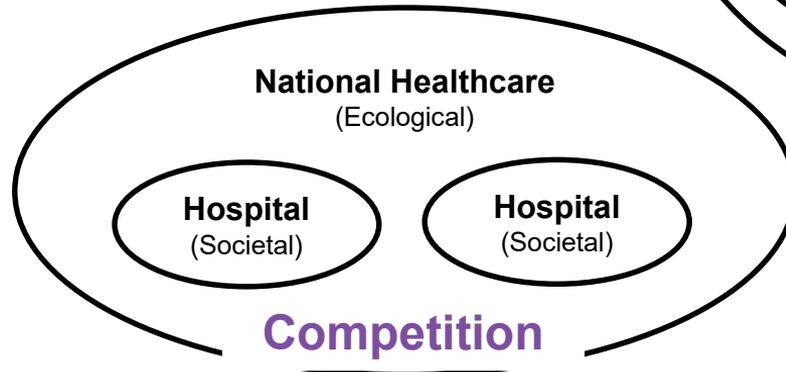
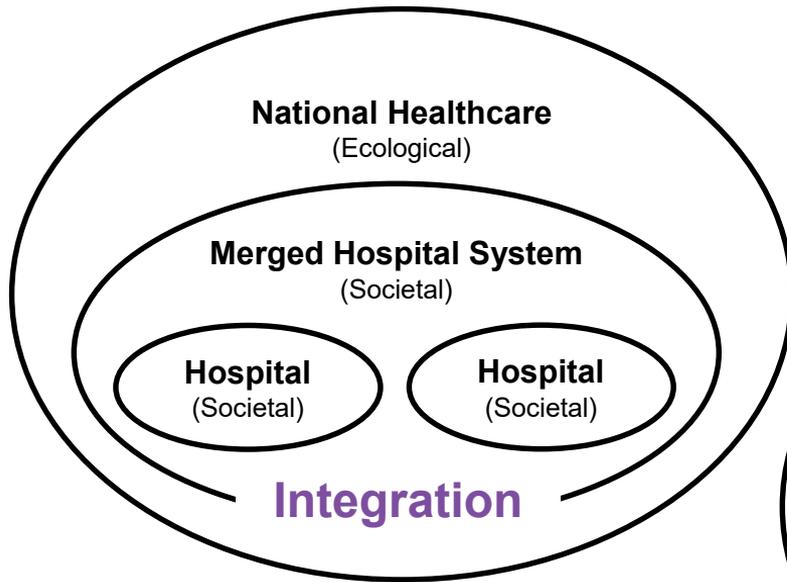




## Integration

Two hospitals that merge into a single societal system attempt to integrate and perform as a single entity in the ecosystem.

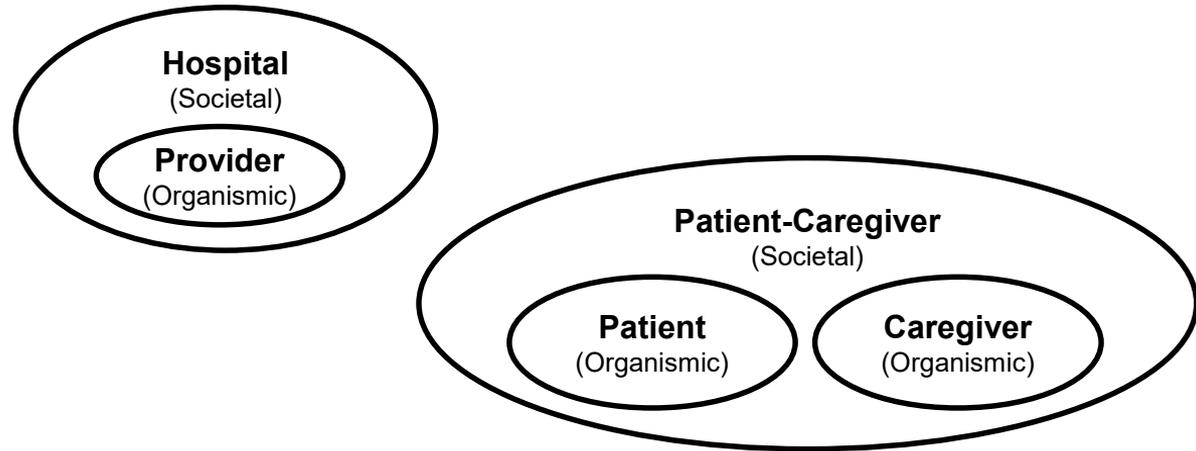
Integration might be imperfect, but the intent is complete integration. Integration doesn't preclude local specialization and focus of individual subsystems.

