

Human Systems Integration and Systems Engineering: Challenges in Communication and Execution

**INCOSE Chesapeake Chapter
20 October 2010**

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Introduction

Objective:

- How to communicate and think about HSI
- What gets in the way of executing HSI

Outline:

- **HSI Grammar**
 - Definitions
 - Parts of Speech
- **HSI Execution:**
 - Interdisciplinary implementation
 - Translation of top-level policy
 - Dealing with the flexibility of the user

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- 1. SE Theory ---
- 1a. Systems Thinking
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- 2a. Requirements Development and Management
- 2b. Architectural Design
- 2c. System Integration
- 2d. Verification/Validation
- 2e. Transition/Operation/Maintenance
- 2f. Project Planning/Assessment/Control
- 2g. Decision Analysis/Management
- 2h. Cause Analysis
- 2i. Risk/Opportunity Management
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3d. Environmental Compatibility

3e. Human Factors/Human System Interface

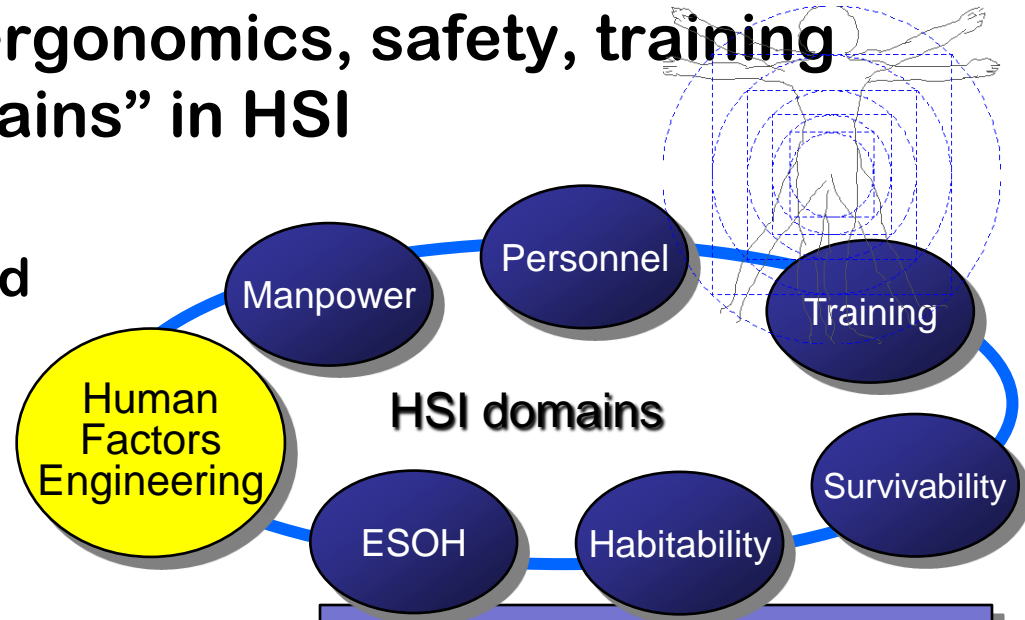
3f. Resource Management

Human Systems Integration (HSI)

- HSI = “a Systems Engineering level consideration of the human users and their interactions with a system”
- Think of “usability,” ergonomics, safety, training
- Seven areas or “domains” in HSI

- Good HSI analysis & design:

- Reduces training needs and costs
- Reduces manpower and personnel requirements
- Mitigates safety issues
- Improves user acceptance of the system/tool
- Enhances task and mission completion through user-centered design



“... to optimize total system performance, minimize total ownership costs, and ensure that the system is built to accommodate the characteristics of the user population.”
DoDI 5000.02

What Part of Speech is “HSI”?

- **The focus areas of HSI domains are spread across the acquisition process**
 - Practitioners bring their own assumptions about how you use, do, or produce “HSI”
 - Differences in perception may not be noticed
- **A basic element of a definition is the word’s grammatical “part of speech”**
 - Many acronyms may be any part of speech!
 - We mimic grammar rules before we learn them
 - More than one part of speech can be applicable to a particular word

If we don’t know how to use it in a sentence, how are we supposed to be able to communicate?

HSI Domain Definitions

Verbs - Activities or Processes

Human Factors
Engineering

Occupational
Health

System Safety

Nouns – Products or Types of People

Manpower

Personnel

Training

Adjectives - Qualities

Habitability

Survivability

HSI “Defined” - DoD

DoD Directive 5000.1

- E1.29. Total Systems Approach. The PM shall apply human systems integration **to optimize** total system performance (hardware, software, and human), operational effectiveness, and suitability, survivability, safety, and affordability.

