An invited presentation to SIG Design and Technology

Education for Design
Design for Education

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The Fundamental Problem

Population Growth

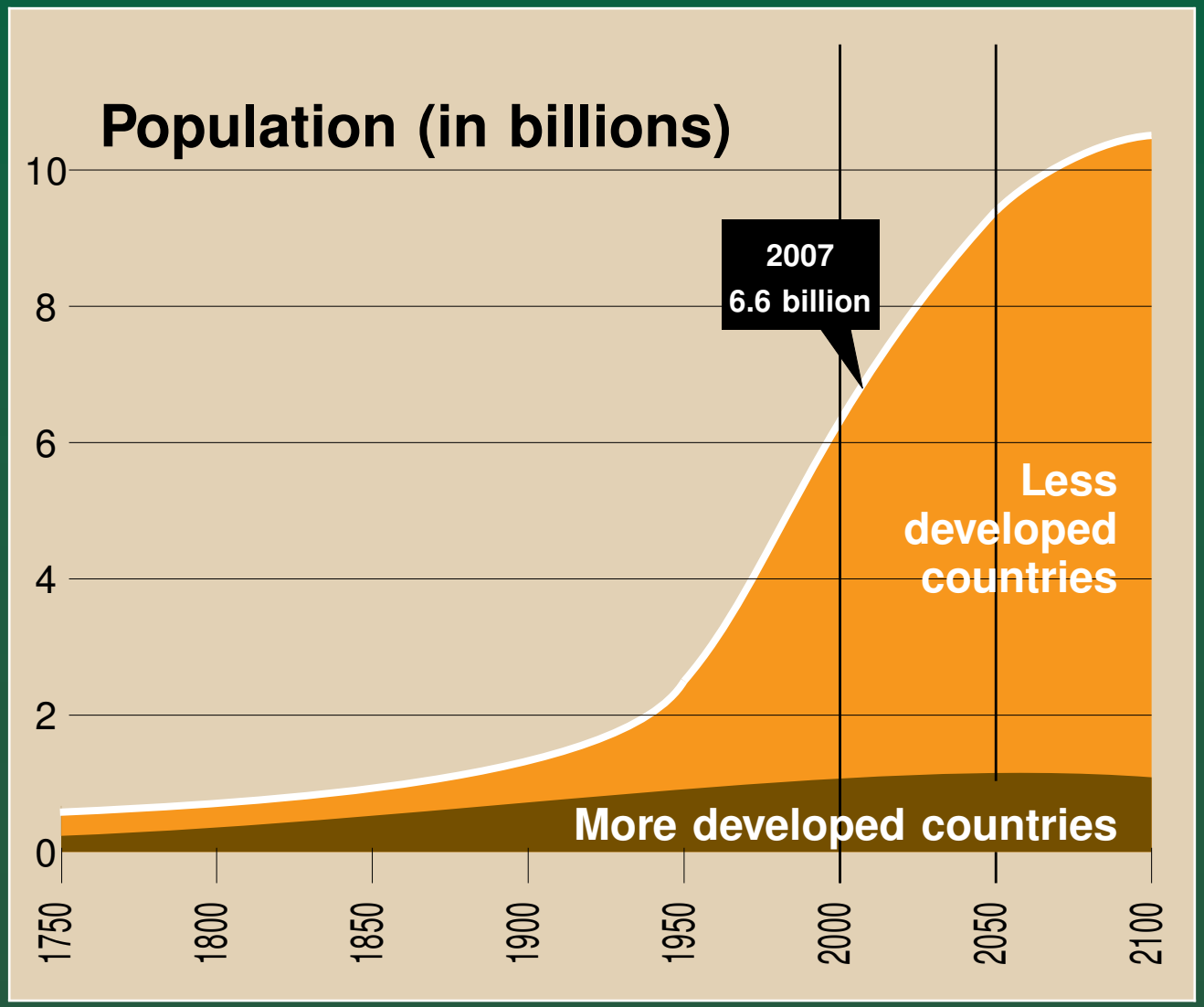
More people = greater need for resources

The big four

- **Energy**
- **Water**
- **Food -** *fisheries*
- **Food -** *agriculture*

Cost of matching western lifestyles:

- **3 Earths!** *(World Wildlife Fund)*



Source: United Nations, World Population Prospects, The 2006 Revision.

Derivative Problem

Global Warming 1989

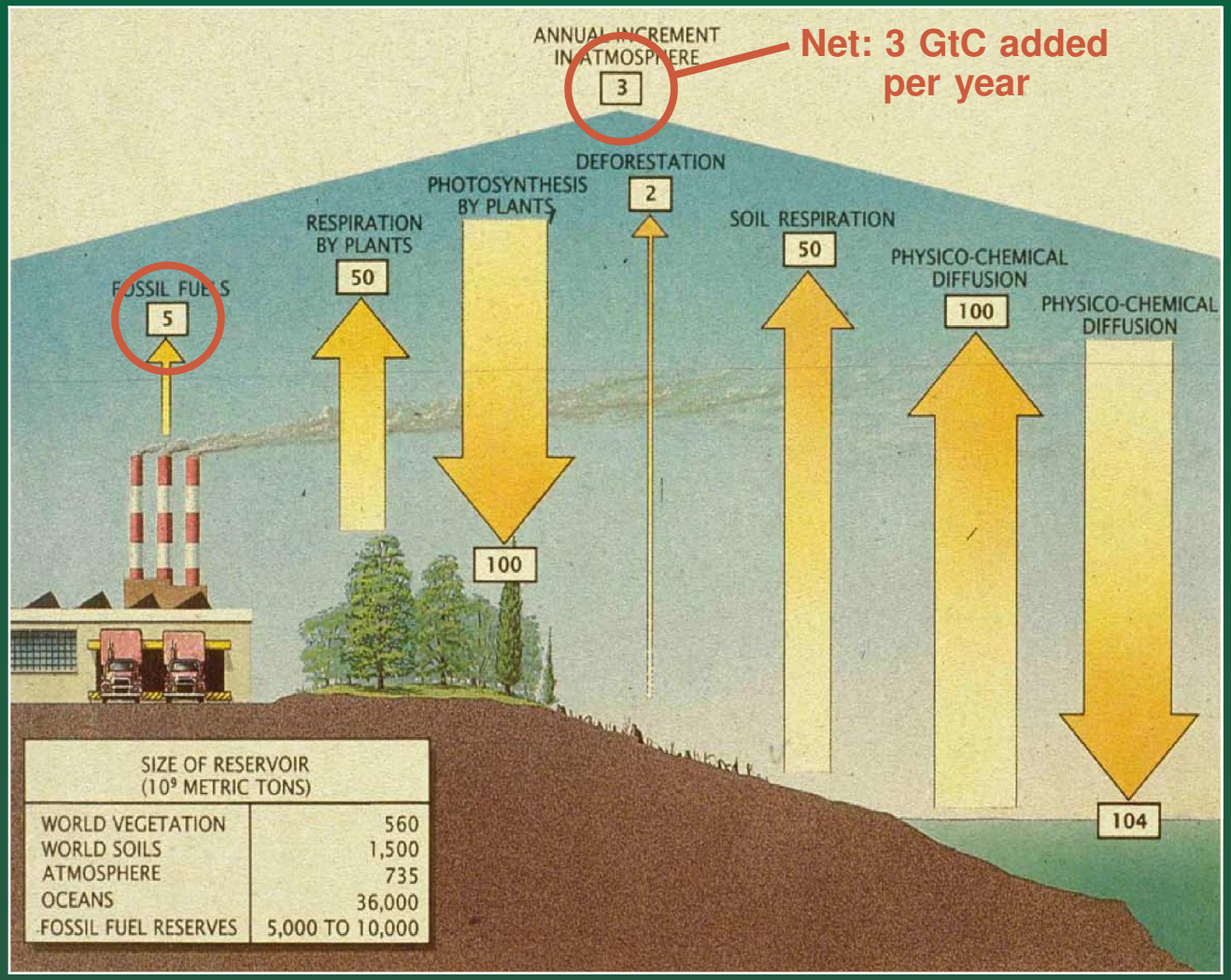
Climate change exacerbates problem

CO_2 concentration increases

- *278 ppm <1900*
- *353 ppm 1989*

Geographic changes predicted:

