INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

Functional Architecture's Mental Roadblocks and Other Things Your Mother Didn't Tell You

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Stevens Institute of Technology

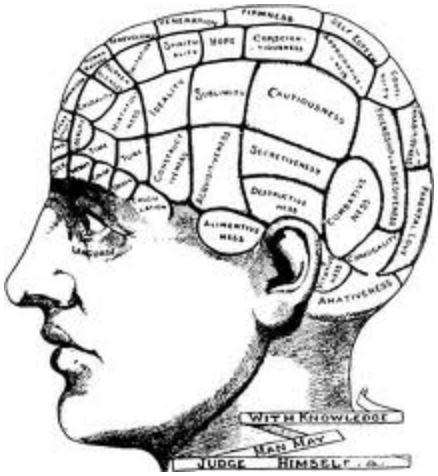
Functional Architecture

Is it really…

"akin to astrology,

phrenology,

and voodoo"?



Definitions

- INCOSE Handbook: a list of artifacts
- Kassiakoff and Sweet and IEEE 1220:

  "An arrangement of functions and their associated interfaces (both internal and external) that defines the configuration, execution sequencing, conditions for control or data flow, and the performance requirements to satisfy the requirements baseline"

Functional Information

- Functional architecture – functional decisions
- Functionality – what the system does
- Sequentiality – which action precedes another
- Data/material flow – what gets used/produced
- Functional interfaces – how functions interact
- States and transitions – conditions and changes
- Functional failure analysis – what if it doesn't happen
- Timing – will it meet limits

Source: IEEE 1220

Functional Flow Block Diagram

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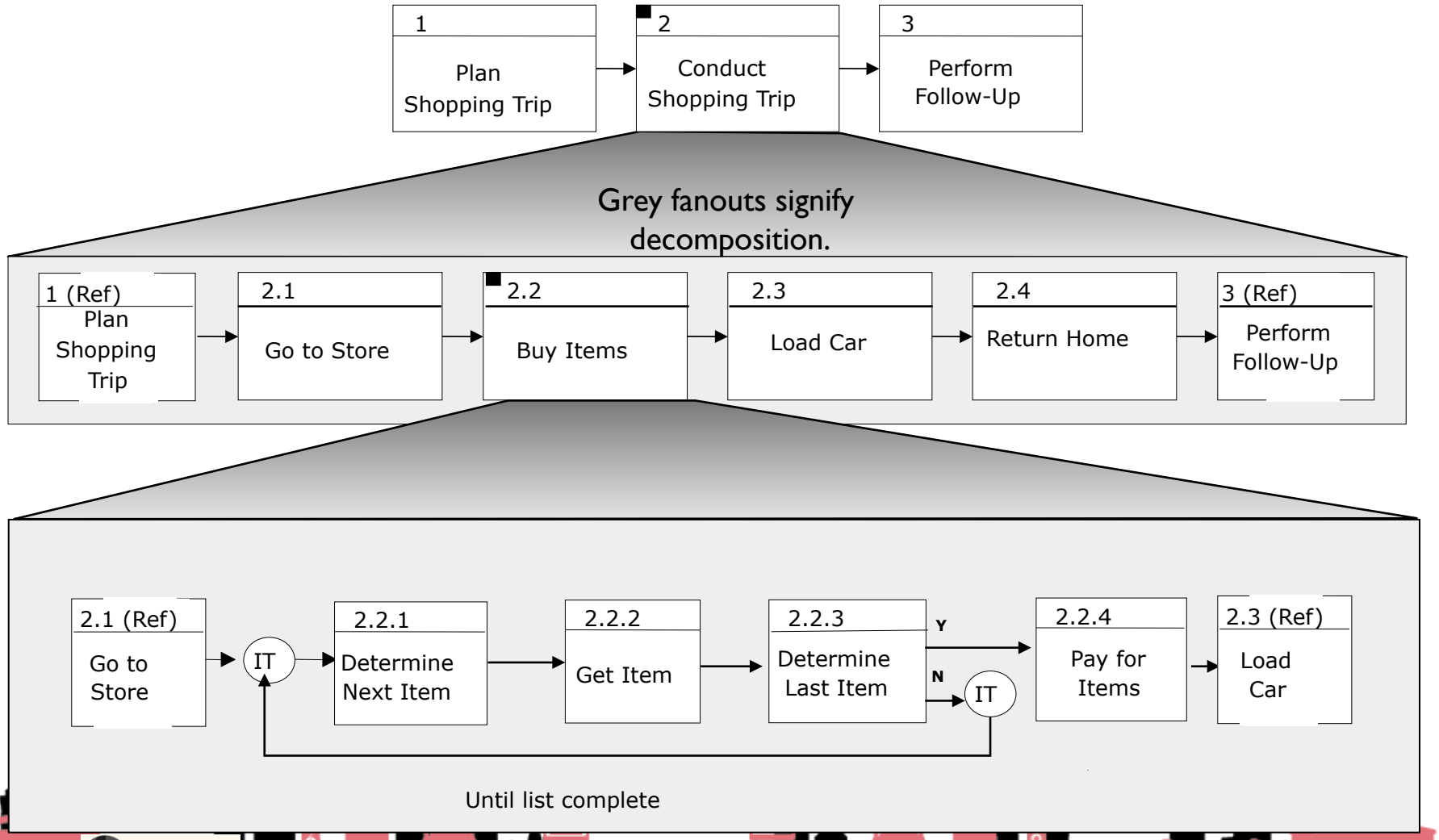
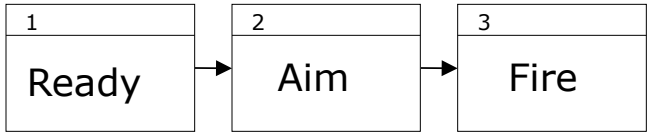


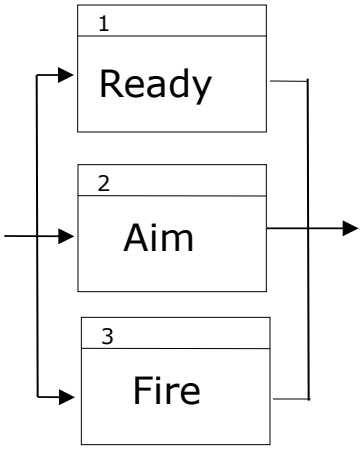
Basic Constructs



Ready completes before Aim starts

Aim completes before Fire starts

No repeats

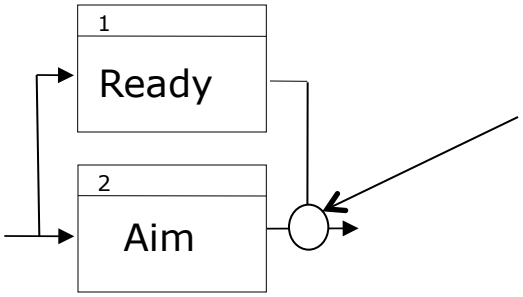


Ready, Aim and fire can happen at the same time

May not be in correct sequence (see EFFBD charts)

