

The background is a light blue gradient with several realistic water droplets of various sizes scattered across the surface. The droplets have highlights and shadows, giving them a three-dimensional appearance.

AN INTRODUCTION TO SYSTEMS THINKING

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INTRODUCTIONS

- ABOUT MURDOUGH CENTER/NATIONAL INSTITUTE FOR ENGINEERING ETHICS AT TTU
 - COURSES (ACADEMIC & PROFESSIONAL)
 - RESOURCES
 - SERVICE (CONFERENCES, WORKSHOPS, PANELS, ETC.)
- ABOUT ME
 - B.S. AND M.A. IN PHILOSOPHY
 - PH.D. STUDENT IN SYSTEMS AND ENGINEERING MANAGEMENT
- ABOUT YOU

OVERVIEW

- 'BIG IDEA' STYLE DISCUSSION
- STUDENT VS. EXPERT
- STRUCTURE
 - INTRODUCTION TO SYSTEMS THINKING
 - CONNECTION BETWEEN ETHICS AND SYSTEMS
 - AN APPLICATION
 - GROUP EXERCISE AND DISCUSSION

AN INTRODUCTION TO SYSTEMS

- SYSTEMS THINKING VS. SYSTEMS TOOLS – A DISTINCTION
- SOME FUNDAMENTAL CONCEPTS AND THINKERS
 - LUDWIG VON BERTALANFFY – GENERAL SYSTEM THEORY
 - DONELLA MEADOWS – THINKING IN SYSTEMS
 - VIRGINIA ANDERSON AND LAUREN JOHNSON – SYSTEMS THINKING BASICS

WHAT IS A SYSTEM?

- SYSTEMS THINKING
 - MORE THAN JUST LOOKING AT THE BIG PICTURE
 - BEWARE THE VENEER OF RESPECTABILITY
- FORMAL REQUIREMENTS (ANDERSON AND JOHNSON)
 - A SYSTEM IS COMPOSED OF PARTS THAT MUST ALL BE PRESENT FOR THE SYSTEM TO CARRY OUT ITS PURPOSE OPTIMALLY
 - A SYSTEM'S COMPONENTS MUST BE ARRANGED IN A SPECIFIC WAY FOR THE SYSTEM TO CARRY OUT ITS PURPOSE
 - SYSTEMS HAVE SPECIFIC PURPOSES WITHIN LARGER SYSTEMS
 - SYSTEMS MAINTAIN THEIR STABILITY THROUGH FLUCTUATIONS & ADJUSTMENTS
 - SYSTEMS HAVE FEEDBACK

WHAT IS A SYSTEM (CONT.)?

- SOME EXAMPLES:
 - MANUFACTURING SYSTEM
 - BUILDING SYSTEM
 - SIDEBAR: EASTGATE CENTRE
 - HEALTHCARE
 - TRANSPORTATION
 - SIDEBAR: SWARM OPTIMIZATION IN AUTONOMOUS VEHICLES
- OTHER EXAMPLES?
- SYSTEM DESIDERATA
 - DESCRIPTION
 - PREDICTION
 - PRESCRIPTION

SYSTEM THEORY - CONCEPTS

- BERTALANFFY'S GENERAL SYSTEM THEORY: A RESPONSE (IN PART) TO EXCESSIVE FOCUS ON REDUCTIONISM IN THE EARLY PART OF THE 20TH CENTURY (SCIENCE, POSITIVISM, ETC.)
- KEY CONCEPTS FROM GST
 - EQUIFINALITY: THE SAME STATE/OUTCOME CAN BE REACHED BY MULTIPLE PATHS
 - NEGATIVE ENTROPY: SYSTEMS MOVE TOWARDS GREATER COMPLEXITY
 - STEADY STATE VS. EQUILIBRIUM:
 - EQUILIBRIUM – CHARACTERISTIC OF CLOSED SYSTEMS
 - STEADY STATE - OPEN SYSTEMS REACH A STEADY STATE
 - WE CAN ALSO TALK ABOUT STATIC VS. DYNAMIC EQUILIBRIUM
 - EMERGENT PROPERTIES: “WHOLE IS GREATER THAN SUM OF ITS PARTS”