DoD Instruction 5000.02, Dec 2008 – Enclosure 8

- 1. General. The PM shall have a plan for HSI in place early in the acquisition process **to optimize** total system performance, **minimize** total ownership costs, and **ensure** that the system is built to accommodate the characteristics of the user population that will operate, maintain, and support the system.

HSI “Defined” - DoD

DoD Directive 5000.1

- E1.29. Total Systems Approach. The PM shall apply human systems integration (*n, v, adj, adv?*) to **optimize** total system performance (hardware, software, and human), operational effectiveness, and suitability, survivability, safety, and affordability.

DoD Instruction 5000.02, Dec 2008 – Enclosure 8

- 1. General. The PM shall have a plan for HSI (*v?*) in place early in the acquisition process to **optimize** total system performance, **minimize** total ownership costs, and **ensure** that the system is built to accommodate the characteristics of the user population that will operate, maintain, and support the system.

Lists goals, but provides no definition
HSI as an activity (*noun*) and action (*verb*) implied

HSI “Defined” - DoD

Defense Acquisition Guidebook

Human Systems Integration (HSI) initiatives optimize total system performance and minimize total ownership cost.

Chapter 6, Human Systems Integration

- Human Systems Integration (HSI) (*adj*) practitioners assist program managers by focusing attention on the human part of the system and by integrating and inserting manpower, personnel, training, human factors engineering, environment, safety, occupational health, habitability, and survivability considerations into the Defense acquisition process.

Describes job of “HSI Practitioners”
“Practicing HSI” implies body of knowledge
(*noun*) and specific activities (*verb*)

HSI “Defined” – HSI and SE Communities

Handbook of Human Systems Integration

- Human systems integration (*n*) is primarily a technical and managerial **concept**, with specific emphasis on methods and technologies that can be utilized to apply the HSI concept to systems integration.

INCOSE Systems Engineering Handbook

- Human Systems Integration (HSI) (*n*): interdisciplinary **technical and management processes** for integrating human considerations within and across all system elements; an essential enabler to systems engineering practice.

“Concept” and “Process” (*noun*) ...
describing or scoping a set of actions

HSI Parts of Speech

► Noun

- Used to name a person, place, thing, quality, or action
- Something you can buy or a specific item you evaluate
- HSI is a “component” that you plug in, paid for just as you would pay for a system component
- HSI is a set of deliverables; HSI is “the user interface”

HSI Parts of Speech

Noun

▶ **Verb**

- Expresses existence, action, or occurrence; something you do
- HSI is a set of activities – perhaps a unique set of activities requiring “HSI people”
- Implies a specific goal for the activities – how else do you know when you have done enough?

HSI Parts of Speech

Noun

Verb

▶ **Adjective**

- Describes or modifies a noun; describes the characteristics of an end state
- HSI is a modifier you add to each component or a particular type of requirement
- All HSI belongs to the HSI organization
- Implies you can take any activity or item and “turn it into” or “add” HSI

HSI Parts of Speech

Noun

Verb

Adjective

▶ **Adverb**

- **Describes or modifies a verb, adjective, or other adverb; tells how you do something**
- **HSI is a “modifier” for systems engineering**
- **HSI is a particular way in which you develop a system**

HSI Parts of Speech

Noun

Verb

Adjective

Adverb

▶ Preposition

- Expresses a relationship between a noun and a verb, and adjective, or another noun
- HSI is “part of systems engineering” or “part of logistics”
- HSI is the means by which the domains are brought into a program or product

HSI Parts of Speech

Noun

Verb

Adjective

Adverb

Preposition

▶ Pronoun

- **Substitutes for a noun and denotes persons or things previously specified**
- **HSI can be applied the same way on every project**
- **HSI plans and organizations can be developed by “copy and paste”**

HSI Parts of Speech

Noun

Verb

Adjective

Adverb

Preposition

Pronoun

▶ **Conjunction**

- **Connects other words, phrases, clauses, or concepts**
- **Implies connection of activities or components without a change to any of them**
- **Whole is not greater than the sum of its parts**
- **HSI is the collocation (and not integration) of domains in a single organization**

HSI Parts of Speech

Noun

Verb

Adjective

Adverb

Preposition

Pronoun

Conjunction

▶ Interjection

- An exclamation, capable of standing alone; used to express emotion; usually has no grammatical connection with the rest of the sentence
- HSI requires no analysis, evaluation, or planning
- HSI requires no connection with the rest of a program
- HSI can be accomplished at the last minute
- Includes lots of four-letter-words...