- *Droughts*
- *Intense precipitation*
- *Violent, frequent storms*
- *Rising seas*
- *Moving climate zones*



Source: Scientific American, April 1989

Derivative Problem, Update

Global Warming 2006

Climate change accelerates

CO_2 concentration increases

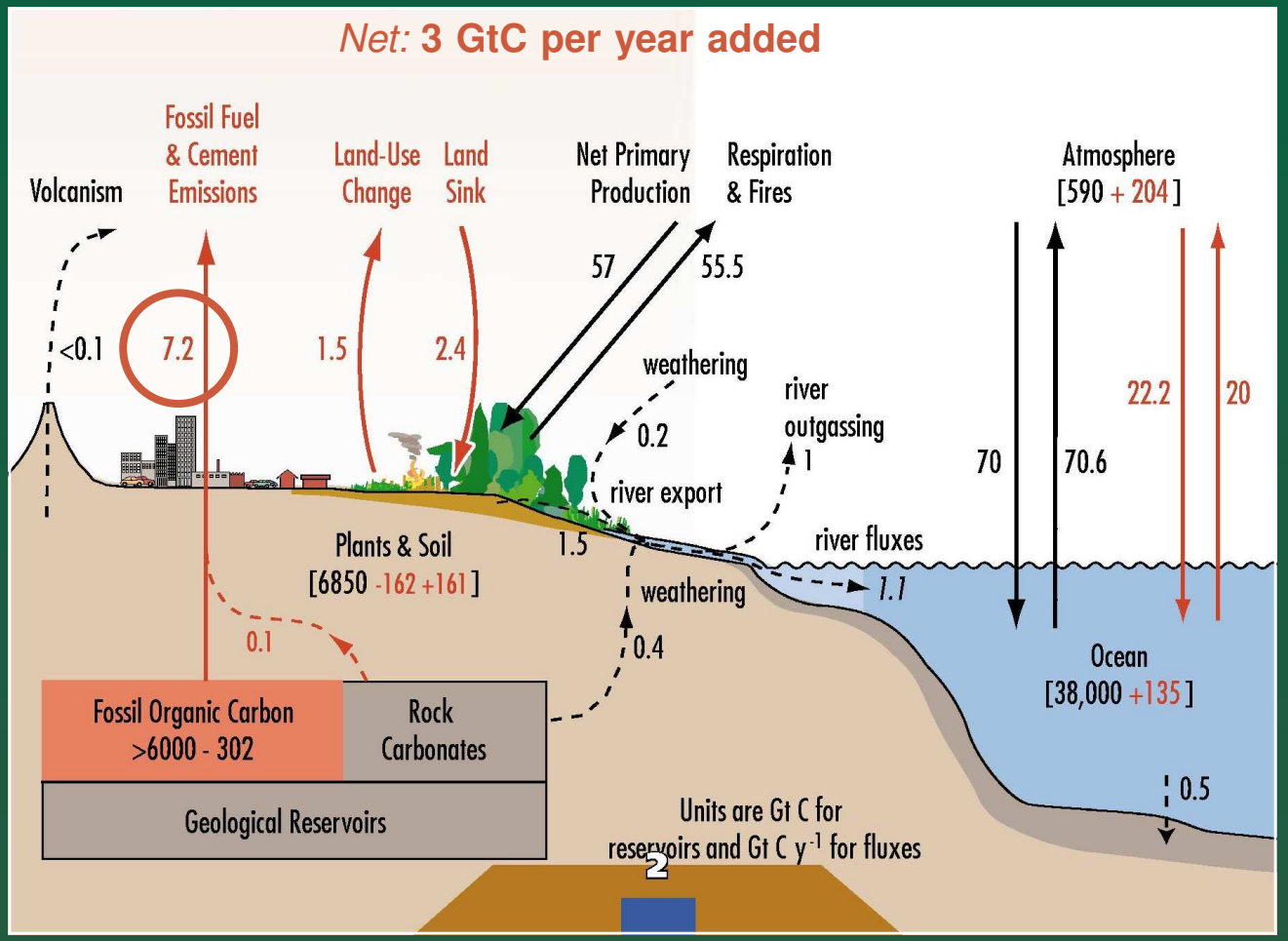
- *278 ppm <1900*
- *353 ppm 1989*
- *383 ppm 2007*

Annual mean growth rate (18 yr)

- *1.87 ppm*
  std dev. = .67

Extrapolation:

- *600 ppm 2100*



Sources: UNESCO - Scope, The Global Carbon Cycle, Policy Briefs No. 2, October 2006.
NOAA Earth Systems Research Laboratory, Trends in Atmospheric Carbon Dioxide, Mauna Loa, 2007.

Possible Solutions?

