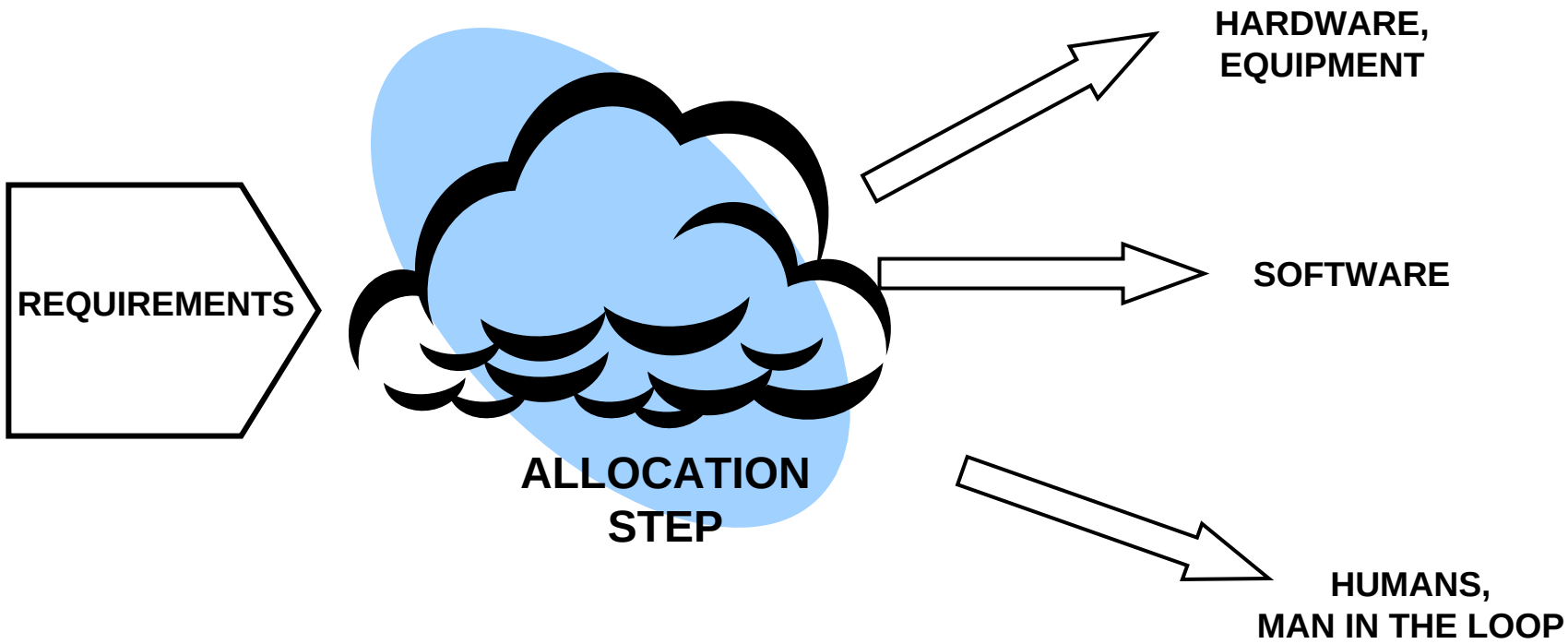
Combining systems & software engineering: Who's in charge of organizational aspects?

Stan Rifkin
MASTER SYSTEMS INC.
2604B El Camino Real 244
Carlsbad, California 92008 USA
+1 760 729 3388 sr @ Master-Systems.com

