CMPE349 Intro to Professional Practice

Architectural View

Functional Trade Studies

- **Trade studies are hard to do at the functional level**
- **Heuristic: Do the hard parts first**
- **What do we trade?**
  - **Function sets defining different mission scenarios**
  - **Different functional decompositions of the same higher-level function**
- **Alternatives should span the range of potential solutions**
- **What are our metrics?**
  - **Number**
  - **Complexity**
  - **Reuse**
  - **Scaleability**
  - **Integrity/reliability**
- **The trade need not be explicit or detailed, but does need to be captured.**
- **Heuristic: Simplify, Simplify, Simplify!**
- **Heuristic: It doesn't exist if it isn't written down**

Functional/architectural tradeoff example

0, 1, 3, 9

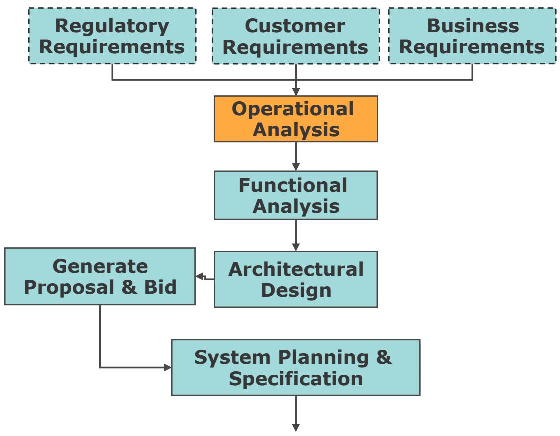
1,2, 3,4,5

		Functional Product Requirements - Operating Parameters						
Maximize, minimize, or target								
Customer Need	Importance Rating	Arch #1	Arch #2	Arch #3	Arch #4	Arch #5	Arch #6	Arch #7
ADS-B functionality	5	9	9	9	9	9	9	9
Advanced Surveillance Functionality	3	9	9	9	9	9	9	9
DSB-AM Voice	5	9	9	9	9	9	9	9
ATS Data Comm.	3	9	9	9	9	9	9	9
Good availability	3	9	3	0	1	3	9	3
Good continuity	4	9	3	0	1	3	9	3
Minimize interference to existing Sys.	3	3	3	3	3	1	3	1
Minimize susceptibility to existing Sys.	3	3	3	3	3	1	3	1
Upgrade of existing radio	1	0	0	0	0	0	0	0
Minimize Number of Antennas	4	0	0	3	3	9	1	9
Comp. wcurrent antenna placement	2	1	1	3	3	9	3	9
AOC Data Comm.	3	9	9	9	9	9	9	9
Minimize acq. cost	5	0	3	1	0	3	1	1
Minimize installation complexity	3	1	3	3	3	9	1	1
Relative Importance		257	236	221	223	294	270	260
Target Range								

Things to consider

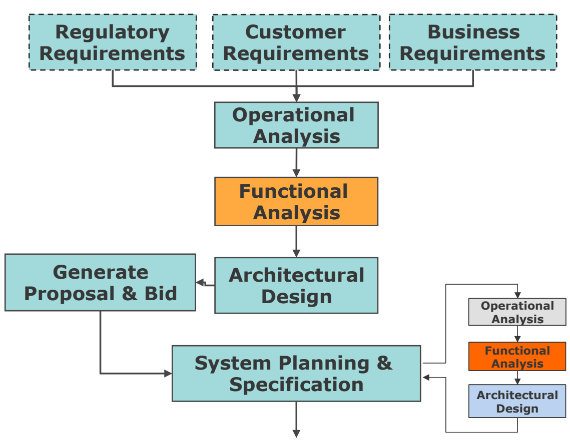
- **Heuristic**: Act on fact!
- Often the simple trade study will only show what you don't know.
- **Heuristic**: Know what you don't know.
- Be careful with your weighting, as it can change the results of table-based trades…
- …try slight modifications of the weighting to check for sensitivity.
- Less sensitivity to weighting is good!
- **Heuristic**: The last time your solution is perfect is before you show it to someone else.