Advanced technology

Technologies that offer hope

Nanotechnology

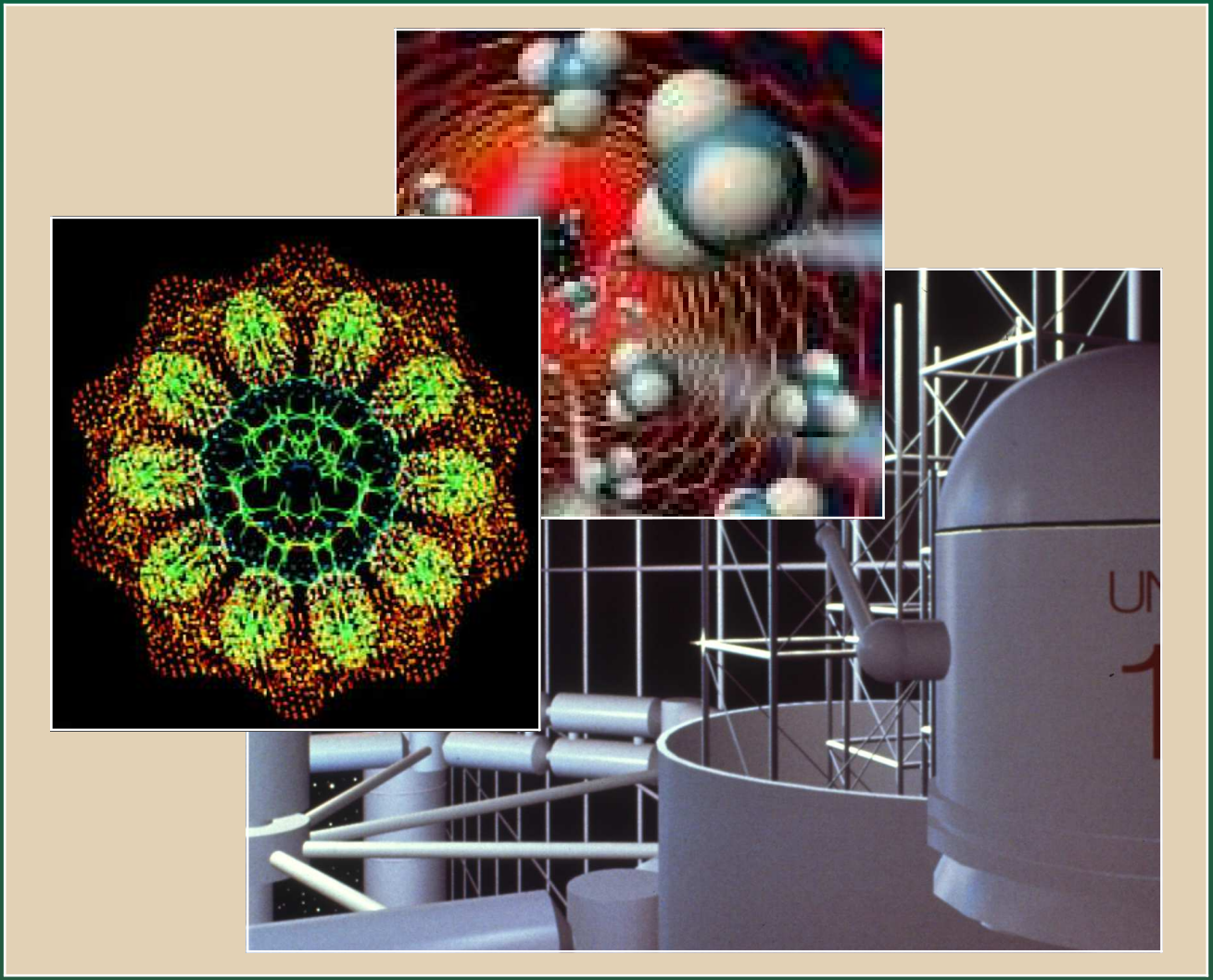
- *Nanotube membranes that can remove salt from water cheaply*

Robotics

- *Robot-constructed solar power satellites*

Biotechnology

- *Crops that can survive in harsh climates*



Sources: *Nanotechnology:* Lawrence Livermore Lab, May 2006.
Robotics: Project Phoenix, 1989. Institute of Design, IIT.
Biotechnology: Tecstra Systems Organization, 2007.

Preparation

How will we address the problems?