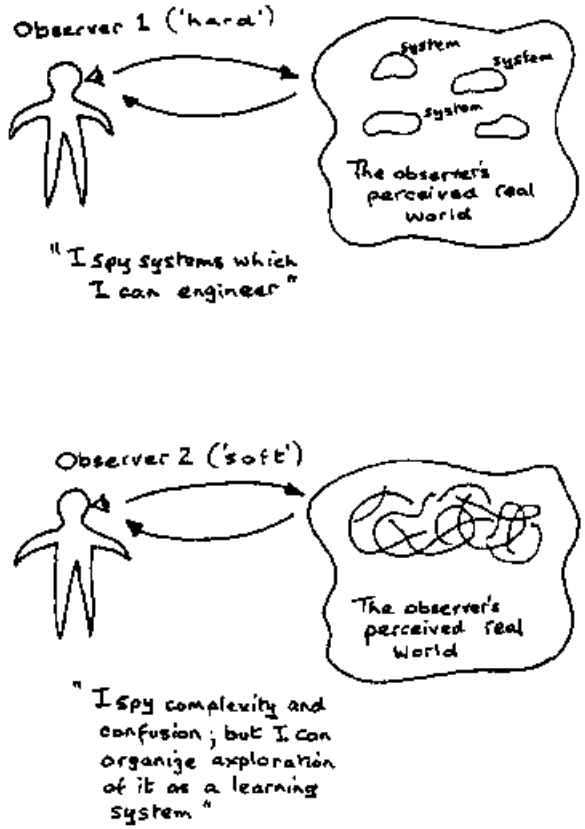
What I do not mean



What I do mean, part I

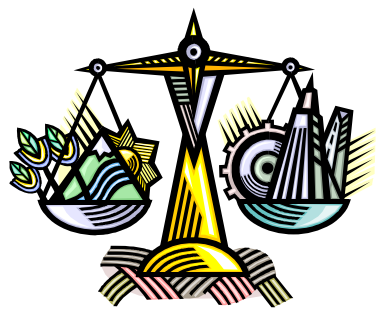
Systems Engineering and its Breakdown – "Systems engineering looks at 'how to do it' when 'what to do' is already defined. This is the Achilles' heel of systems engineering.... What is needed is a *system of enquiry*."

– Checkland & Scholes, Soft Systems Methodology in Action, 1999, pp. 17-18.



