

SYSTEMS ARCHITECTING AND WORKSHOP

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GENERAL PRINCIPLES/GROUNDRULES

- System Structure is its Architecture and its Architecture is its Framework
- Stress “essence” of system
- Stress simplicity of process (Rechtin..)
- Stress repeatability of process
- Stress Knee-of-Curve concept
- Not the same as Enterprise Architecture

WHAT IS AN ARCHITECTURE?

“An organized top-down selection and description of design choices for all the system functions and subfunctions, placed in a context to assure interoperability and the satisfaction of requirements” *

- Preferred architecture: a choice among several architectures that is balanced, cost-effective and most congruent with what the customer is seeking, as tempered by program and/or system constraints *

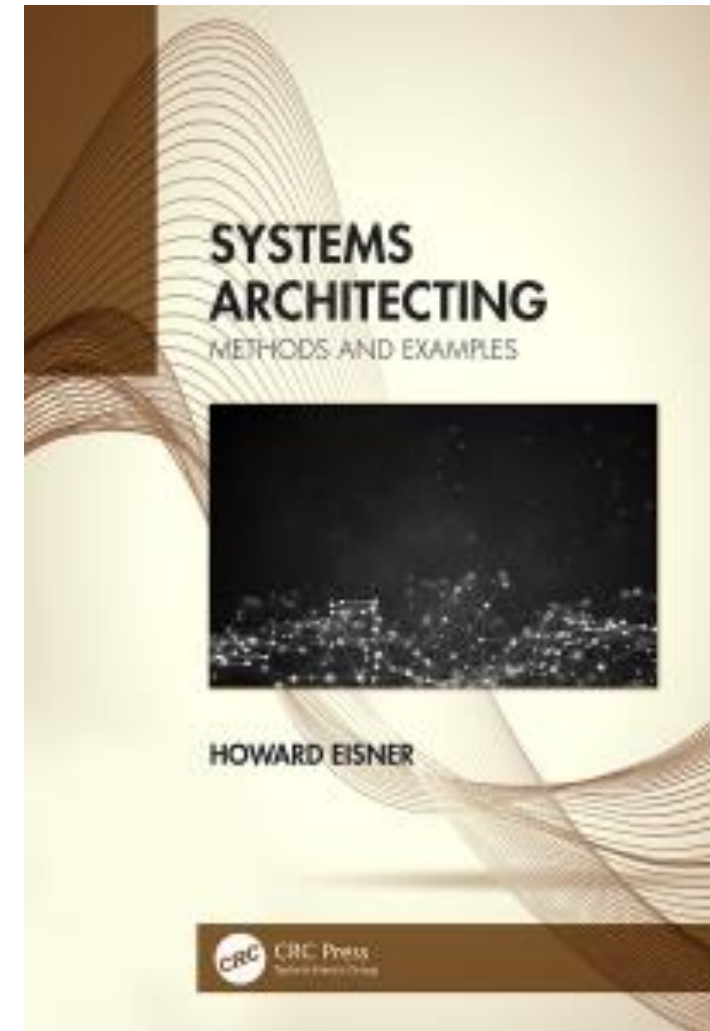
* Eisner, Howard, “Essentials of Project and Systems Engineering Management, Third Edition”, John Wiley, 2008

BASIC STEPS – EAM*

“Systems Architecting”, H. EISNER, CRC PRESS, 2020

- Functional Decomposition
- Synthesis (The Architectures)
- Analysis (Evaluation Of Alternatives)
- Preferred Architecture Based Upon Cost-effectiveness Considerations

* Eisner Architecture Method



Severe Climate Anemometry System

Functional Decomposition (R. D. Anderson)

<p><u>Atmospheric Sensing</u></p> <ul style="list-style-type: none">• Wind Speed Sensing• Wind Direction Sensing• Pressure Sensing	<p><u>Power Service</u></p> <ul style="list-style-type: none">• Main Power Supply• Power Regulation• Backup Power
<p><u>Mechanical Service</u></p> <ul style="list-style-type: none">• Instrument Housing• Orientation/Position	<p><u>Indoor/Outdoor Transmission</u></p> <ul style="list-style-type: none">• Power Transmission• Signal Transmission• Physical Linkages
<p><u>Environmental Service</u></p> <ul style="list-style-type: none">• Ice Control	<p><u>Data Handling</u></p> <ul style="list-style-type: none">• Data Collection• Data Proccession/Storage• Reporting/Distribution

Severe Climate Anemometry System

Synthesis (1 of 2) (R. D. Anderson)

	<u>Low Cost</u>	<u>Knee-of-Curve</u>	<u>High Effective.</u>
<u>Atmospheric Sensing</u>			
• Wind speed sensing	COTS Pitot	Add Xducer	Radio Xducer
• Wind direction sense.	Shaft Drive	Shaft Drive	Shaft Drive
• Pressure sensing	COTS Pitot	Add Xducer	Radio Xducer
<u>Mechanical Service</u>			
• Instrument Housing	Machined Alum	+ Mold Comp.	Less weight
• Orientation	Vaned Bearing	Less Tail Boom	High Prec Bear.
<u>Environmental Service</u>			
• Ice Control	Analog Temp	Add digital	Add Heat Pipes
<u>Power Service</u>			
• Main Power Supply	110/220 Comm	110/220 Comm	110/220 Comm
• Power Regulation	Conditioners/Rods	+GroundFault	Add Lightning Arr.
• Backup Power	Batteries	Gas Generator	Diesel w/switch