Not just a few will be called

Leaders

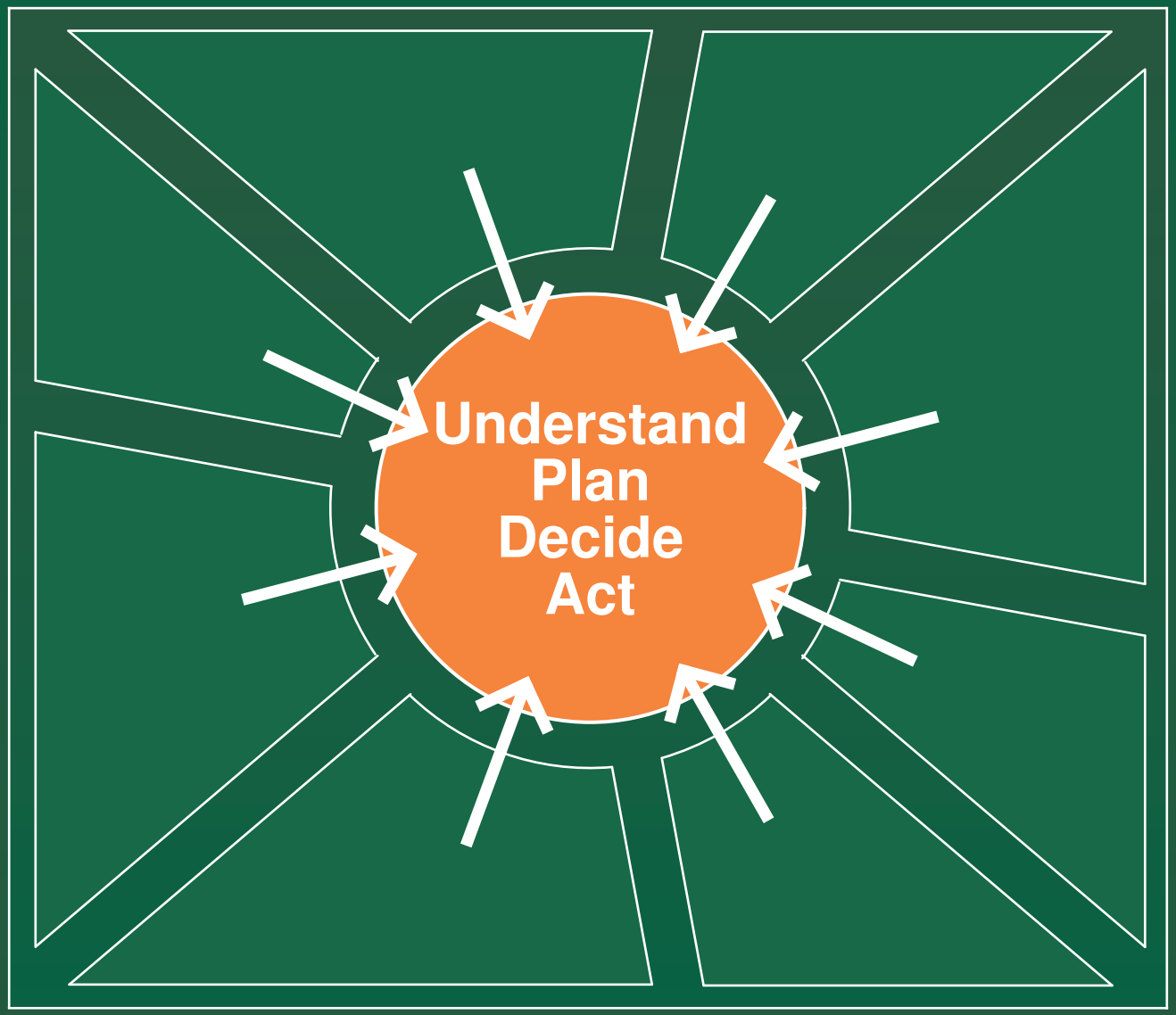
- *Will leaders plan and act wisely?*

Citizens

- *Will society accept and adapt to change?*

Educators

- *Are we providing the tools needed to* **understand** *and* **plan** *well?*



Kinds of Thinking

The Creative Basis

The two-domain thinking model

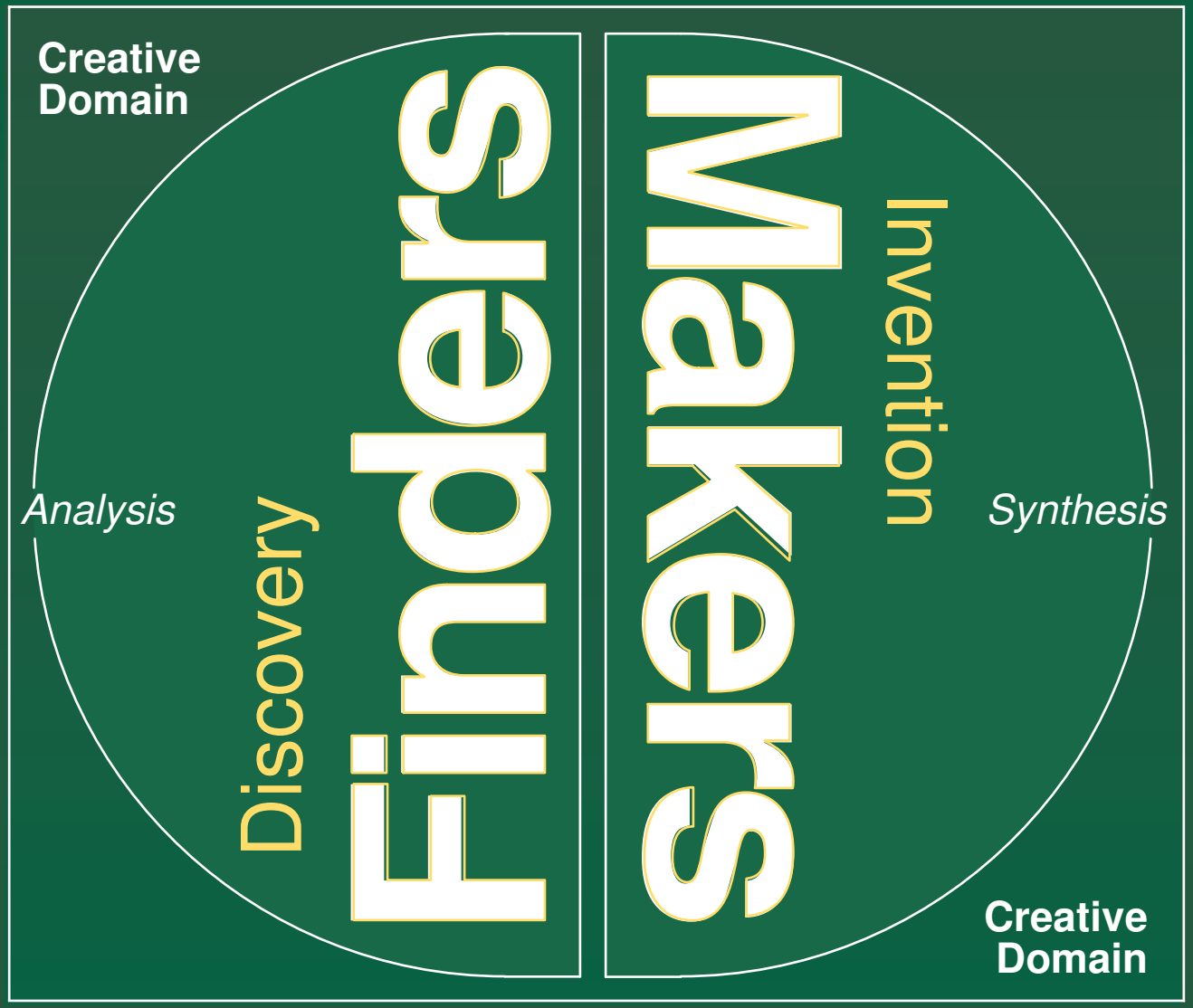
Understanding and planning increase in value with:

Discovery

- *Oriented toward* ***Analysis***

Invention

- *Oriented toward* ***Synthesis***



Qualitative Difference

Map of Fields

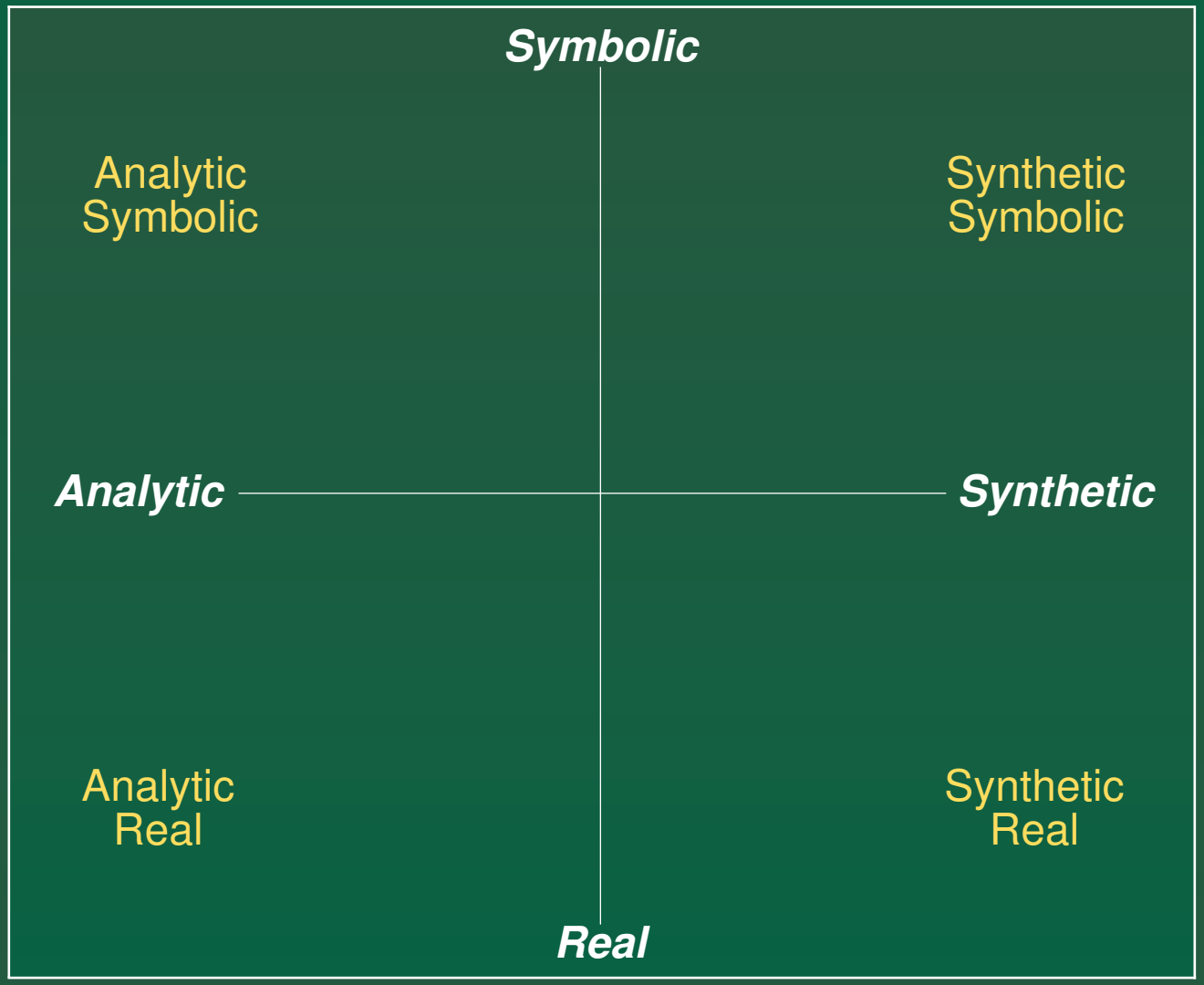
Process & Content **differentiate fields**