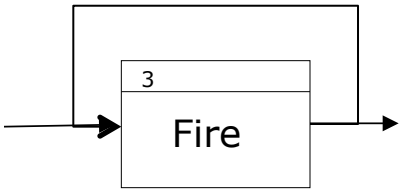
Still no repeats

Additional Options

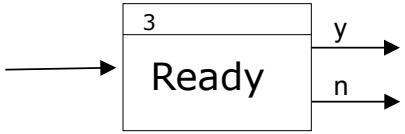


And – all must complete to proceed

Or – any complete OK to proceed



Iteration – repeats fixed number of times or until limit is reached



Conditional exit – alternative outcomes or decisions

Data or Object Flow

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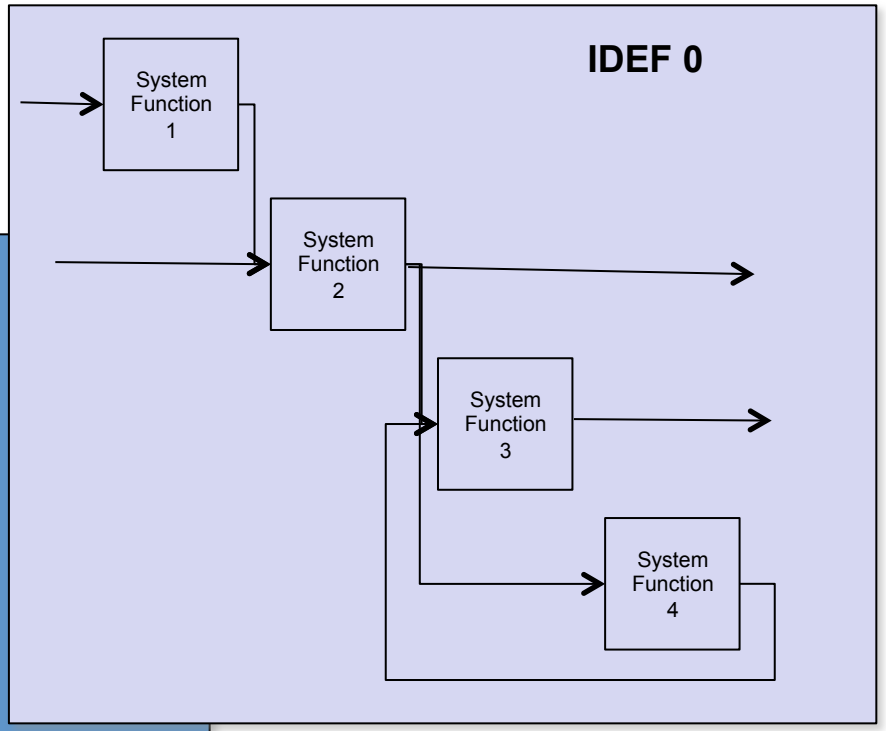
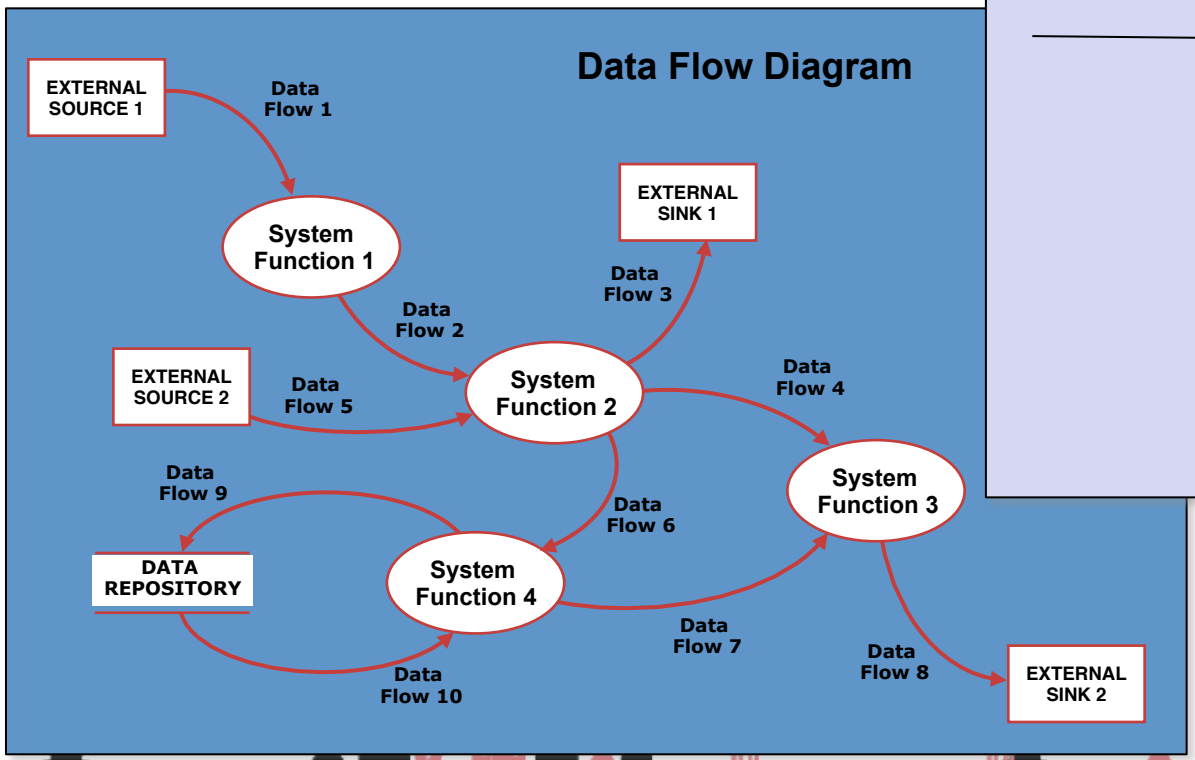
Data flow is the principal concern of IDEF 0 and the Data Flow Diagram