What's the Right Part of Speech?

Verb: an action

- HSI (*v*) is a coherent *activity* with specific goals or end state

Adverb: modifies a verb

- HSI (*adv*) is *how* you should do systems engineering or domain activities

Preposition: expresses a relationship

- HSI (*prep*) defines the *relationship* between systems engineering and the domains of HSI

Different situations may call
for different uses

Key Challenges of HSI

- **You have to integrate diverse disciplines**
 - Individual backgrounds
 - Domain schedules and processes
- **You have to translate top-level policy for an engineering environment**
 - Cost
 - Performance
- **You have to deal with the flexibility of the user**
 - Highly flexible
 - Completely inflexible

Working Across Disciplines

- **Managing and executing HSI requires a broad skill set**
 - Different expectations – what is “the system”?
 - Different timeframes – early or late
 - Different processes – rigid or adaptable
- **Check the terminology**
- **Likely to require multiple personnel**
- **Coordinate the schedules and documents**
- **Get the organization right**
 - Where it can influence design
 - Personal effort and relationships help with communications – but not decisions

Policy: “Optimize Performance”

- “The PM shall apply human systems integration **to optimize** total system performance (hardware, software, and human)”
- “Optimize” is not an engineering term!
 - Dependent on the resources you assign
 - Not a verifiable requirement
- **Put the operator and maintainer in the context of system and mission performance**
 - Identify impact on system and mission performance
 - Focus on *risks* to performance

Policy: “Minimize TOC”

- “The PM shall have a plan for HSI to ... **minimize** total ownership costs”
- Complicated by disconnected funding sources and extended time frame



Acquisition

NRE + Construction



Manpower

Active Duty, Retirement, etc.



**Readiness
and Training**

HSI and the System Lifecycle

Research feeds
Design...

Requirements
specify
performance ...

Design drives
MPT costs

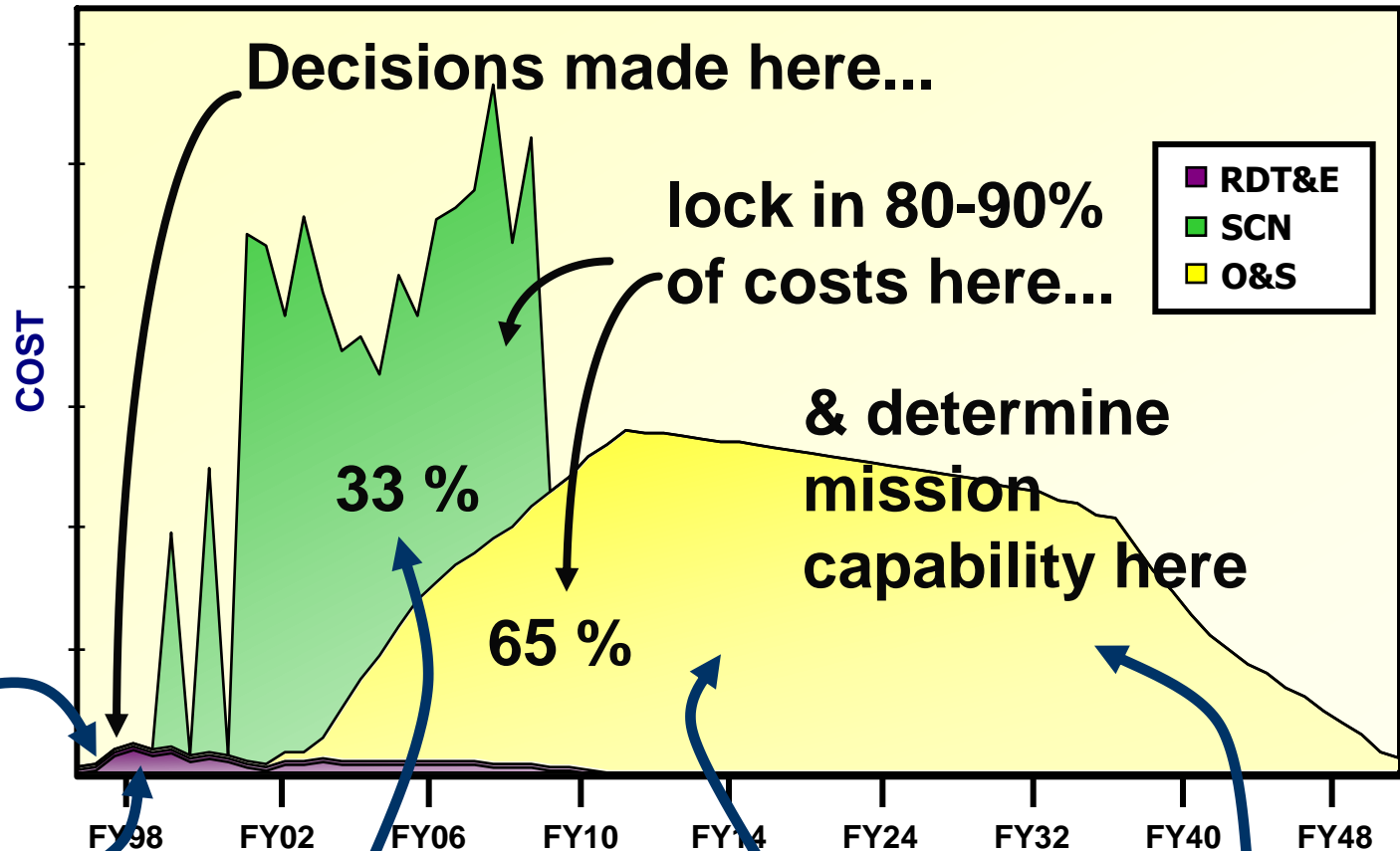
Research
(ONR)