What I do mean, part II

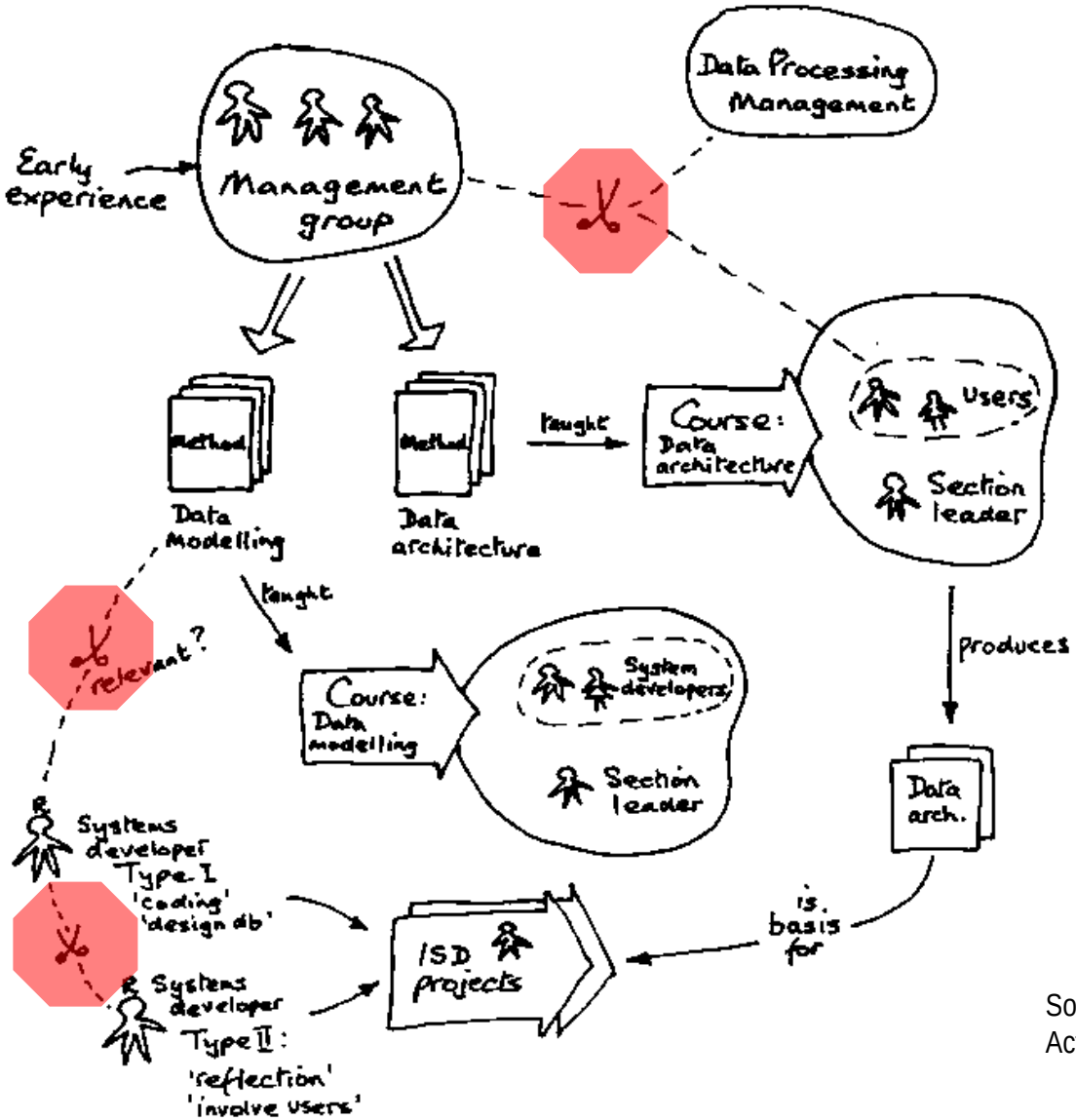
- Systems engineering, and by inheritance, software engineering, deal with “wicked problems,” ones where the problem changes as solutions are examined.
- Engineered solutions exist in an environment, and that environment includes people and systems of people – some touched directly and some not directly touched.



Some examples

- "In every system there are winners and there are losers." – Tom Demarco
- London Ambulance Service (1992): Sense of ownership removed. – Ian Sommerville's www.comp.lancs.ac.uk/computing/resources/IanS/SE7/CaseStudies/LondonAmbulance/ LASFailure.ppt
- US Federal Aviation Administration: Air traffic controllers are not permitted to participate during the system requirements phase.

Diagram, showing mismatches



Source: Soft Systems Methodology in Action, Checkland & Scholes, 1990, p. 47.

Two areas we impact

1. Systems & software engineering processes, procedures & tools.
2. The organizations in which our systems are situated, into which our systems are inserted.

- *Who is in charge of understanding, planning, and managing the human sides of the changes in those areas?*

Application of methods to systems engineering phases

Applications of Methods to Systems Engineering Phases:
Black denotes high method/phase applicability, gray denotes medium applicability, and white denotes low or no applicability