Functions are defined and decomposed

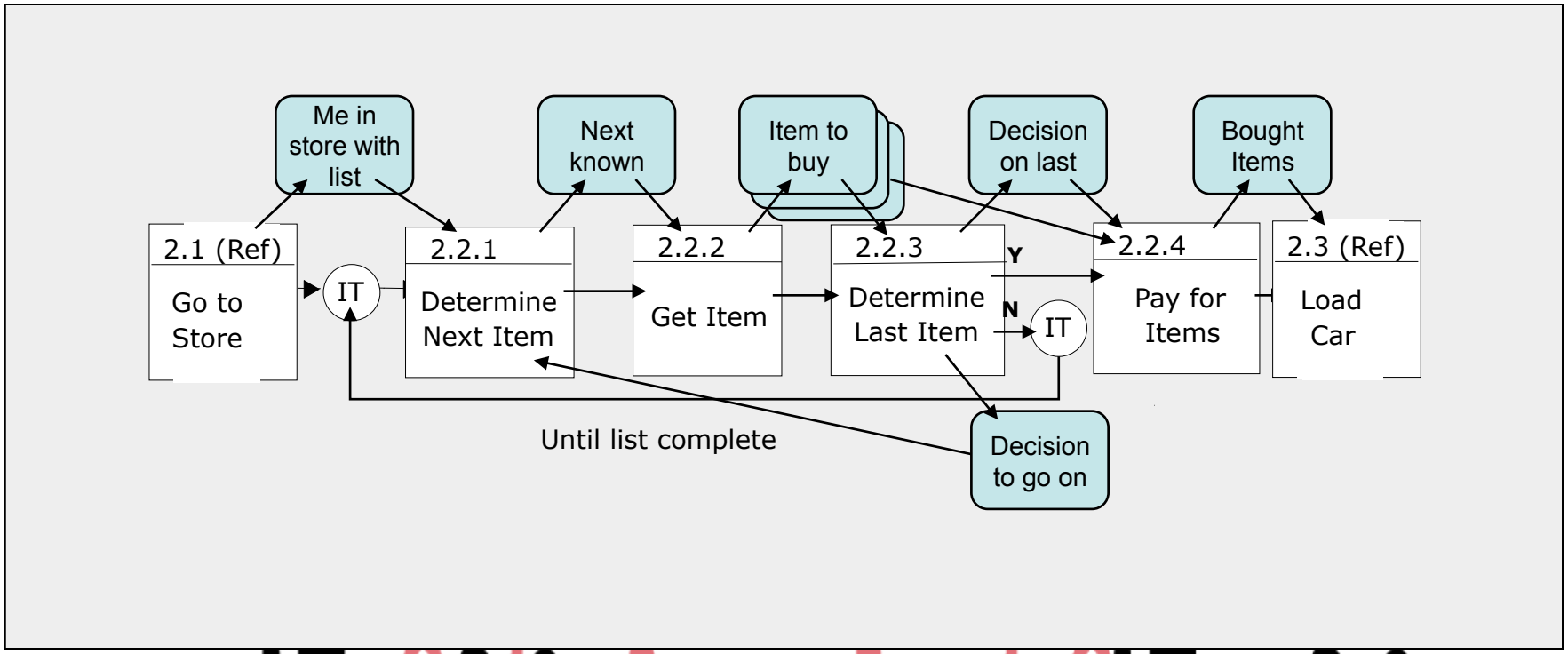




Sequence is not part of these methods

Enhanced FFBDs

- EFFBDs or Behavior Diagrams provide full, executable modeling of functionality with loops, decisions, replications, and other constructs.



Defining Interfaces with EFFBD

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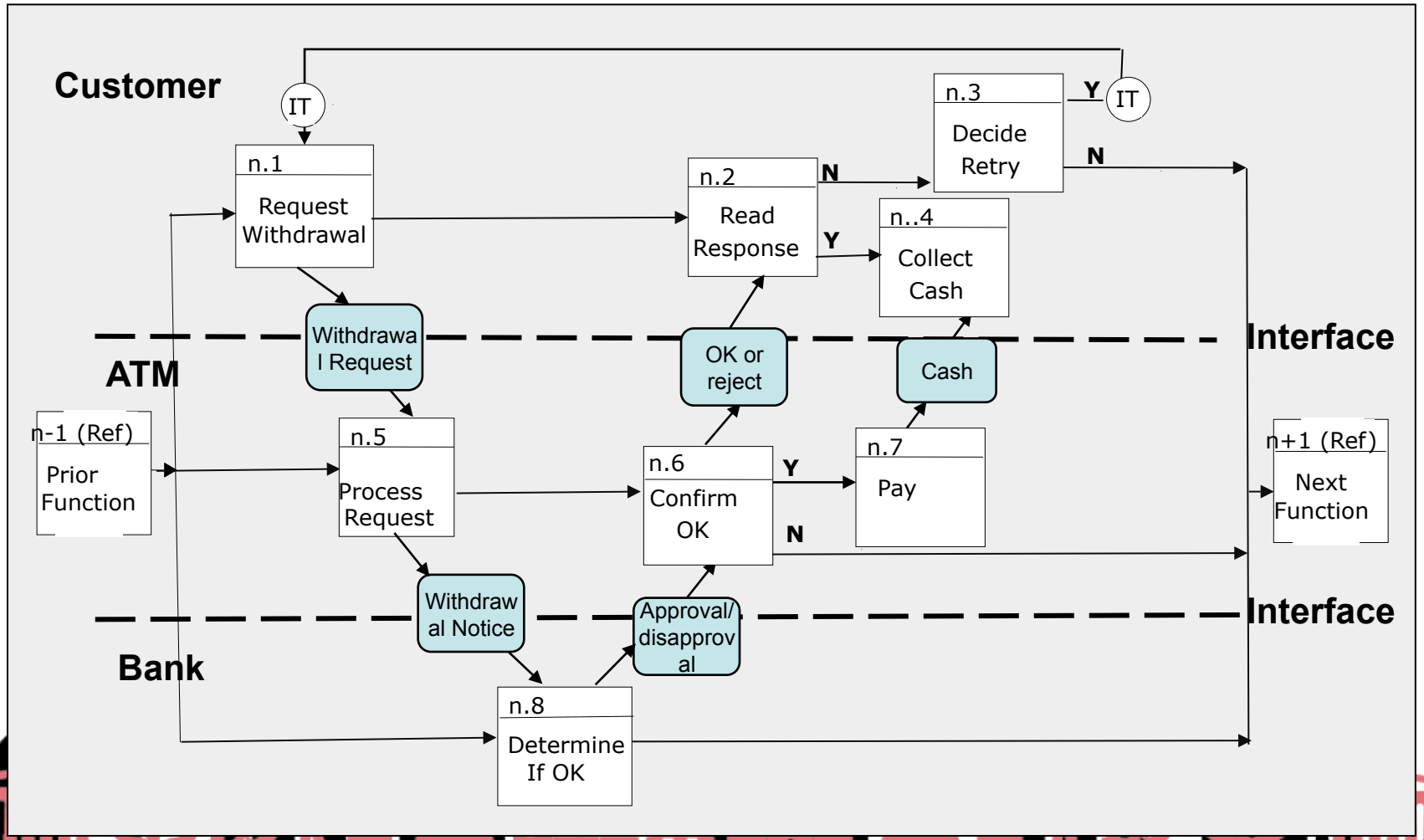
Not only what crosses interface, but logical constraints (not cash until approval)
Understanding other side of interface