Process

- ***Analytic***
  vs
  Synthetic

Content

- ***Symbolic***
  vs
  Real



Qualitative Difference

Map of Fields

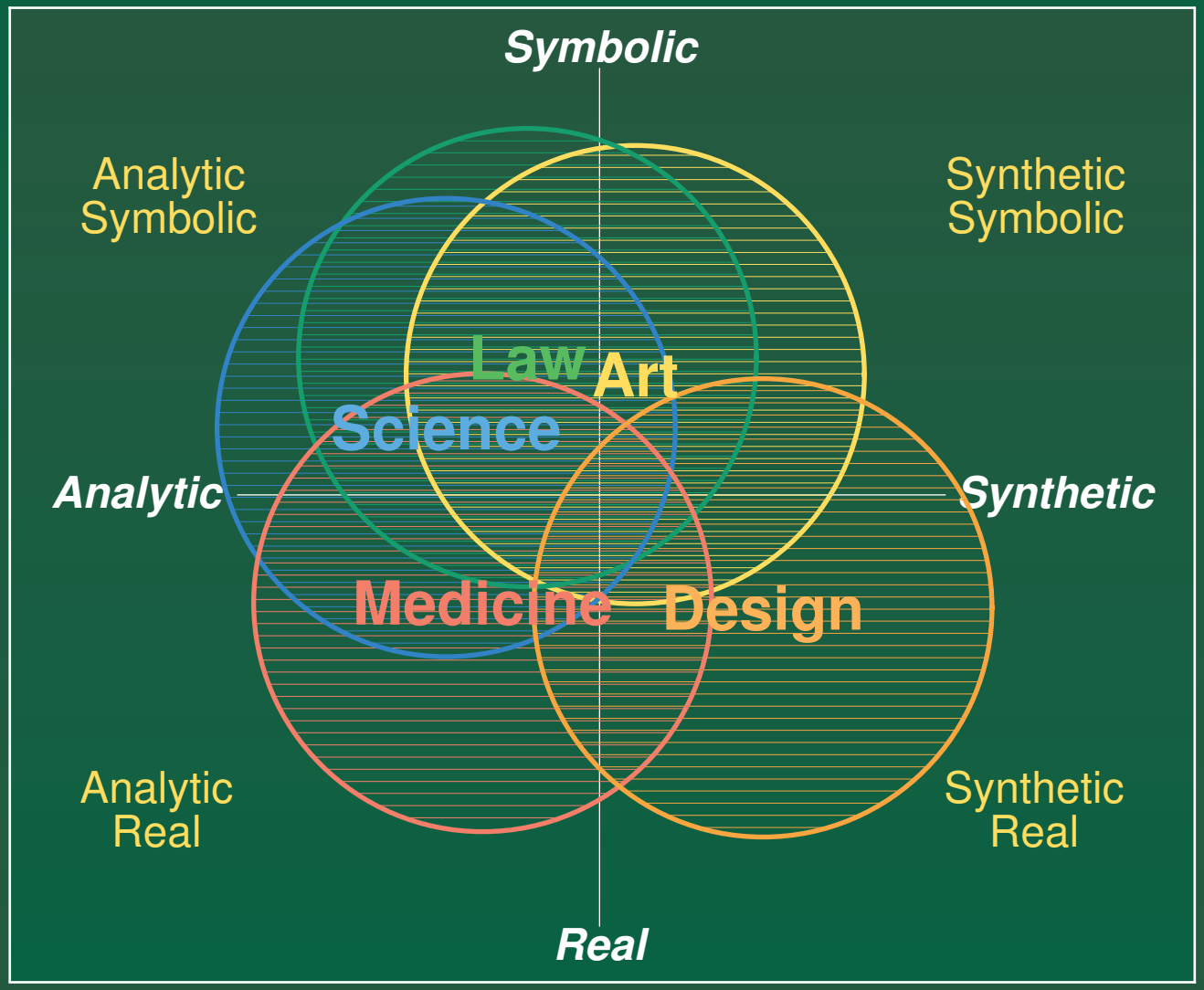
Fields on the map reveal differences by their position