		Method	Concept Definition	Requirements Analysis	Function Analysis	Function Allocation	Task Design	Interface and Team Development	Performance, Workload, and Training Estimation	Requirements Review	Personnel Selection	Training Development	F
Cognitive Task Analysis	I.A.1	Applied Cognitive Task Analysis (ACTA)	■	■	▒	▒	■	■	▒	▒	■	■	
	I.A.2	Critical Decision Method (CDM)	■	■		▒	▒	▒	▒			■	
	I.A.3	PARI Method					▒	▒	▒		■	■	
	I.A.4	Skill-Based CTA Framework	▒	▒		▒	■	▒	▒		■	■	
	I.A.5	Decompose, Network, and Asses (DNA) Method					▒	▒	▒		▒	■	
	I.A.6	Task-Knowledge Structures (TKS)					■	■	■			■	
	I.A.7	Goal-Directed Task Analysis (GDTA)	▒	■	■	■	■	■	■	▒		■	
	I.A.8	Cognitive Function Model (CFM)			■	■	■	▒	■			■	
	I.A.9	Cognitively Oriented Task Analysis (COTA)					▒	▒	▒		■	■	
	I.A.10	Hierarchical Task Analysis (HTA)	▒	■	■	■	■	■	■	▒		■	
	I.A.11	Interacting Cognitive Subsystems (ICS)					■	■	■			■	
	I.A.12	Knowledge Analysis and Documentation System (KADS)					■	■				■	
	I.A.13	Team CTA Techniques					■	■				■	
		Method	Concept Definition	Requirements Analysis	Function Analysis	Function Allocation	Task Design	Interface and Team Development	Performance, Workload, and Training Estimation	Requirements Review	Personnel Selection	Training Development	F
Knowledge Elicitation	I.B.1	Unstructured Interviews	■	■			■	■		■		■	
	I.B.2	Structured Interviews	■	■			■	■		■		■	
	I.B.3	Step Listing	▒	▒			■	■	■			■	
	I.B.4	Group Interview	■	■			■	■		■		■	
	I.B.5	Questionnaires	■	■			■	■		■		■	
	I.B.6	Teachback	▒	▒			■	■	■			■	
	I.B.7	Field Observations/Ethnographic Methods	■	■		■	■	■				■	
	I.B.8	Twenty Questions	▒	▒	▒	▒	■	■	▒	■	▒	■	

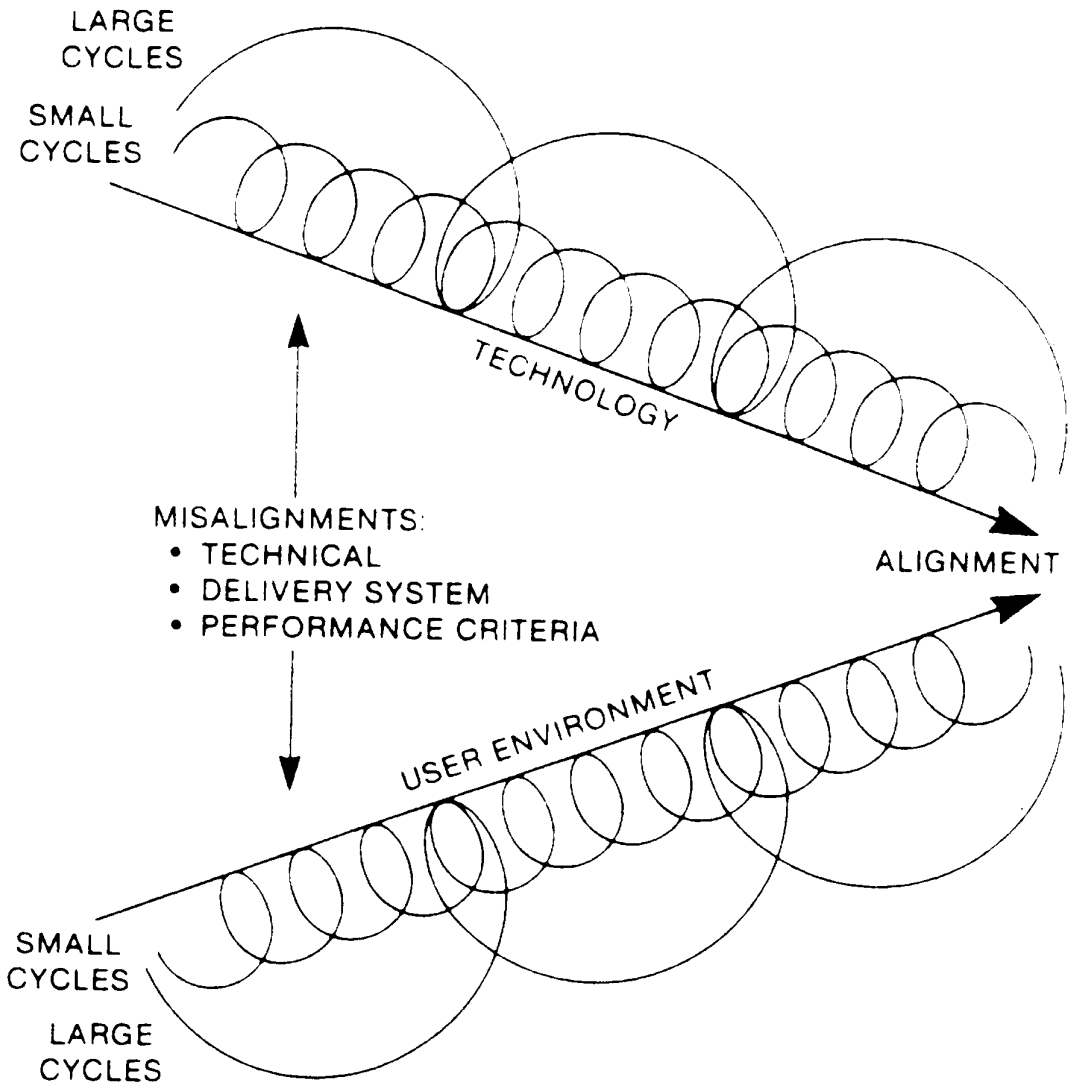
Source: mentalmodels.mitre.org/cog_eng/ce_sys_eng_phases_matrix.htm