Sequence Diagram

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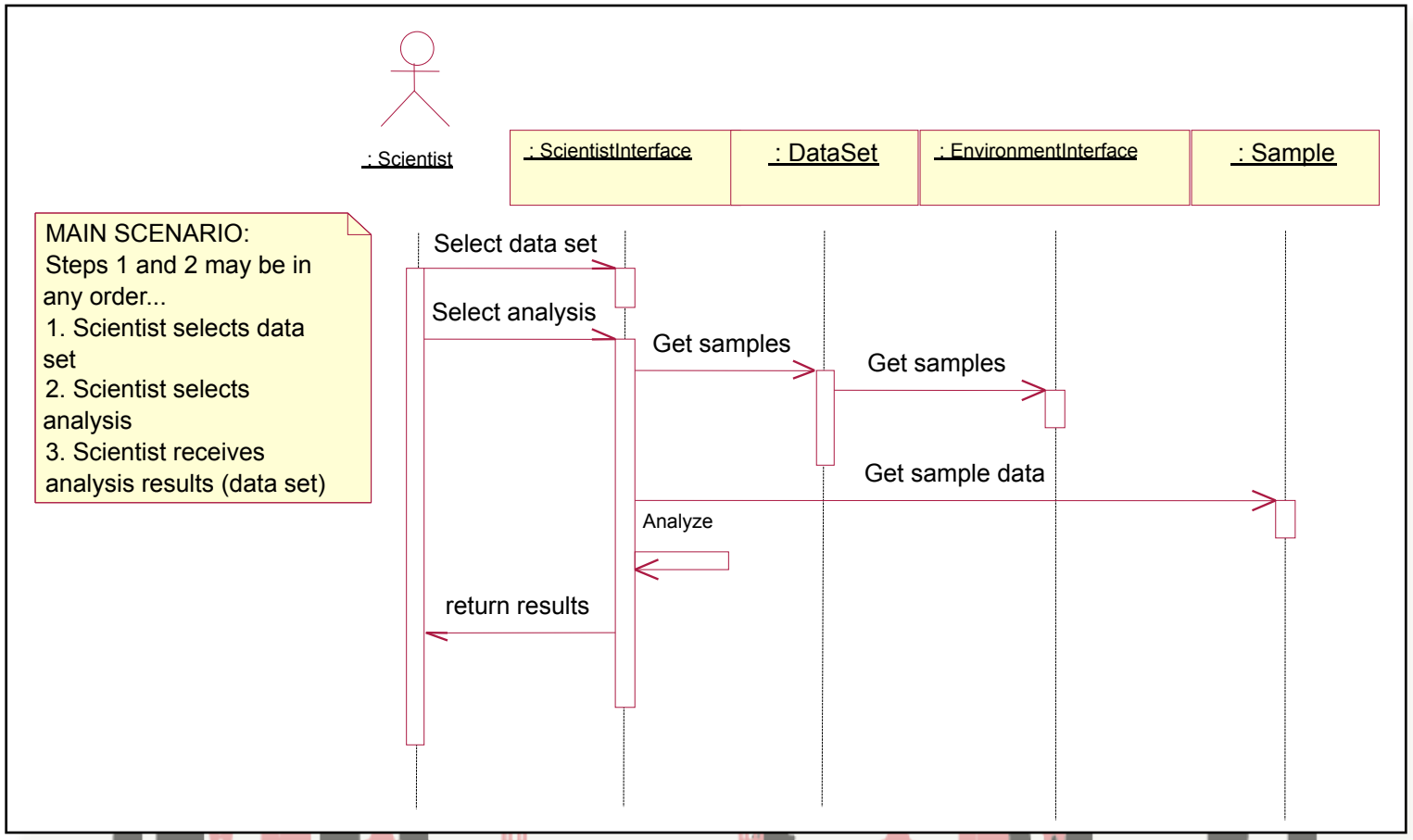
Sequence Diagrams provide limited combination of sequence and data



Logical Alternatives

- Push or pull
- Demand or schedule
- Simple transmission or “ack-nack”
- Data storage or process and discard
- Command movement or exception-only control
- Discrete/flood search/other (telephone)

States and Modes

Many different and conflicting definitions; in this course

- State: A condition of the system
  - Storage
  - Operations
  - Standby

- Mode: A manner in which the system operates
  - Remote control mode
  - Failure mode
  - Training mode
- Inverse of Functions – blocks are end states and arrows are actions to make transition

Functional Failures

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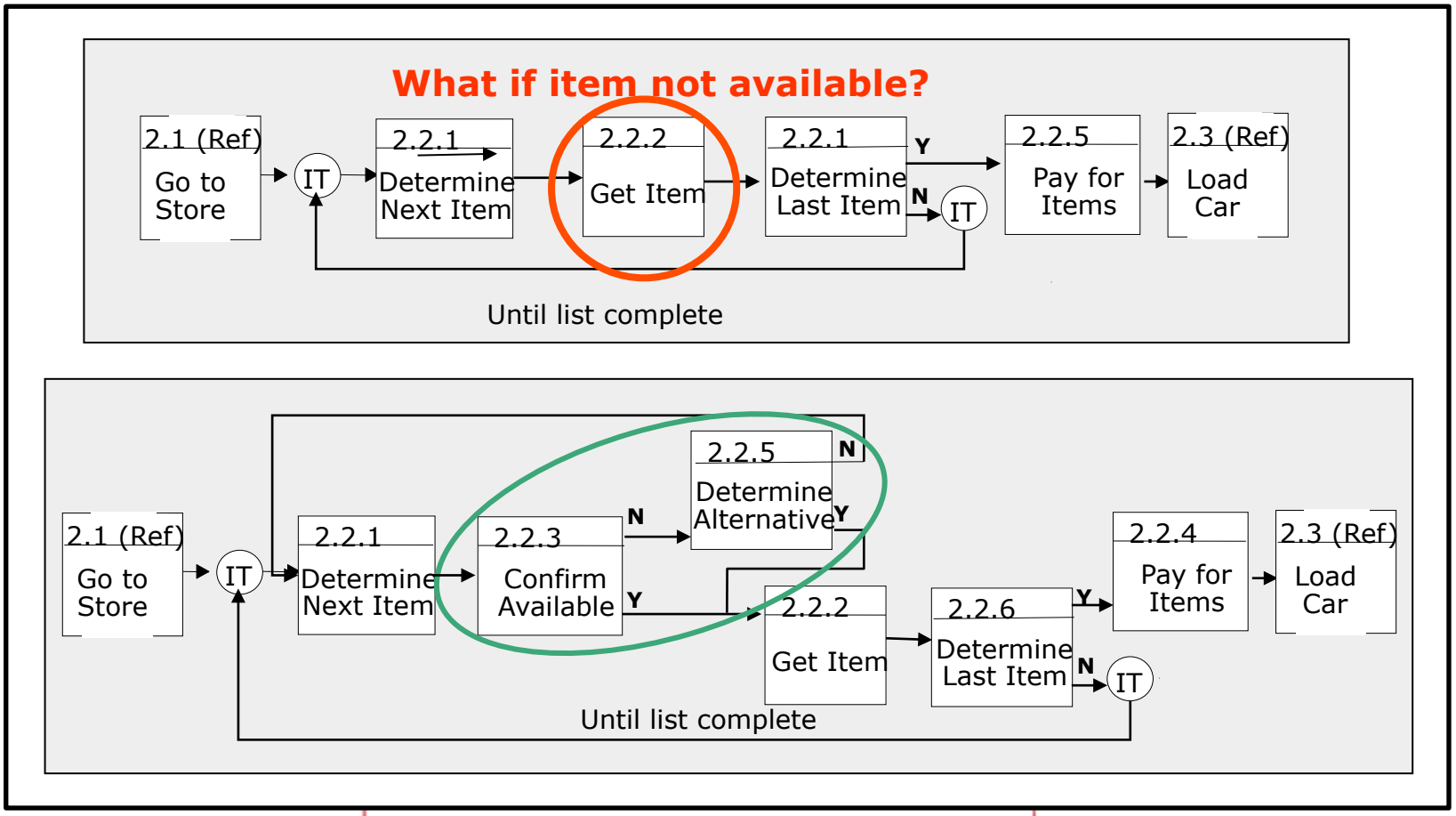
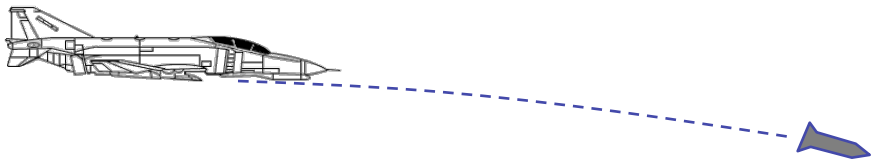
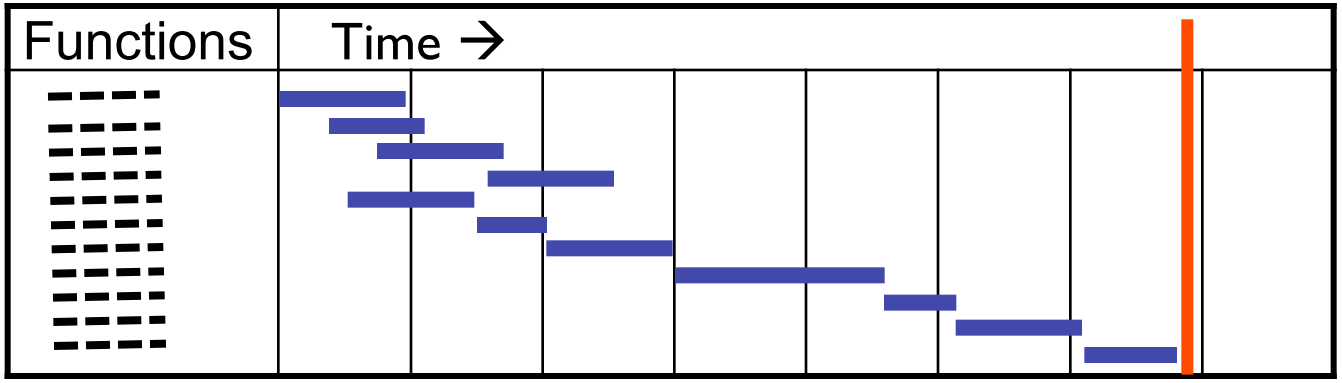