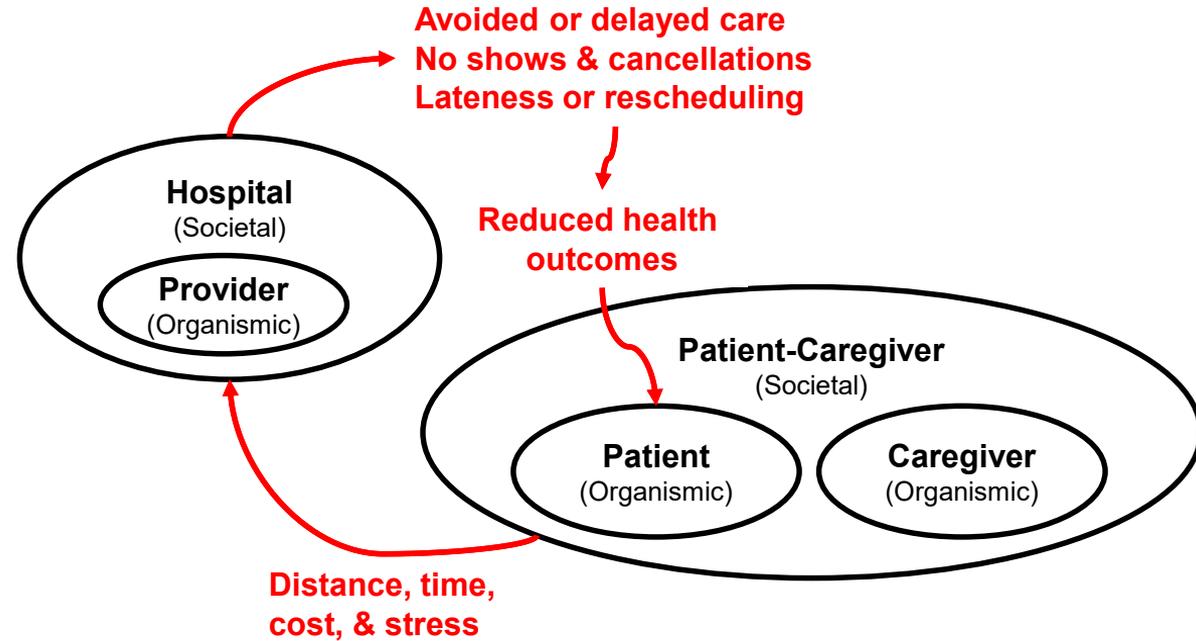


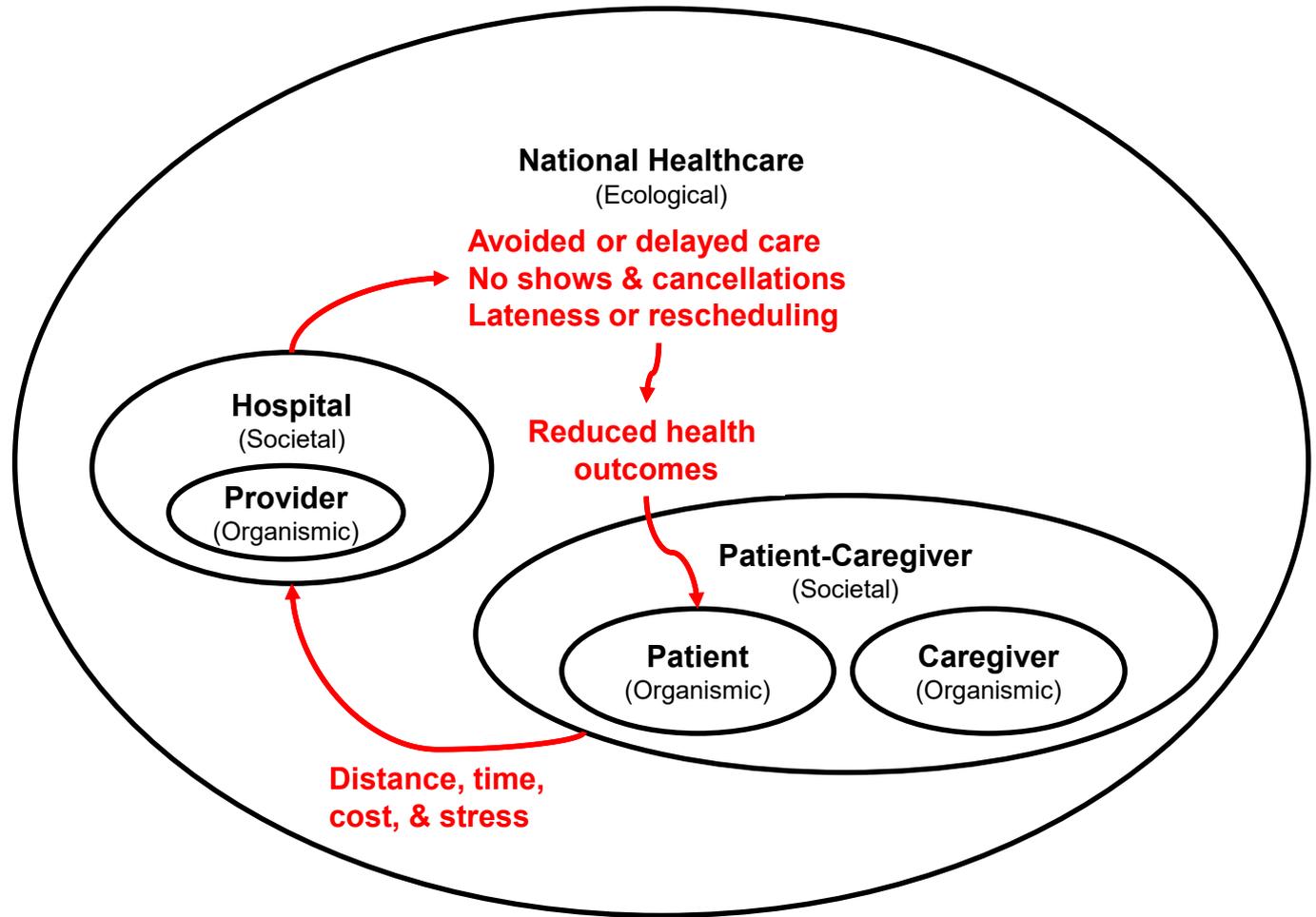
# Population Health

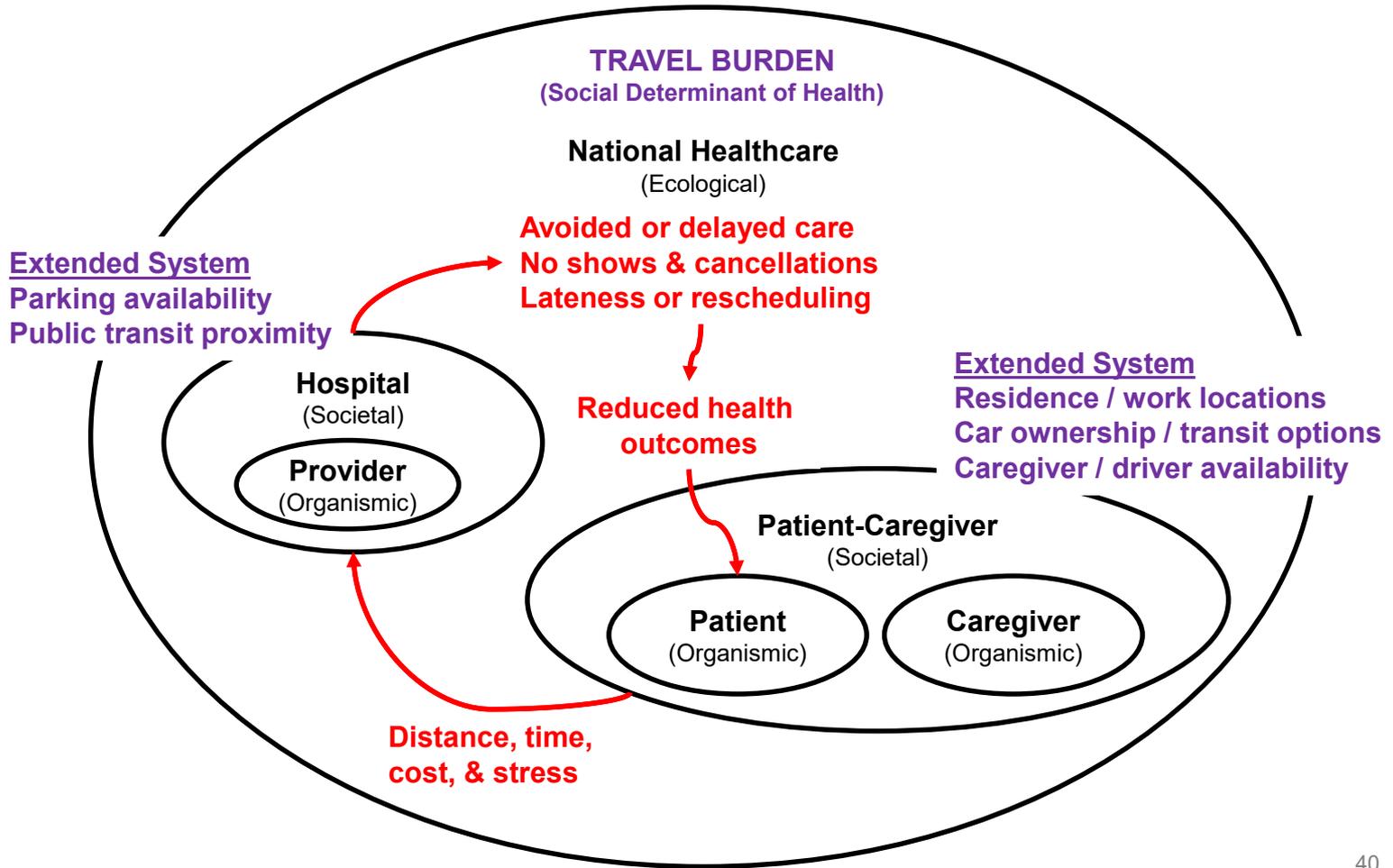
- Population members spend more time outside than inside of healthcare
- *Person* is much more complicated than *Patient*
- A person is impacted by many mechanical systems while participating in many societal systems across many ecosystems
- We lose this complexity when we see only the *Patient role*.
- Social determinant variables become important to understanding behaviors, drivers, and outcomes outside of our societal systems
- Population variables emerge from the aggregation of all of this interaction and complexity