Operational Analysis review



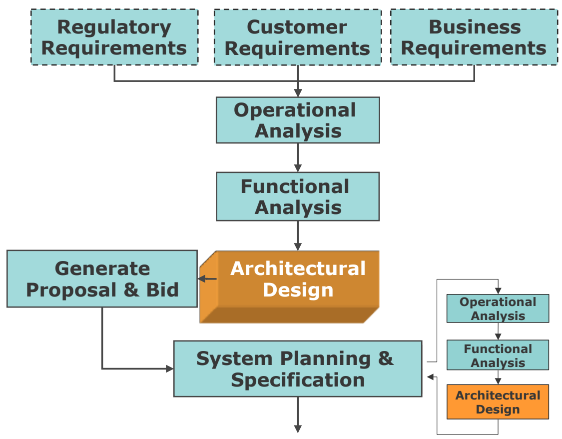
- What is the **scope** of work of the system?
- What are the **lifecycle effects**
- What are the **missions**
- What do we know about the **interfaces**
- What doesn't the **customer/consumer/client/caretaker** know or understand?

Functional Analysis Overview



- **Define** what the system must do to accomplish the work.
- **Translate** operational requirements into a functional model.
- **Output** functional requirements that constrain the behavior of the model.
- These will be the **system** requirements

Architectural Design Overview



- Create the **physical model** of the system
- **How** the system implements the requirements
- **Defines** hardware and software components
- **Defines** the interfaces that connect components
- **Defines** the behavior of the components.
- **Allocates** requirements to Configuration Items (CIs)

Design is less conceptual than *analysis*

- **Heuristic** (paraphrase): There comes a time to shoot all the analysts and get around to building something.
- **Heuristic**: Avoid the "analysis to paralysis" syndrome.
- The design **problem** is "**where to start?**"
- The design **weakness** is "I already know how to do this!"

Taylor's Rules for Decomposition (1 of 5)

- Apply Operational and Functional Analysis steps to assure that top level specification ("A Spec") is
  - Unambiguous
  - Accurate
  - Complete
  - Consistent
  - Verifiable
- Assure that the A-Spec has quantifiable and quantified performance requirements, e.g.
  - Accuracy
  - Availability
  - Capacity
  - Response time
  - Scaleability

Taylor's Rules for Decomposition (2 of 5)

- Decomposition adds detail, not clarity
  - If the requirements in the top level specification aren't clear, fix them first
- If a given function (element of the functional analysis) can't be mapped into a single architectural component or configuration item, decompose it until it can.
- The first level of decomposition below the system level is often the "site" level, not necessarily the subsystem level.
  - A "site" is a physically distinct type of location where elements of the system must reside.
  - Example: A mobile communication system may have two types of sites: mobile users and base stations.
  - Example: A banking system might have headquarters, regional centers, local centers, remote elements for 4 site types

Taylor's Rules of Decomposition (3 of 5)

- Allocate functions to a single site type
  - If the function can't be allocated to a single site type, then decompose it!
  - A function that can be allocated to a single site type need not be decomposed at this time.
  - This decomposition is the "B Spec"
  - Update the functional analysis to match any additional decompositions done in this step
- A Configuration Item is the instantiation of a group of similar functions that are
  - Relatively autonomous from other functions
  - Can be developed by a single team of 3-8 developers
- Reapply the functional allocation and decomposition rules to the CIs

Taylor's Rules of Decomposition (4 of 5)

- Most systems continue the decomposition to the component level
  - This is the level where COTS or pre-existing products come in
  - The component spec (functional, performance, etc) is the "C Spec".
- Update the functional analysis! DO IT!
- Each leaf in the functional architecture must map to a single CI.
  - Multiple functions to one CI is fine.
  - Single leaf function to multiple CIs is a recipe for disaster.
  - Stop the decomposition when this rule is met!

Taylor's Rules of Decomposition (5 of 5)

- **How to handle performance requirements?**
  - **If performance can be allocated to single CI, handle like functional requirement.**
  - **If not, performance must be partitioned!**
- **Maintain a quantitative assessment of the performance partitioning**
  - **Technical Budgeting (we'll discuss later in detail)**
- **Heuristic: It doesn't exist if it isn't written down!**