Twelve systems engineering roles

Role	Abbr.	Short Name
1	RO	Requirements Owner
2	SD	System Designer
3	SA	System Analyst
4	VV	Validation/Verification Engr.
5	LO	Logistics/Ops Engineer
6	G	Glue Among Subsystems
7	CI	Customer Interface
8	TM	Technical Manager
9	IM	Information Manager
10	PE	Process Engineer
11	CO	Coordinator
12	CA	Classified Ads SE

Source:
www.software.org/pub/externalpapers/12ROLES.html,
INCOSE 1996 Proceedings

Mutual adaptation



Source: Leonard-Barton, D. (October 1988). Implementation as mutual adaptation of technology and organization. *Research Policy, 17*(5), 251-267

Mapping Alternative World Views

	"Normal Science"					"Pure Subjectivism"
Core Ontological Assumption	reality as a concrete structure	reality as a concrete process	reality as contextual field of information	reality as realm of symbolic disclosure	reality as social construct	reality as projection of human imagination
Metaphors	machine	organism	hologram, brain	theater, drama	sense-making	transcenden-tal
Human Nature Assumption	people are responders	people are adaptors	people are information processors	people are actors, symbol users	people are symbol creators	people are spirit, being
Epistemological Stance	construct a rational objective science, empha-sizing networks of causal laws and rule-governed relations	study systems, process and change	map contexts to understand how actions and contexts mutually evolve over time	understand pat-terns of symbolic discourse; symbolic actions used to shape and make mean-ingful social reality	understand processes by which social reality is created and sustained	obtain phenomenol-ogical insights; get/receive revelations
Knowledge Generated	systematic laws to explain and predict	understanding the impact of context on organization	understanding mutual causality; causal loops	identification of typologies of symbolic actions	understanding of processes used to create org. reality	understand-ing of the contents of consciousness
Research Approaches	lab experiments, surveys	historical analysis	contextual analysis	symbolic interactions	semiotics, ethno-methodology	explore pure subjectivity

“But I’m (just) an engineer!”

- Yes, of course, we are trained problem-solvers.
  Not necessarily sociologists.
- OK, it’s true that human & organizational issues are messy, not billiard balls. As objects we humans are interpretive.
- There is a growing literature aimed at engineers to help us
  - See what we do through the lens of socio-technical systems, becoming systems that generate meaning
    (www.Master-Systems.com/filecabinet/WhatIWouldDoDifferently02A.zip)
  - Evolve our technical solutions as the organizational solutions & meaning evolve
- Let’s add this to what the combined Systems + Software Engineer field is responsible for!