SYSTEMS THEORY – ISOMORPHOLOGY

- ISOMORPHOLOGY (BERTALANFFY): WHEN TWO OR MORE SYSTEMS DEMONSTRATE KEY STRUCTURAL SIMILARITIES
 - CAN EXIST BETWEEN TWO VERY DIFFERENT SYSTEMS
 - LEVELS
 - ANALOGY – NOT ISOMORPHOLOGICAL, SUPERFICIAL SIMILARITY
 - HOMOMORPHY – CHARACTERISTIC (ARGUABLY ESSENTIAL) LAWS AND BEHAVIOR ARE FORMALLY IDENTICAL
 - EXPLANATION – HIGHEST DEGREE OF CONNECTION, SPECIFIC MATHEMATICAL LAWS AND LOGICAL RELATIONS ARE ESTABLISHED

SYSTEMS AND PHILOSOPHY

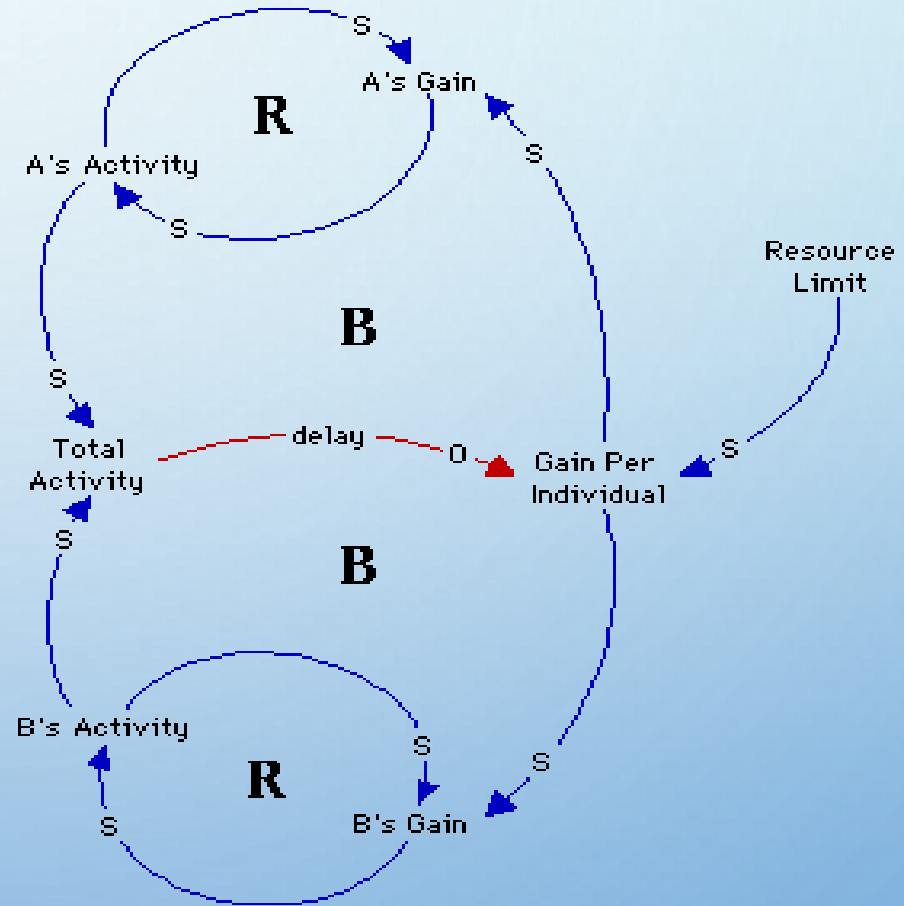
- PHILOSOPHY AND SYSTEMS ENGINEERING
 - EPISTEMOLOGICAL & ONTOLOGICAL IMPLICATIONS (E.G. ISOMORPHOLOGY)
 - NORMATIVE IMPLICATIONS
- ARISTOTLE'S ETHICS
 - NICOMACHEAN ETHICS
 - KEY CONCEPTS
 - EUDAIMONIA – HAPPINESS OR FLOURISHING
 - VIRTUE
 - INTELLECTUAL
 - MORAL
 - GENERAL
 - ROLE
 - PRACTICAL WISDOM

AN ARISTOTELIAN SYSTEM

- GOALS
 - SYSTEMS SHOULD BE DESIGNED SO THAT THEY NOT ONLY DO NOT INTERFERE WITH EUDAIMONIA BUT PROMOTE IT
 - SYSTEMS SHOULD BE CONDUCIVE TO THE PRACTICE OF VIRTUE FOR BOTH AGENT (SYSTEM DESIGNER/ARCHITECT) AND SUBJECT
 - ACCURATE MODELING ENTAILS EFFICACY – A CHANCE TO EXERCISE PRACTICAL WISDOM
- BILATERAL IMPROVEMENT
 - ETHICS IN SYSTEMS ENGINEERING
 - SYSTEMS THINKING AND TOOLS IN ETHICS
 - RECOGNIZING YOU'RE IN A SYSTEM
 - UNDERSTANDING LEVERAGE POINTS FOR MAXIMUM EFFICACY