Process

- ***Analytic***
  vs
  Synthetic

Content

- ***Symbolic***
  vs
  Real



Qualitative Difference

Map of Fields

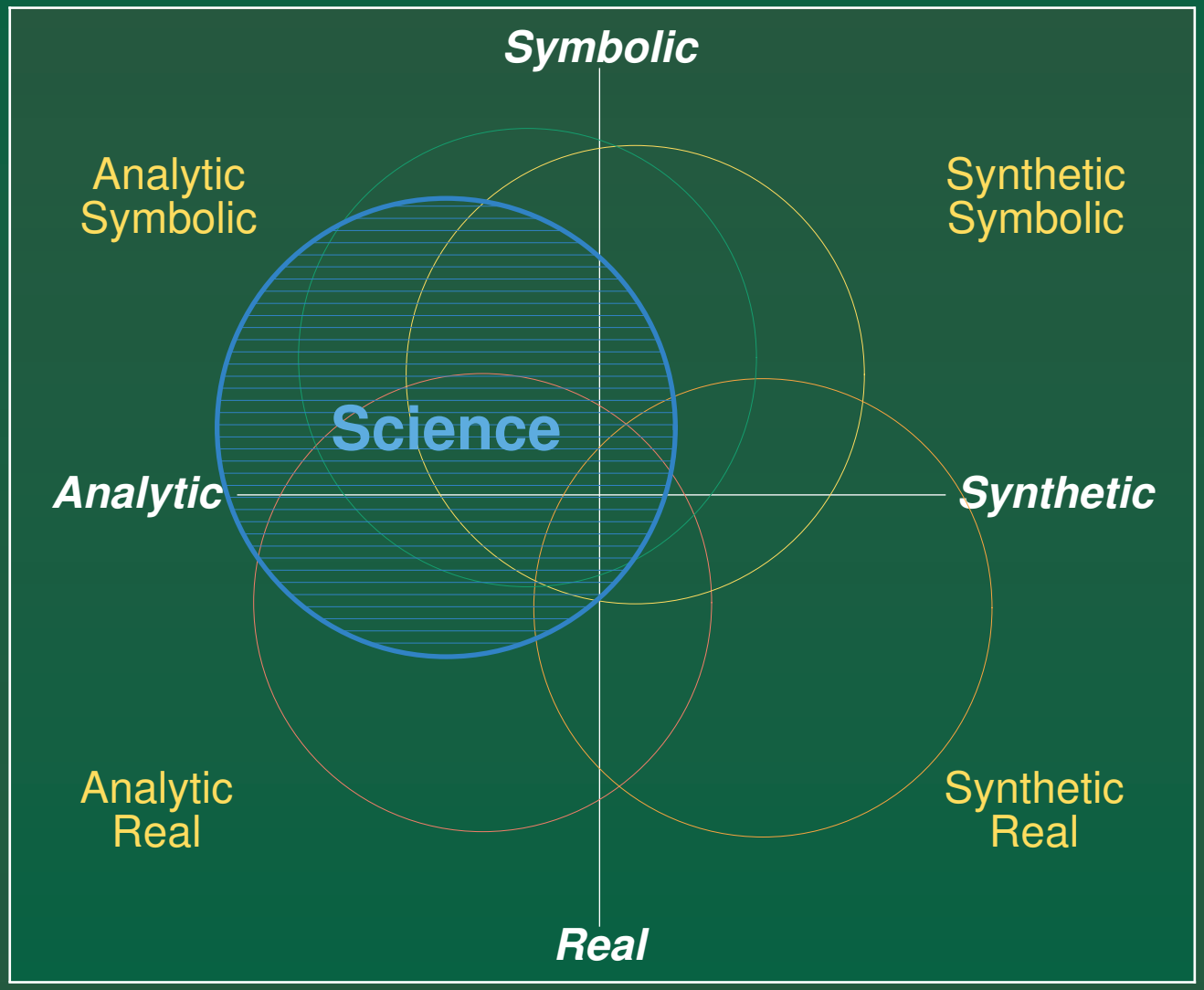
Science on the Map

Process

- *heavily* ***Analytic***

Content

- *more* ***Symbolic*** *than* ***Real***



Qualitative Difference

Map of Fields

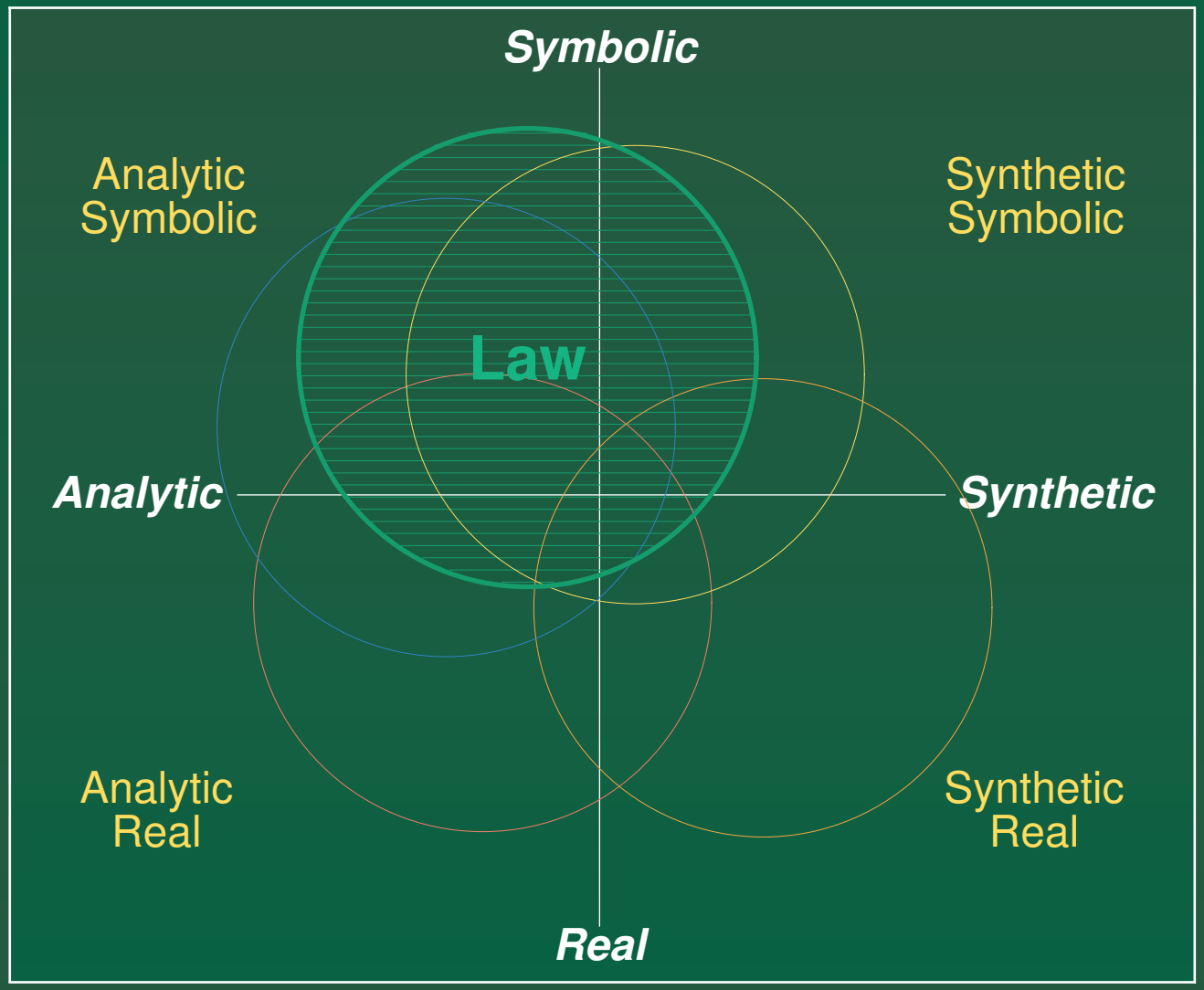
Law
on the Map

Process

- ***Analytic***, *but less so than Science*

Content