Severe Climate Anemometry System

Synthesis (2 of 2) (R. D. Anderson)

	<u>Low Cost</u>	<u>Knee-of-Curve</u>	<u>High Effective.</u>
<u>Indoor/Outdoor Trans</u>			
• Power Transmission	Stranded Wire Harness	Stranded Wire Harness	Custom Slip Rings
• Signal Transmission	Foil-Shielded Wire	Coax with Slip Rings	2-way Radio
• Physical Linkages	Shaft/Conduit	Add Transducer	Minimum Shaft
<u>Data Handling</u>			
• Data Collection	Pneumatic Cell	Magnetic Sensor	Optical Sensor
• Data Processing	Manual Database	Computer Control	Comp Control
• Reporting and Distribution	Physical/Manual Network	GUI+Modem	DBMS + Packet

Architecting a House

Functional Decomposition

- Eating
- Food Preparation
- Baths
- Recreation
- Environment
- Style/Design
- Security
- Plumbing
- Electrical
- Car/Facility
- Living/Dining Space
- Sleeping Quarters
- Closets
- Lawn/Garden

Architecting a House - Synthesis

(P. 1 of 2)

<u>Functions</u>	<u>Low Cost</u>	<u>Knee-of-Curve</u>	<u>High Effective.</u>
• <u>Eating</u>	Standard Dining	1.5xStandard	2xStandard;High ceiling
• <u>Food Preparation</u>	Standard Kitchen	Std + hi extras	Std+hi extras+ extra equip & counters
• <u>Baths</u>	Two Baths	Three Baths	Five baths w/bidet+
• <u>Recreation</u>	Small Deck	Front/Back Decks	Wraparound Decks + Pool
• <u>Environment</u>	Single Furnace Low Capacity	Two Zone Medium Cap.	Three Zone; High Capacity
• <u>Style/Design</u>	Ranch	Faux Farm	Contemporary
• <u>Security</u>	Need To Hire	Camera/Tape	Add Alarms & Internet
• <u>Plumbing</u>	Std Copper	Std+ extra Flareouts	Add Sprinkler System

Architecting a House - Synthesis

(P. 2 of 2)

<u>Functions</u>	<u>Low Cost</u>	<u>Knee-of-Curve</u>	<u>High Effective.</u>
• Electrical	Std. Amps	Add 50% More	Add 100% More
• Car/Facility	One Car Garage	Two Car	Three Car
• Living/Dining Space	2400 SQFT	3000 SQFT	4500 SQFT
• Sleeping Quarters	3 Bedrooms	4 Bedrooms	5 Bedrooms + Rec Room & Den
• Closets	Five total	3+ All Bdrms	5 + All Bdrms + Increased Size
• Lawn/Garden	Small Lawn	Add Water Lines	Large lawn + Gazebo

Analysis (Evaluation of Alternatives)

Evaluation Criteria (Illustrative)	Weight	System A		System B		System C	
		Rating	WxR	Rating	WxR	Rating	WxR
Maintainability	0.3	7	2.1	8	2.4	9	2.7
Aesthetic	0.1	6	0.6	7	0.7	9	0.9
Overall Livability	0.1	7	0.7	7	0.7	9	0.9
Food Preparation	0.3	8	2.4	9	2.7	9	2.7
Bath areas/closets	0.2	7	1.4	8	1.6	9	1.8
	SUM		7.2		8.1		9

Analysis (of Alternatives)

	System A	System B	System C
Effectiveness	7.2	8.1	9
Cost	800K	1.2M	4M

Effectiveness on Scale of 1 TO 10

Weighting and Rating Schema

WHICH ALTERNATIVE WOULD YOU CHOOSE?

More Detailed Evaluation Criteria (Stakeholder Fidelity)

Performance

- Varying stability
- Average power consumption
- Impact Resistance
- Data Availability
- Useful Life

Human Factors

- Ease of Use
- Operator Safety
- Bystander Safety

Reliability

- Generic Failure Rate
- Level of Redundancy

Maintainability

- Scheduled maintenance
- Mean-time-to-repair

Risk

- Schedule risk
- Performance risk
- Societal risk
- Cost risk

Sustainability

- Year-by-year cost vs budget
- Technology obsolescence

TRADEOFFS

Can See Areas For Tradeoffs From Synthesis Chart?

- Power Transmission Example
- Environmental Service
- Radio Transducer
- Physical Linkages
- Power Regulation. Etc.

INTEROPERABILITY

Can See Areas For Interoperation By Moving From
Top To Bottom On Synthesis Chart?

- Wind Speed Sensing Vs. Wind Pressure Sensing
- Power Transmission Vs. Signal Transmission
- Data Collection Vs. Data Processing
- Data Processing Vs. Data Reporting/Distribution

Other Evaluation Criteria

Transportation & Communications

Transportation

- Trip Time
- Demand
- Capacity
- Speed
- Fuel Consumption
- Safety
- Security

Communications

- Number of Channels
- Grade of Service
- Signal-To-Noise Ratio
- Probability of Detection
- Alarm Probability
- Response Time
- Connectivity

FINAL COMMENTARY

- Cost of alternatives
- Effectiveness of alternatives
- “Knee-of-Curve” – ?
- Preferred Levels of Functional Decomposition = 3
- Can Obtain Deeper Evaluation with More/Sub-criteria
- Can Visually See (a) tradeoff areas, (b) interoperability areas
- Consider Using Team Approach/Experiments

System A	System B	System C
800K	1.2M	4M
7.2	8.1	9

QUESTIONS?