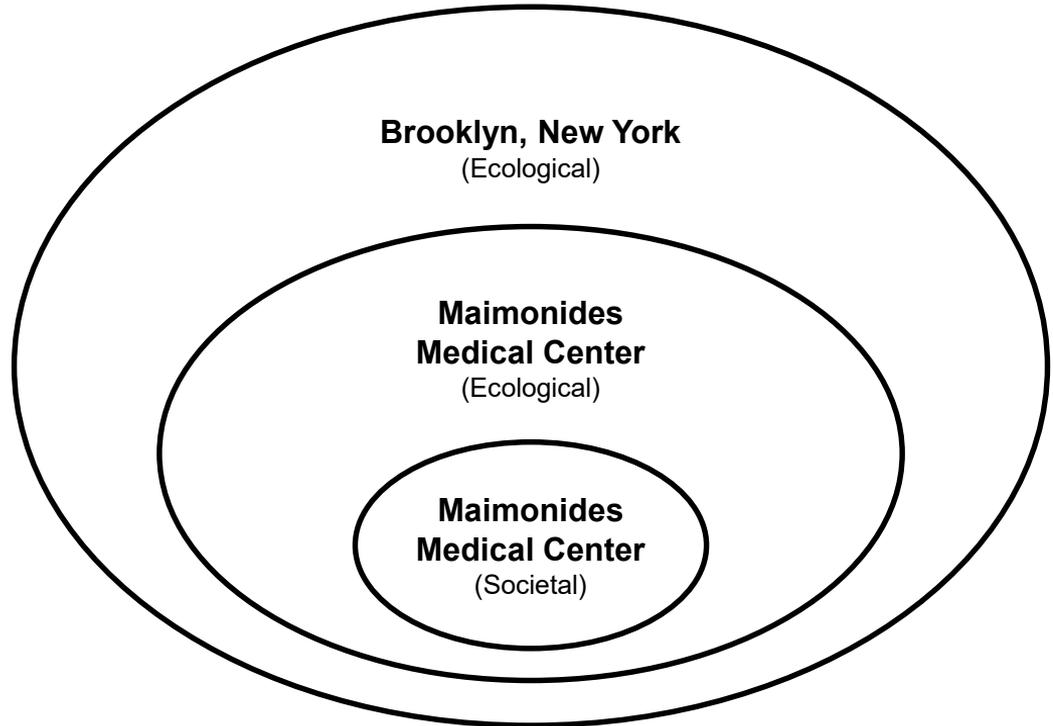
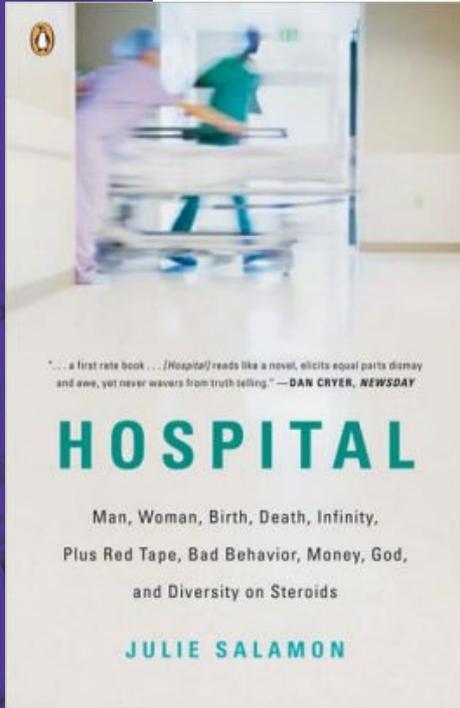