Analysis
(OPNAV N8)

Design
(PEO/PM)

Personnel
(OPNAV N1)

Support
(Fleet)



Costs Managed and Minimized Separately

Policy: “Minimize TOC”

- “The PM shall have a plan for HSI to ... **minimize** total ownership costs”
- Complicated by disconnected funding sources and extended time frame
- **Focus on known and connected costs**
 - Look in the short term for tradeoffs, cost cut-offs
 - Get buy in from those with distant costs (training, manpower) for specific issues
 - Focus on the best allocation of resources within acquisition
 - Augment “XO/CO Fleet Up” with “PM/XO Fleet Up”

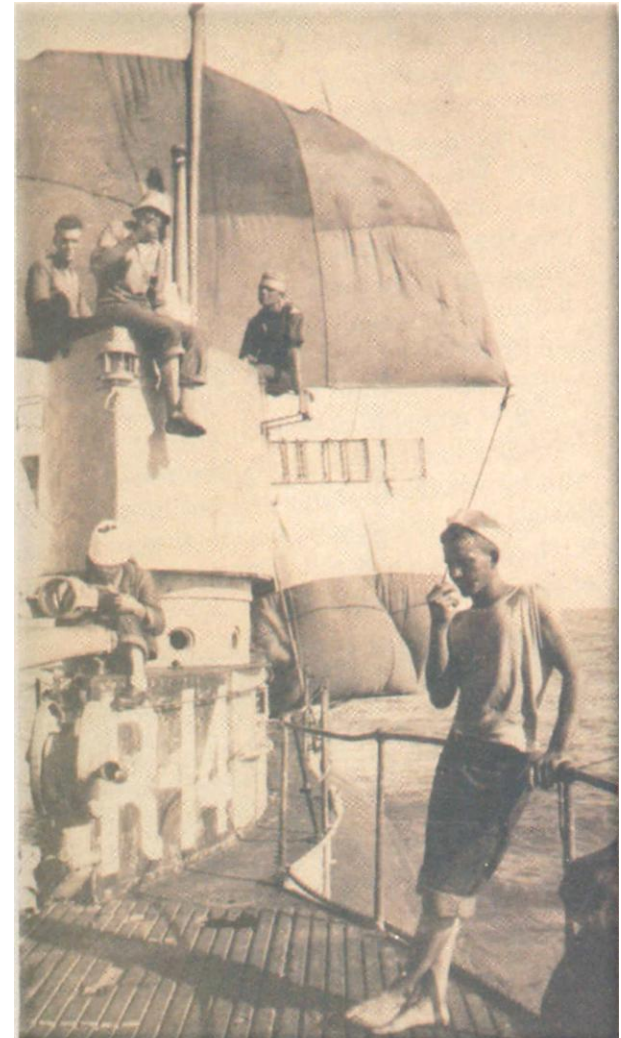
The Flexible User

2011 CNO Guidance:

- “Our Sailors demonstrate daily that our Navy is flexible, adaptable, and ready to respond globally”

2003 DoD Mishap Reduction Initiative:

- “I challenge all of you to reduce the number of mishaps and accident rates by at least 50% in the next two years.”
- “Training” is a “quicker” solution
- Individual and personal variability make it harder to test