Two Types of Physical Architectures

Generic Architecture

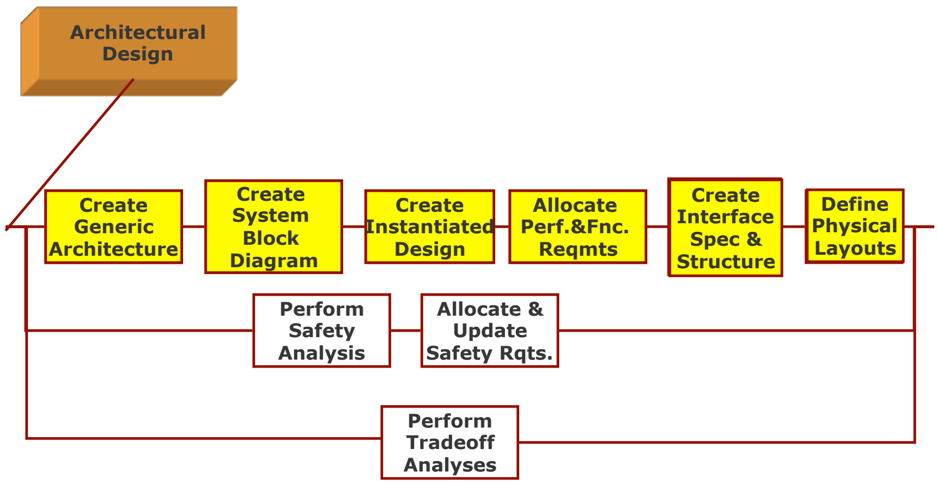
- **Contains components that support all required functions**
- **Includes support resources for operation, maintenance, distribution, training, etc.**
- **Does not specify performance characteristics of each physical resource.**
- **Contains components that can be implemented multiple ways.**

Instantiated Architecture

- **Starts with generic architecture**
- **Includes complete definitions of performance characteristics**
- **Allocates specific COTS products or custom development to components**
- **Identifies quantities of each component**

Heuristic: Except for good and sufficient reasons, generic and instantiated structuring should match

The architectural design process



Architectural Heuristic

- **"When working on a problem, I never think about beauty. I think only of how to solve the problem. But when I have finished, if the solution is not beautiful, I know that it is wrong."**

Buckminster Fuller

Cautions related to the physical architecture

- There is cultural inertia to jump immediately to this step based on perceived prior experience
  - Local optimizations in the architecture
  - Reduce the effectiveness and/or increase the cost of the final implementation
- Successful architectural design requires iteration.
- Consider multiple options.
- Be careful not to let pre-conceived ideas drive architectural decisions.
- Interface definition is critical
  - Spend the time required to complete this step.
  - It will reduce the need for future rework.

Architectural Heuristic

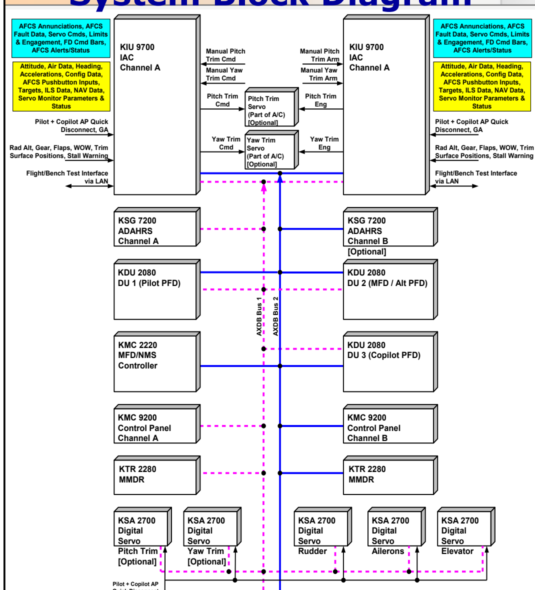
- Employ the principle of “deferred commitment”
- The later that you can commit to a specific implementation technology, the more **robust** the final architecture will be.
- Make a implementation technology choice when you must, not when you can.

Configuration Item Matrix

- **Brainstorming activity results in list of CIs**
- **In some cases, the customer will have specified configuration items as part of the requirements. Capture this as part of the Architectural Design step.**

		Functions				
		Navigation	Lateral Guidance	Vertical guidance	Threat Avoidance	Mission Planning
Configuration Items	ADC #1	X		X		
	ADC #2	X		X		
	CDU #1	X				
	CDU #2	X				
	CMFD#1		X	X		
	CMFD#2		X	X		
	EFIS #1			X		
	EFIS #2			X		
	EGI #1	X		X		
	EGI #2	X		X		
	IFF	X		X		
	ILS	X	X	X		
	MISP #1	X	X	X	X	X
	MISP #2	X	X	X	X	X
	Radar Alt	X		X		
	CSDS				X	X
	MMU					X

System Block Diagram



- **You may violate the 7+/-2 rule!**
- **Use previous results**
  - **System Boundary Diagram**
  - **Data Flow Diagram**
  - **Control Flow Diagram**
- **Show the connectivity between CIs first**
- **Assign preliminary interconnection types, i.e., analog, digital, discrete**
- **Evaluate interconnects based on performance**
- **Show unidirectional vs. bidirectional interfaces.**
- **Establish point-to-point & bus interconnections**