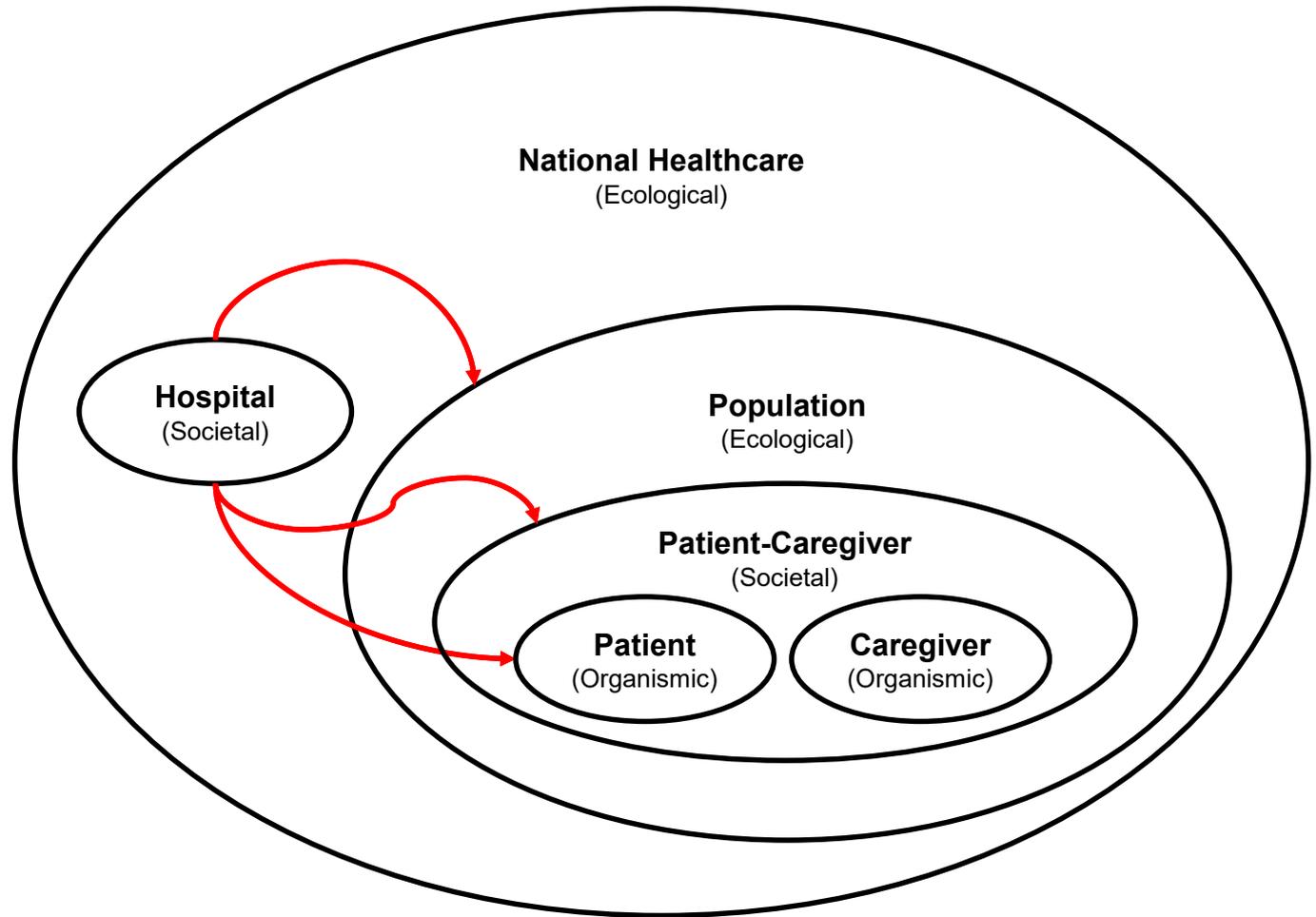


# HOSPITAL

Man, Woman, Birth, Death, Infinity,  
Plus Red Tape, Bad Behavior, Money, God,  
and Diversity on Steroids







# Questions

You are welcome to contact me  
with questions at any time:

- Richard E. Biehl, Ph.D.  
Online Masters Program, Healthcare Systems Engineering  
Industrial Engineering & Management Systems Dept.  
College of Engineering & Computer Science  
University of Central Florida

- [richard.biehl@ucf.edu](mailto:richard.biehl@ucf.edu)

- LinkedIn: **rbiehl**



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## Appendix



# References

- Ackoff, Russell L.; & Emery, Fred E. (1972). *On purposeful systems: An interdisciplinary analysis of individual and social behavior as a system of purposeful events*. New Brunswick, New Jersey. Aldine Transaction.
- Ackoff, Russell L.; & Gharajedaghi, Jamshid (1996). Reflections on systems and their models. *Systems Research*, 13(1). p13-23.
- Eriksson, Derek, M. (2004). On the usefulness of the Ackoff-Gharajedaghi model of system types for the design of business systems. *Systemic Practice and Action Research*, 17(2).
- Wheatley, Margaret J. (1999). *Leadership and the new science: Discovering order in a chaotic world*. San Francisco: Berrett-Koehler.



# Acknowledgements

- The theme for this area of my research was originally inspired by a talk given by Theodore Gordon at a World Future Society conference in Cambridge, Massachusetts in July 1995.
- The work of Russell Ackoff and Margaret Wheatley have further inspired and guided my journey.