R-14 (1921) – No Power, No Radio

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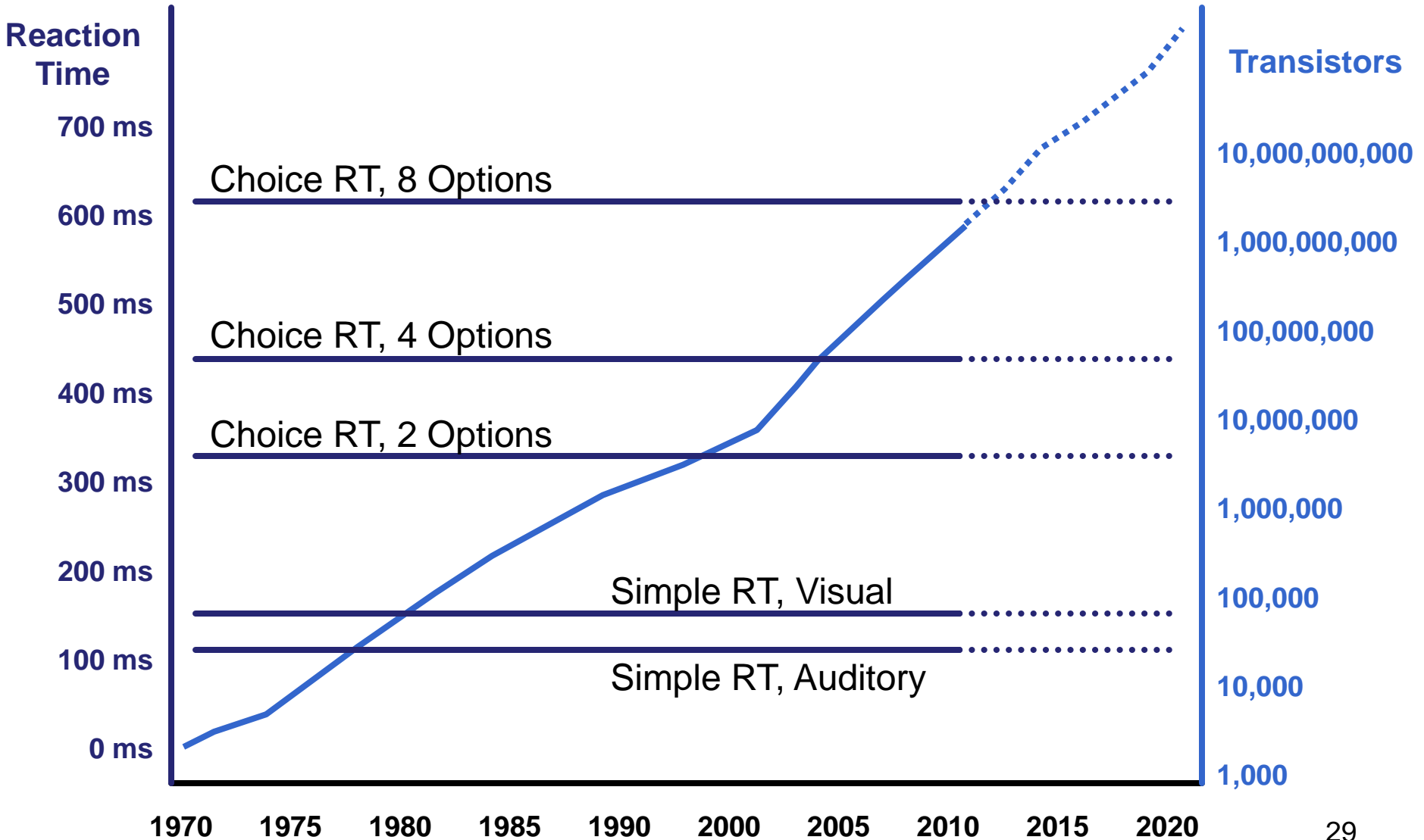
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- Conduct tests and assessments separately
- Ensure scenarios capture variability
- Don’t use flexibility as a the mitigation for a design flaw
 - Procedures
 - Units of measures

The Inflexible User

- **How do you “upgrade” a user?**
 - **Can you wait for a better model?**
 - **Can you get an upgrade through practice?**

The User vs Moore's Law



The Inflexible User

- **How do you “upgrade” a user?**
 - Can you wait for a better model?
 - Can you get an upgrade through practice?
- **Know the constraints of the user population**
- **User flexibility comes with a cost**
 - Performance
 - Training time
 - Variability
- **Expect changes in technology to change the interface**

Summary

- **HSI Grammar: Know how to communicate, how others may perceive HSI**
- **Diverse Disciplines: Require integration, not co-location**
- **Top-Level Policy: No easy translation to engineering**
- **Flexibility of the User: A double-edged sword**