Timing Analysis



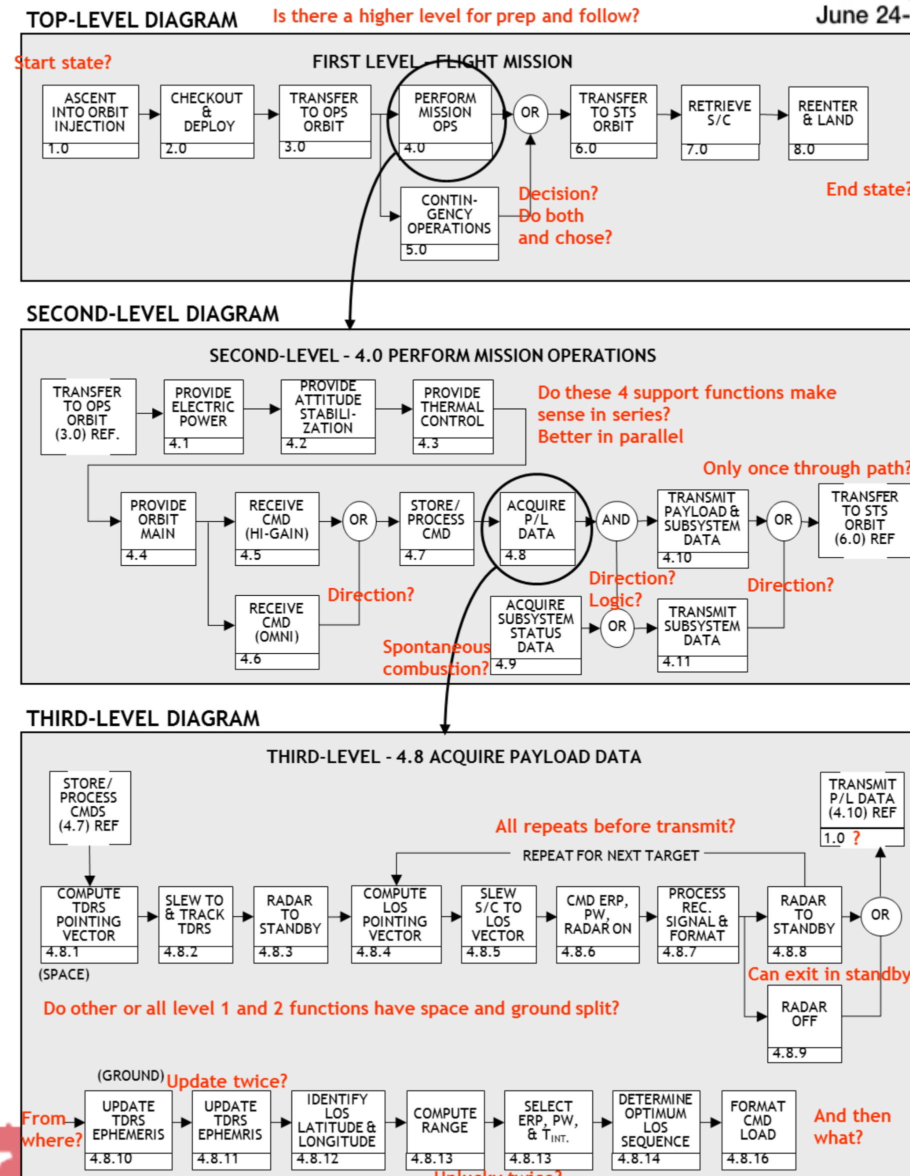
Single Shot Timeline

High and slow time limit



It Looks Easy

- But it isn't…
- Even the pros have problems!