- *Extensively* ***Symbolic***



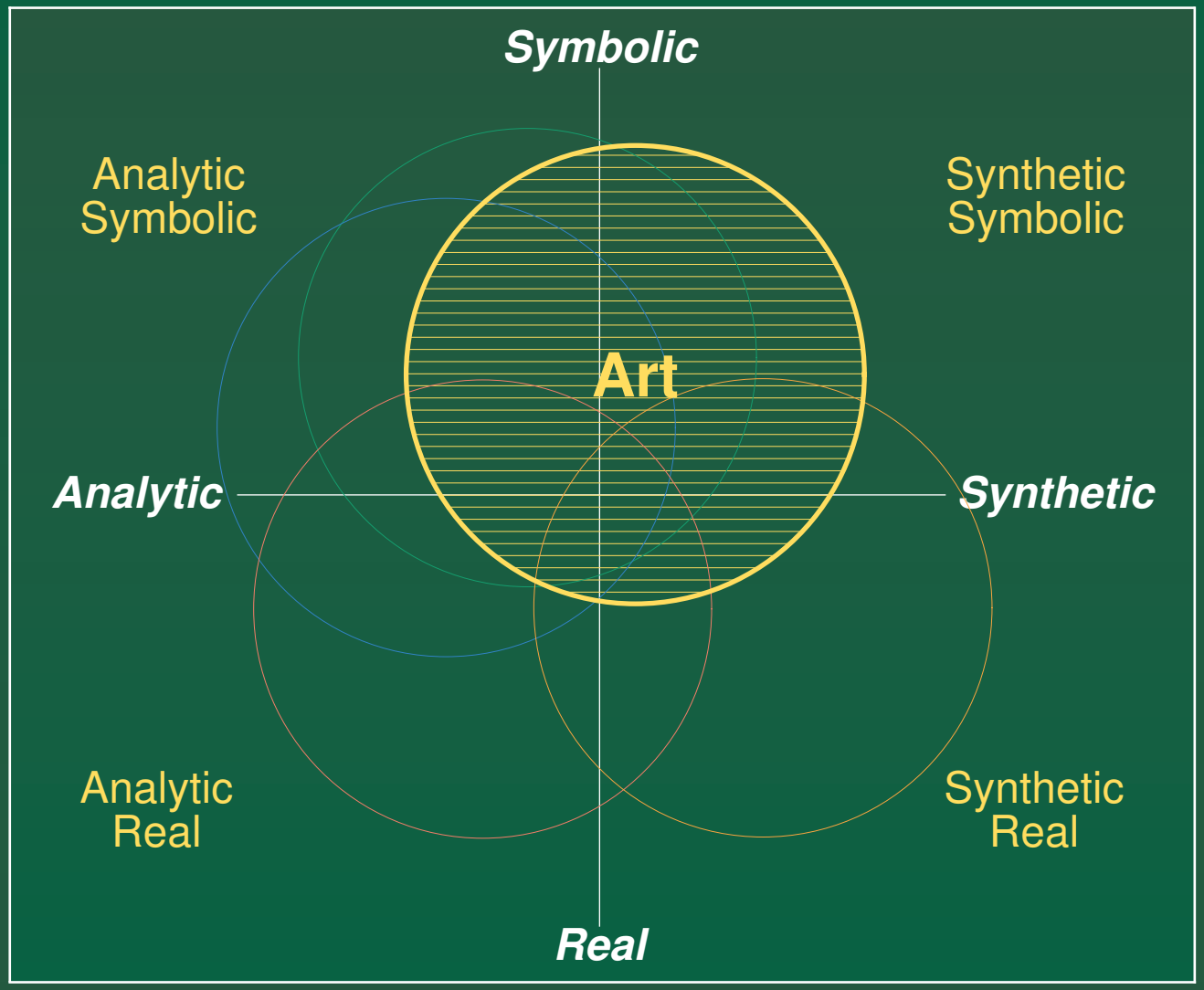
Qualitative Difference

Map of Fields

Art
on the Map

Process
- *Almost evenly divided*

Content
- *Strongly* ***Symbolic***



Qualitative Difference

Map of Fields

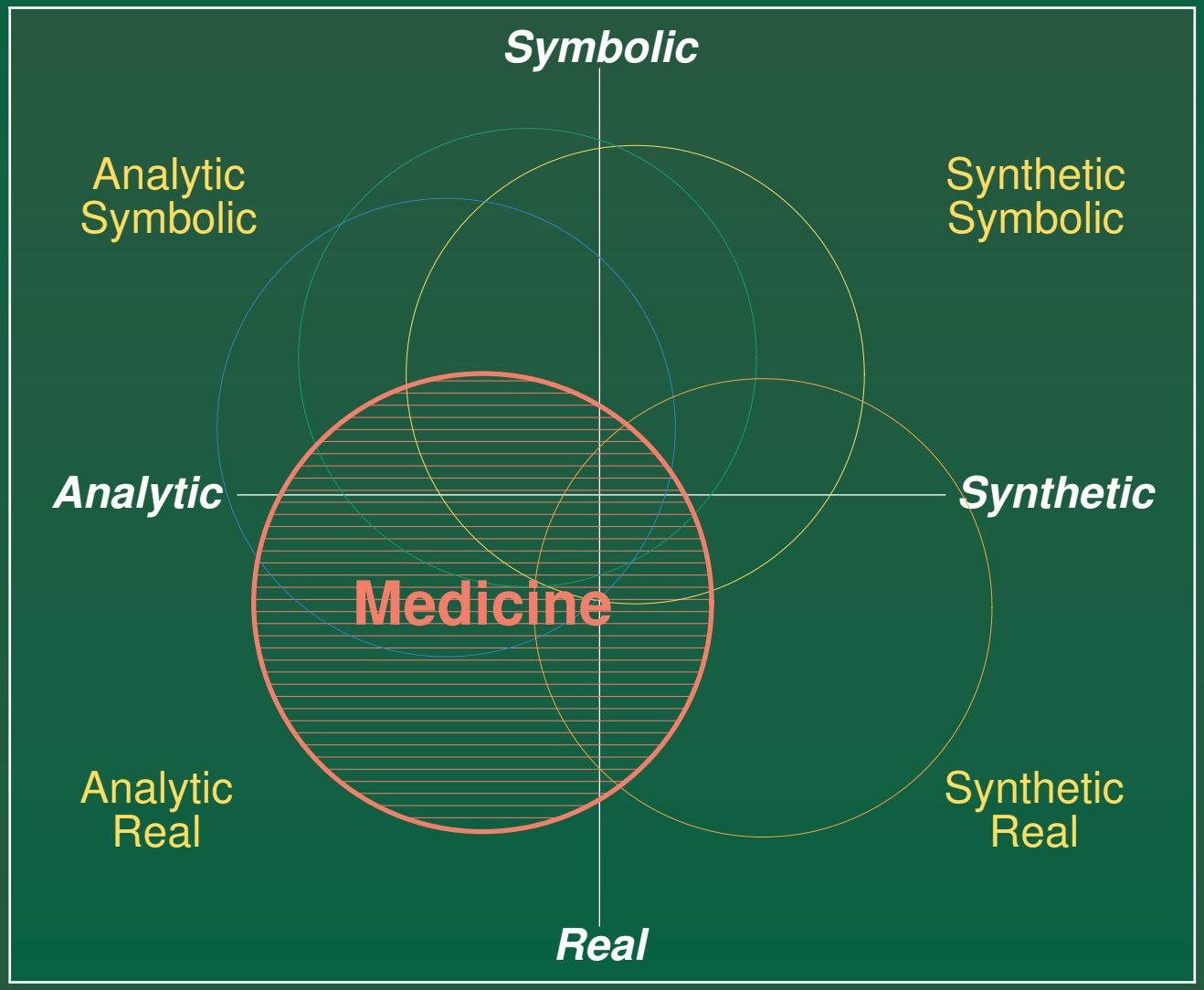
Medicine on the Map

Process

- *Strongly **Analytic***

Content

- *Sharply **Real** concerned with real problems of health*



Qualitative Difference