TRAGEDY OF THE COMMONS

- ARCHETYPES: RECURRENT SYSTEM PATTERNS
- HARDIN'S "TRAGEDY OF THE COMMONS"
- WHAT ARE COMMONS?
 - LAND
 - WATER
 - AIR
 - DIGITAL COMMONS
 - OTHER EXAMPLES?
- WHAT CAUSES THE TRAGEDY
 - INCENTIVES TO TAKE MORE THAN ONE'S FAIR SHARE
 - IS NOT SIMPLY AN INFORMATION PROBLEM THE WAY A PRISONER'S DILEMMA IS



TRAGEDY OF THE COMMONS - IMPLICATIONS

- RESOURCE:
 - DEPLETION
 - EXHAUSTION
- ISSUES OF JUSTICE
 - BIGGER PLAYERS HAVE BIGGER ADVANTAGE
 - “BIG STRAW” APPROACHES TO WATER DRAW DOWN
 - DISPROPORTIONATE IMPACTS OF GLOBAL CLIMATE CHANGE
- STRATEGIES
 - CENTRALIZED REGULATION (HARDIN’S “MUTUAL COERCION, MUTUALLY AGREED UPON”)
 - PRIVATIZATION
 - DECENTRALIZED REGULATION/STAKEHOLDER ENGAGEMENT (ELINOR OSTROM)

EXERCISE AND DISCUSSION

- EXERCISE

- CONSIDER A MAJOR PROBLEM YOU ARE WORKING ON (OR HAVE HISTORICALLY). IS IT APPROPRIATE TO ADOPT A SYSTEMS APPROACH IN DEALING WITH THIS PROBLEM? IS THERE A SYSTEM INVOLVED? WHY/WHY NOT?
- WHICH SYSTEMS CONCEPTS AND TOOLS WOULD YOU APPLY TO RESOLVE OR, AT LEAST, FRAME THIS PROBLEM? WHY?
- WHAT ARE THE ETHICAL ISSUES INVOLVED IN THIS SYSTEM? HOW WOULD YOU ADDRESS THESE?

- DISCUSSION

QUESTIONS?

- THANK YOU FOR YOUR TIME!
- CONTACT INFORMATION:
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SYSTEMS RESOURCES – AN INCOMPLETE LIST

1. VIRGINIA ANDERSON AND LAUREN JOHNSON, 1997, SYSTEMS THINKING BASICS: FROM CONCEPTS TO CAUSAL LOOPS, LEVERAGE NETWORKS, ACTON.
2. LUDWIG VON BERTALANFFY, 1969, GENERAL SYSTEM THEORY: FOUNDATIONS, DEVELOPMENT, APPLICATIONS, GEORGE BRAZILLER, NEW YORK.
3. DONELLA H. MEADOWS, 2008, THINKING IN SYSTEMS: A PRIMER, CHELSEA GREEN PUBLISHING, WHITE RIVER JUNCTION.
4. PETER M. SENGE, 2006, THE FIFTH DISCIPLINE: THE ART & PRACTICE OF THE LEARNING ORGANIZATION, DOUBLEDAY, NEW YORK.
5. JOHN D. STERMAN, 2000, BUSINESS DYNAMICS: SYSTEMS THINKING AND MODELING FOR A COMPLEX WORLD, BOSTON: MCGRAW-HILL EDUCATION.
6. SYSTEMS DYNAMICS SOCIETY - [HTTPS://WWW.SYSTEMDYNAMICS.ORG/](https://www.systemdynamics.org/)

REFERENCES

- TEXT

- VIRGINIA ANDERSON AND LAUREN JOHNSON, 1997, SYSTEMS THINKING BASICS: FROM CONCEPTS TO CAUSAL LOOPS, LEVERAGE NETWORKS, ACTON.
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- DONELLA H. MEADOWS, 2008, THINKING IN SYSTEMS: A PRIMER, CHELSEA GREEN PUBLISHING, WHITE RIVER JUNCTION.
- ELINOR OSTROM, 1991, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION, CAMBRIDGE UNIVERSITY PRESS, CAMBRIDGE.

- IMAGE

- *SYSTEMS THINKING*, “TRAGEDY OF THE COMMONS ARCHETYPE” (JUNE 24, 2017), RETRIEVED FROM [HTTP://WWW.SYSTEMS-THINKING.ORG/ARCH/ARCH.HTM](http://www.systems-thinking.org/arch/arch.htm)