Function/Component Mixing

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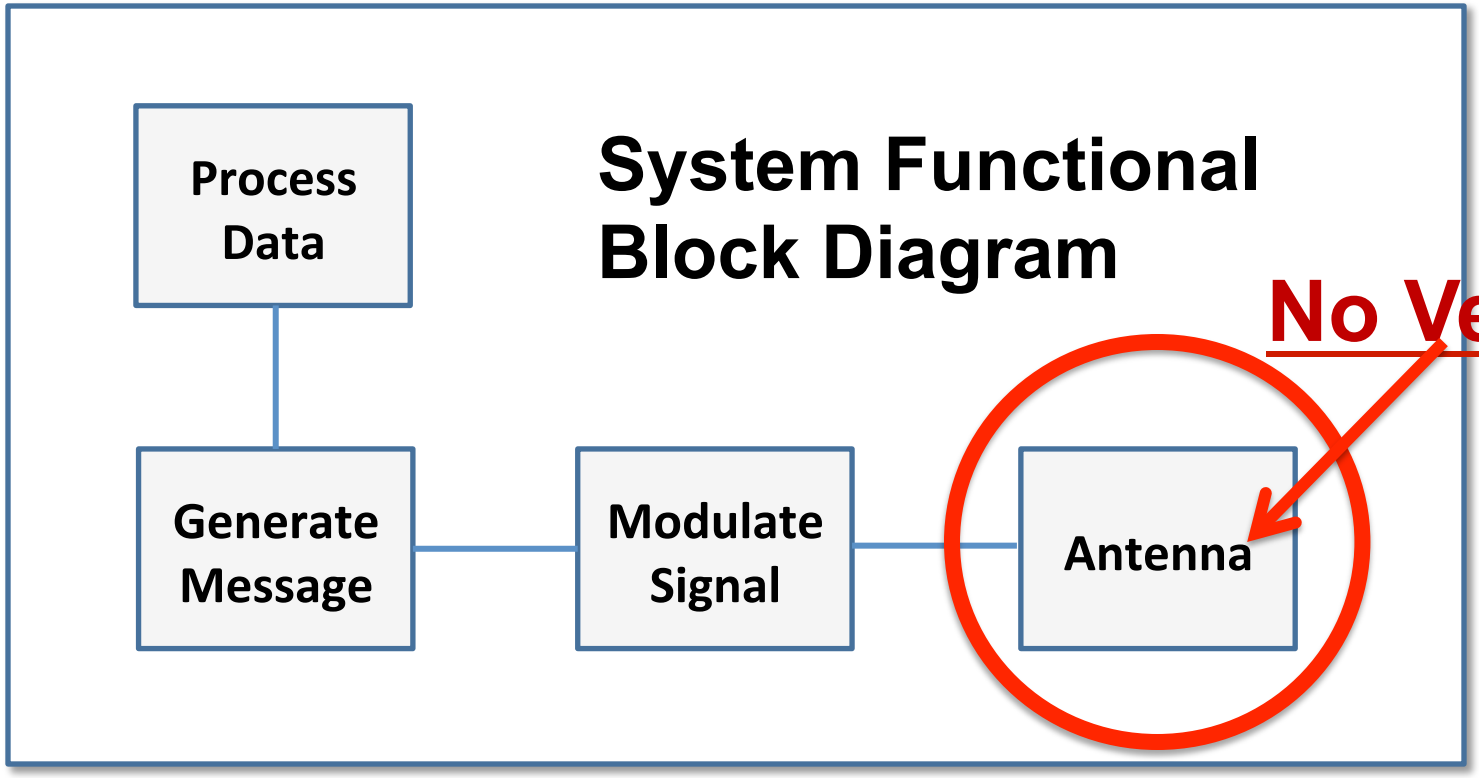
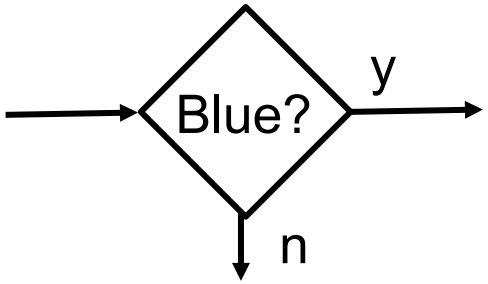
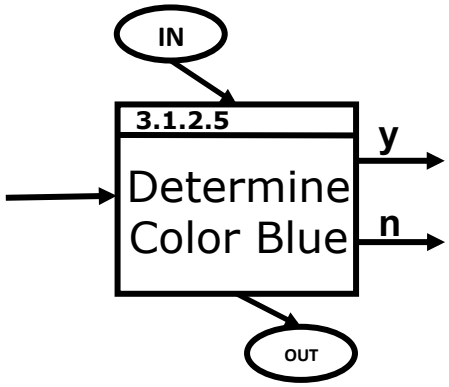
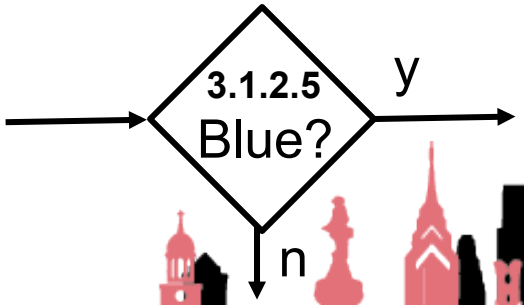


Decisions Are Functions

- Common depiction
  - Done by??
  - How fast??
  - Inputs/Outputs??
- Better approach
  - Clearly one of the functions
  - Traceable to component/ requirements
  - Inputs/outputs
- Acceptable







Functional Interfaces

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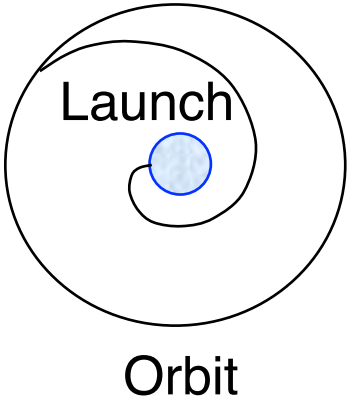
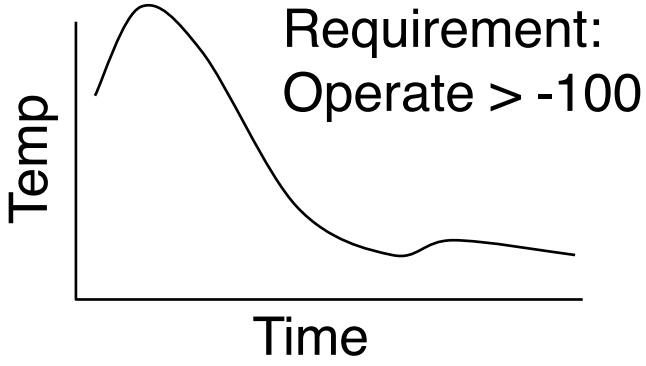
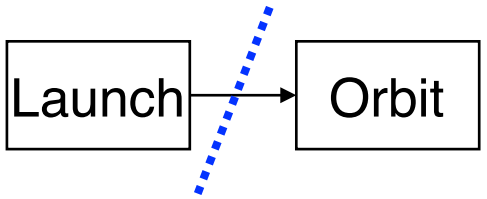
Space Example







Problem: Discovered in test that the sensor could not **turn on** below -50

Cause: Functional Interface & State Transition not analyzed

Hit the EFFBD Button Errors

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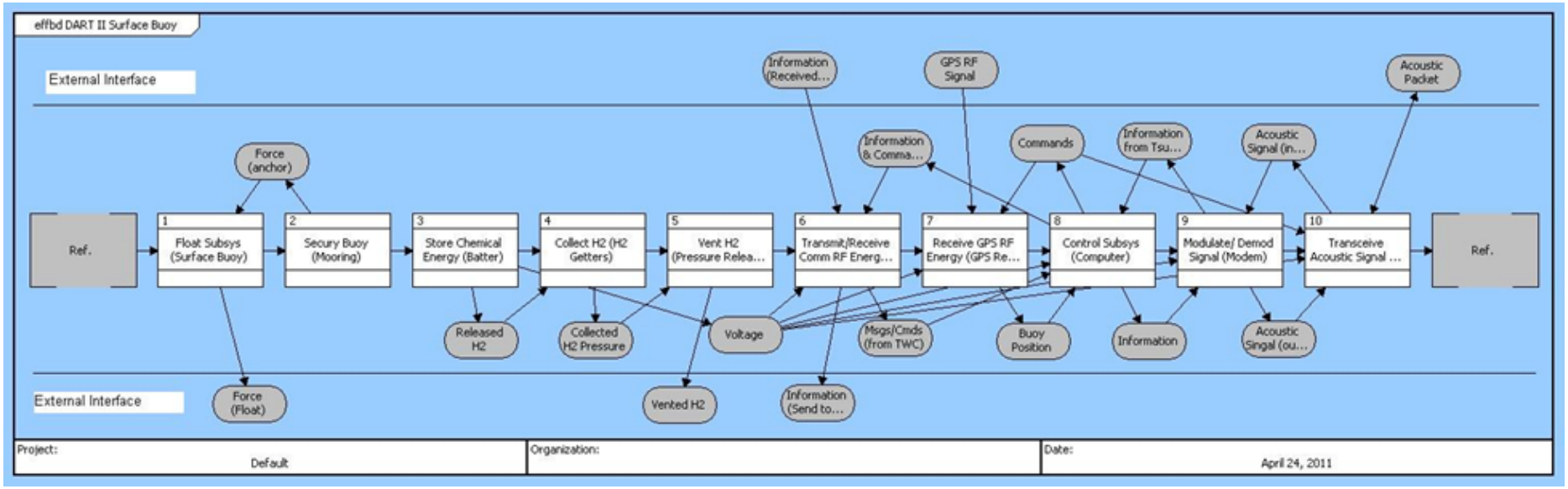

