ESD.83 Assignment 6: Historical Roots and Current Methodologies of Engineering Systems

One paper and one presentation per two-person team, approx. ~5000 word paper; 30% of total grade

The field of contemporary engineering system derives from many historical roots. Some selected roots of engineering systems are as follows:

Some Selected Historical Roots of ES

Author	Field or concept	Starting date (approximate)
L. Euler	Network Analysis	1776
A. Marshall	Equilibrium Economic Analysis	1890s
F. Taylor	Scientific Management	1890s
J. Von Neumann	Game Theory	1928
J. Schumpeter	Impact of Technology on the Economy	1930
L. Bertalanffy	General Systems Theory	1930s
K. Lewin	Social Psychology	1930s
H. Simon	Organizational Theory	Early 1940s
C. Shannon	Communication Theory	1940s
P. Morse	Operations Research	1940s
N. Weiner	Cybernetics and Control Theory	1950
S. Ramo	Systems Engineering	1950s
J. Forrester	Systems Dynamics	Late 1950s
T. Shelling	Agent Based Modeling	1960s
V. Hubka	The Science of Engineering Design	1960s
R. Richta	Technological Evolution	1960s
H. Simon	Complexity Theory	1962
E. O. Wilson	Sociobiology	1975

From these roots (and others as well), the field of contemporary engineering systems has emerged.

One way (but far from the only way) to characterize the field of contemporary engineering systems is by considering the various methodologies that support the field now. Examples of what we might consider as methodologies for contemporary engineering systems along with key authors are as follows:

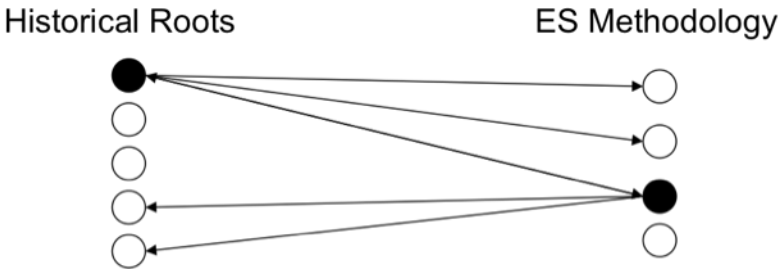
Some Methodologies for Contemporary ES

ES Methodology	Suggested Authors
System Dynamics	J. Sterman

Agent Based Modeling	R. Axtell, R. Axelrod, J. Epstein
Benefit Cost Analysis for Project Evaluation	T. Nas
Real Options Analysis	R. de Neufville
Stakeholder Analysis	R. Freeman
Strategy Development	H. Mintzburg, M. Porter
Grounded Theory	B. Glaser, A. Strauss
Decision Making Under Uncertainty	R. Keeney, H. Raiffa
System Architecting	E. Rechtin, M. Maier
Social Networks	S. Wasserman, K. Faust
Modern network analysis	A. Barabasi, D. Watts, M. Newman
Dynamic programming	D. P. Bertsekas
Stochastic optimization	J. Schneider, S. Kirkpatrick, J.C. Spall
OR Network analysis	R. Ahuja, T. Magnanti and J. Orlin
Technological Dynamics	J. Utterback, C. Magee, J. Trancik

We note that some of the same terms appear in both the list of historical roots and methodologies of contemporary engineering system (e.g., system dynamics, agent based modeling), reflecting the evolution of these concepts. The system dynamics of today is substantially different than the technique developed by Jay Forrester a half-century ago and was likely influenced along the way by other roots.

This relationship between historical roots and current engineering systems methodologies can be approached in one of two possible ways and is illustrated in the figure below.



The first approach is to choose one of the possible historical roots noted above (or perhaps an additional one you would like to suggest) and trace it forward to indicate its impact on the field of contemporary engineering systems as characterized by the methodologies, also noted above. So you want to identify scholarly work that built upon the root, tracing it through to today's foundation methodolog(ies). Some of the roots may impact several of the foundation methodologies.

There is an alternative way to think about the relationship between past intellectual developments and the field of contemporary engineering systems. This involves "backcasting" from where we are today to the roots. In this construction, one chooses one of the methodologies of *contemporary engineering systems* and works backwards in time to ascertain from whence it came. Again, a methodology as used today may derive from several of the roots. We have defined each methodology as currently used by noting the work of key authors on that methodology. Again, you could suggest additional current methods or authors.

For this assignment, we ask you to work in pairs, which we have specified, to create diversity in interests. Each pair will select one historical root and one contemporary Engineering Systems methodology as currently practiced.

We suggest (but don't require) that you choose a root and methodology that are related such that you expect that the root will be one you believe *a priori* affects your current methodology. The instructing staff will approve your root/method pair, and we will let you know this via email. *Remember you are invited to propose other historical roots or current methodologies.*

It will be interesting to contrast what we learn from the two approaches—eg if a root-based analysis shows impact on a methodology, did the methodology-based analysis trace back to that root?

This assignment should involve careful historical research of the literature and result in a single jointly submitted paper that describes **both** the flow from historical root to current methodologies, and the flow from current methodology to historical roots. The paper should be about 5000 words, not including tables and figures you may use to illustrate the interconnections in the literature. (Remember, visual thinking can be powerful.) It is envisioned that the references should be extensive (30-40 might be typical).

Some approaches you should include in your paper:

- Contributors *not* listed in the historical roots table and contemporaneous scholarly responses to the work of the author we cite
- Citation analysis to estimate the influence of various works as paths between roots and methodologies are developed
- Influences on practice and research in various domains/contexts that are clear today

Some useful resources

In many cases, Wikipedia may provide an excellent starting point (www.wikipedia.org). From there you may be able to identify the major works which you may then build from in more rigorous and in-depth library research. Many Eyes provides data visualization tools you may find helpful. http://services.alphaworks.ibm.com/manyeyes/home

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