No student sequence input
Software lines functions sequentially as listed

Hit the EFFBD Button Errors

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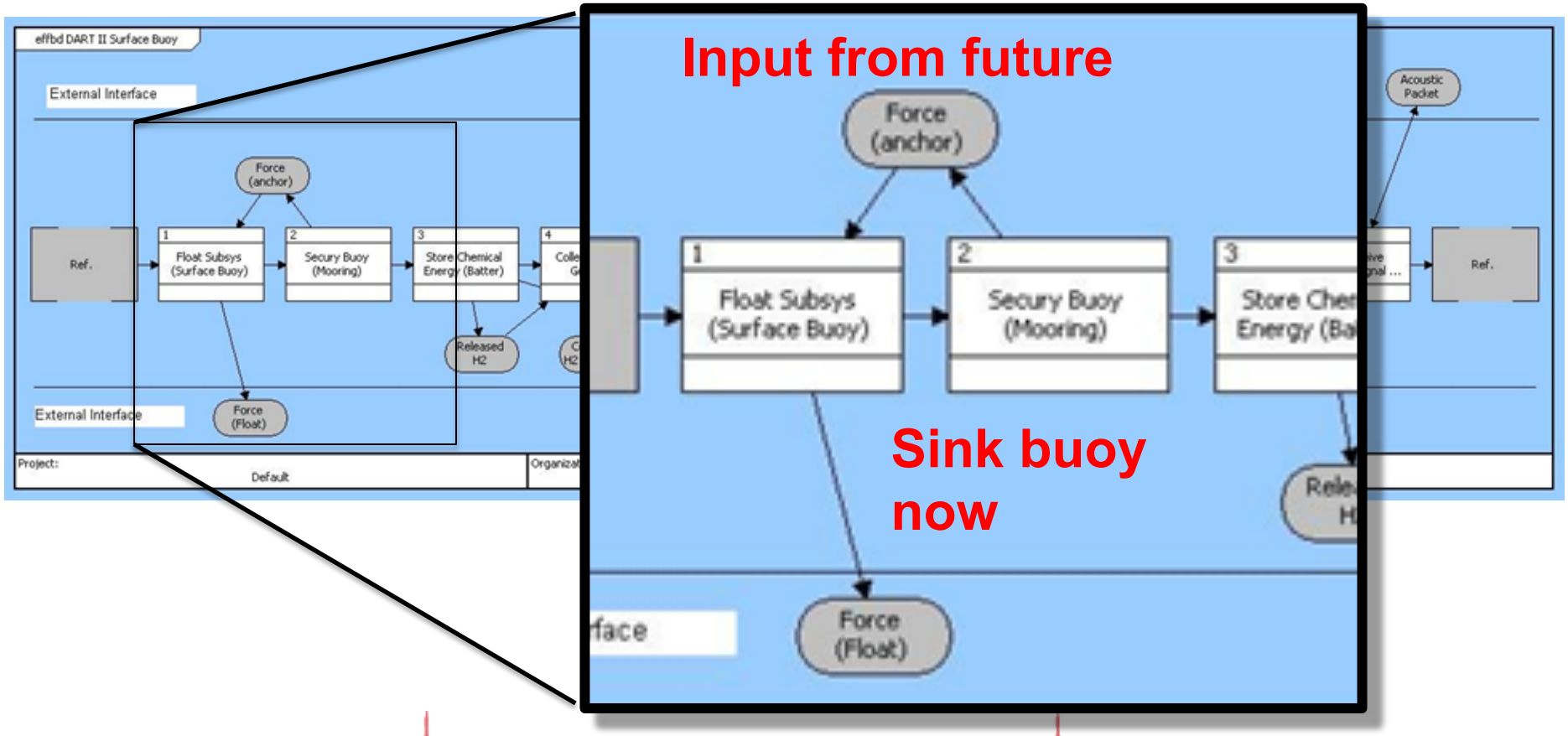
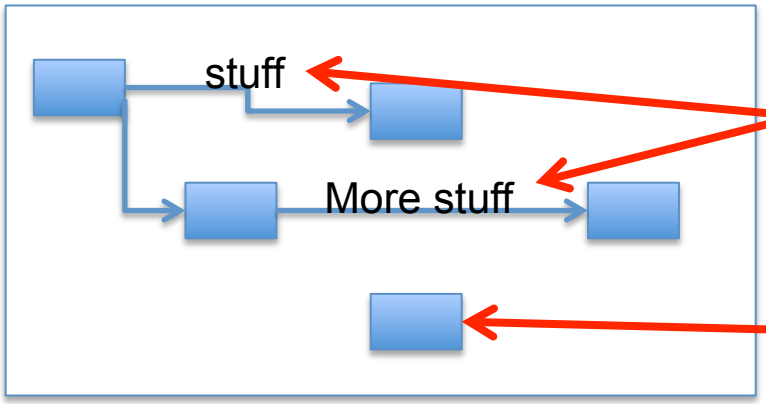


Start Outside Computer

- First drafts on paper or board

- But maintain discipline



Mixing control and I/O

Disconnected function

Three Types of Functions

From Business Process Reengineering

- Management
  - System control functions
  - Often missed
- Support
  - Keep it alive
  - Can overrun a diagram
- What you do to make money
  - Operational functions

Basic Analysis Steps

1. Identify overall activity to be analyzed
   - Verb and noun (object)
2. Define interfaces, input, and output
3. Identify component action (subactivities)
   - A decision is a function!
   - Obey conservation of I/O
4. Determine sequence of these actions
5. Determine internal interfaces
6. Allocate actions to physical parts of system
7. Analyze for issues with
   - Timing
   - Resources
   - Deadlocks/livelocks

(Note: Allocate and analyze can iterate with each other and with Synthesis)

Better Example of EFFBD

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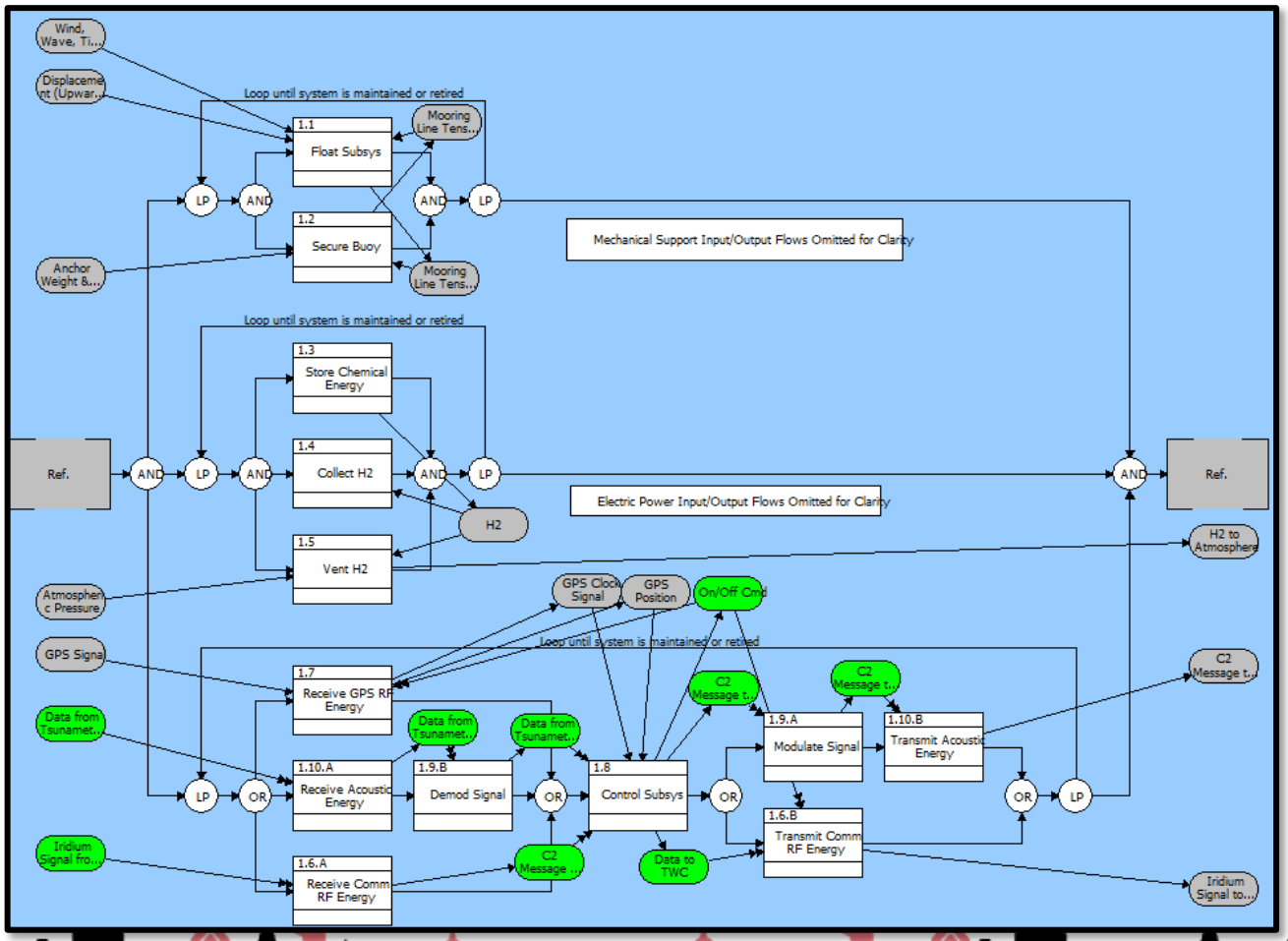
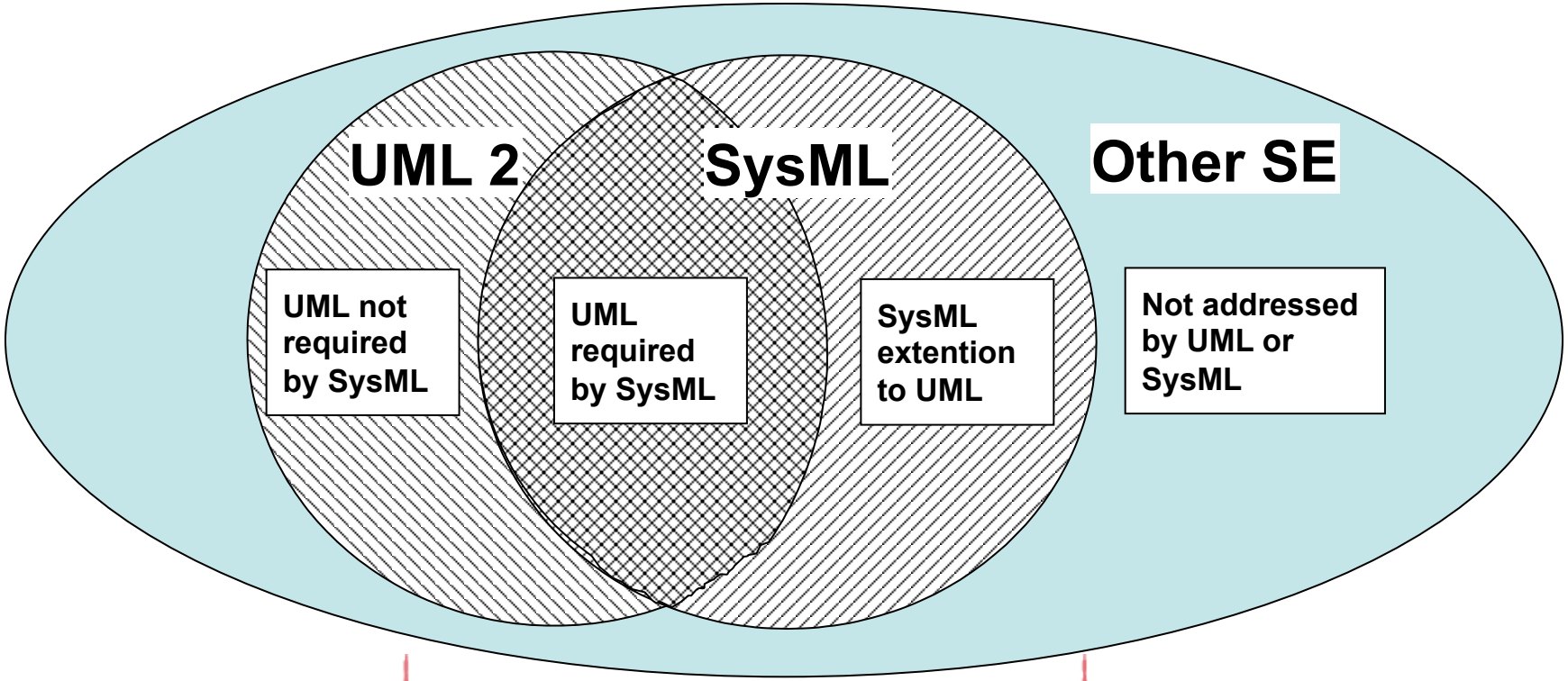


SysML Caution

- SysML not intended to address all of SE



Summary

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Keep functions and components separate

Beware of the solution bias and lack of divergent thinking

Define start/end states and inputs/outputs

Distinguish between control and data/material flow

Note the three types of functions – management, operations, and support

Decisions are functions – beware of diamond decision icons

Be aware of functional interfaces

Analyse functional failures

Don’t analyse abnormal until normal has been defined

Tailor methods to address issues of concern

SysML does not cover all of Systems Engineering

Tools can help but can also be misused

It only looks easy

Questions?

Survey

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System Summary Use Case

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