Map of Fields

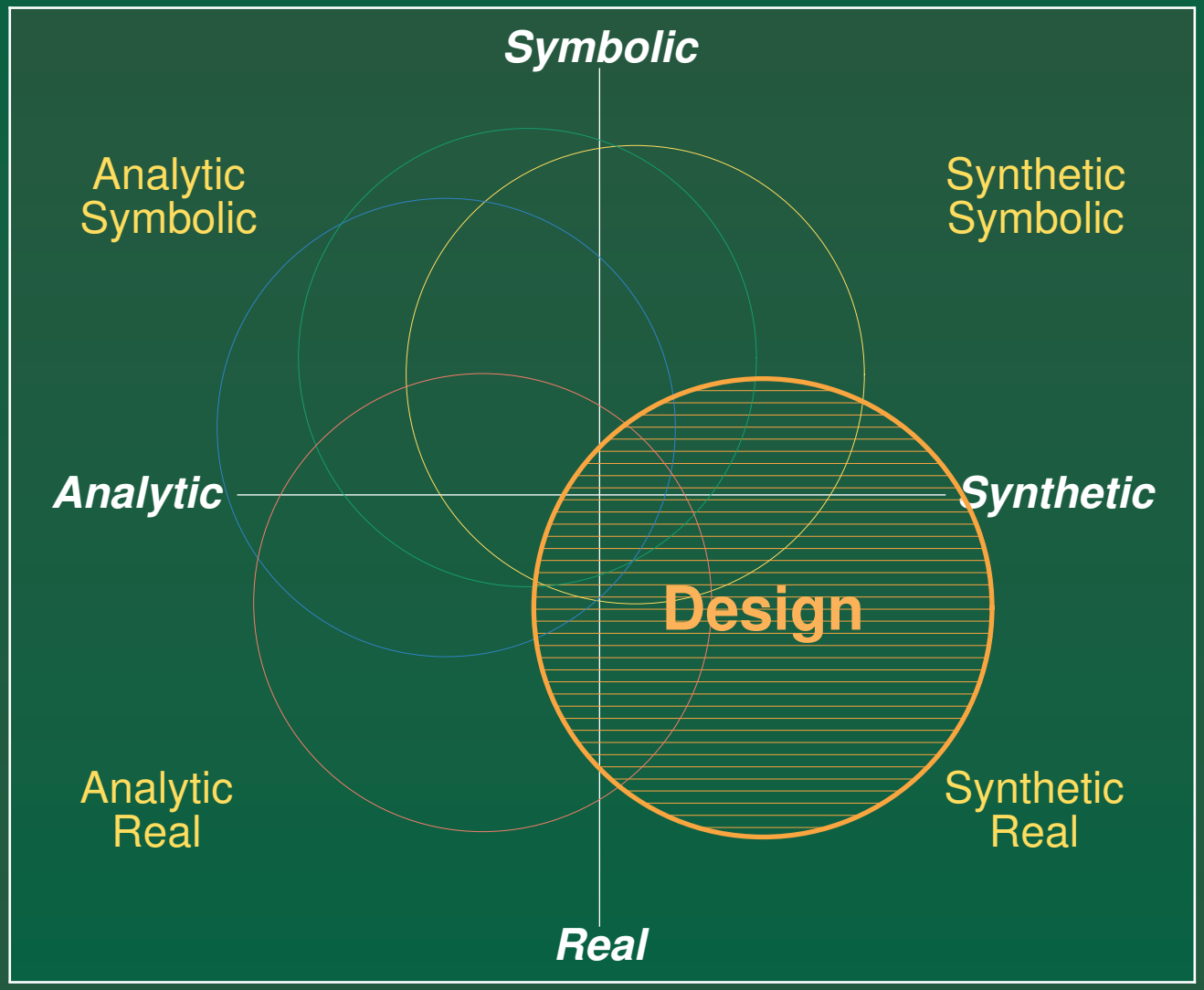
Design on the Map

Process

- *Highly* ***Synthetic***

Content

- *Strongly concerned with the* ***Real*** *world*



Qualitative Difference

Map of Fields

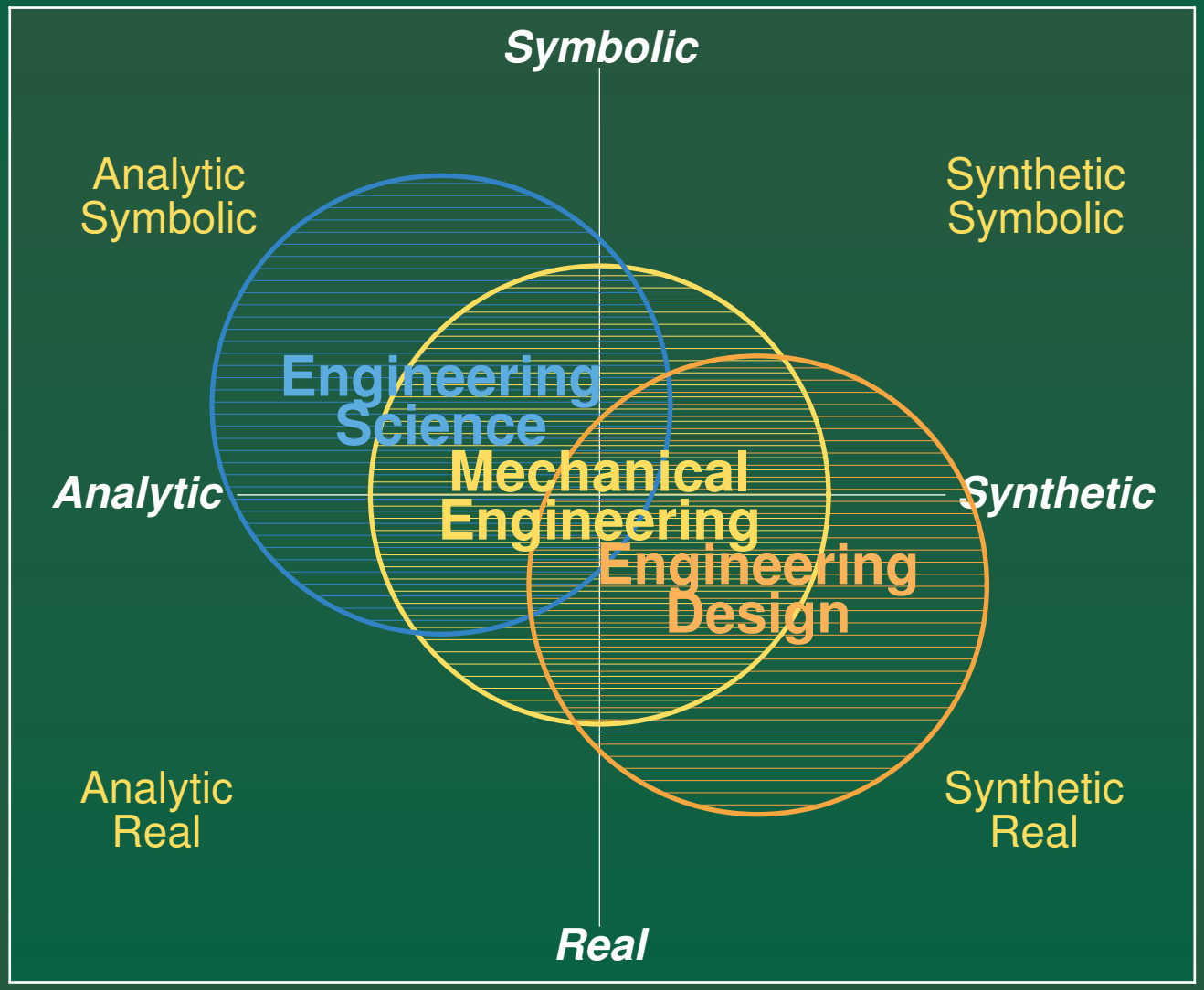
Hierarchies within Fields

Decomposition

- *Separates disciplines by sharpening specialization*

Composition

- *Merges disciplines by leveling generalization*



Qualitative Difference

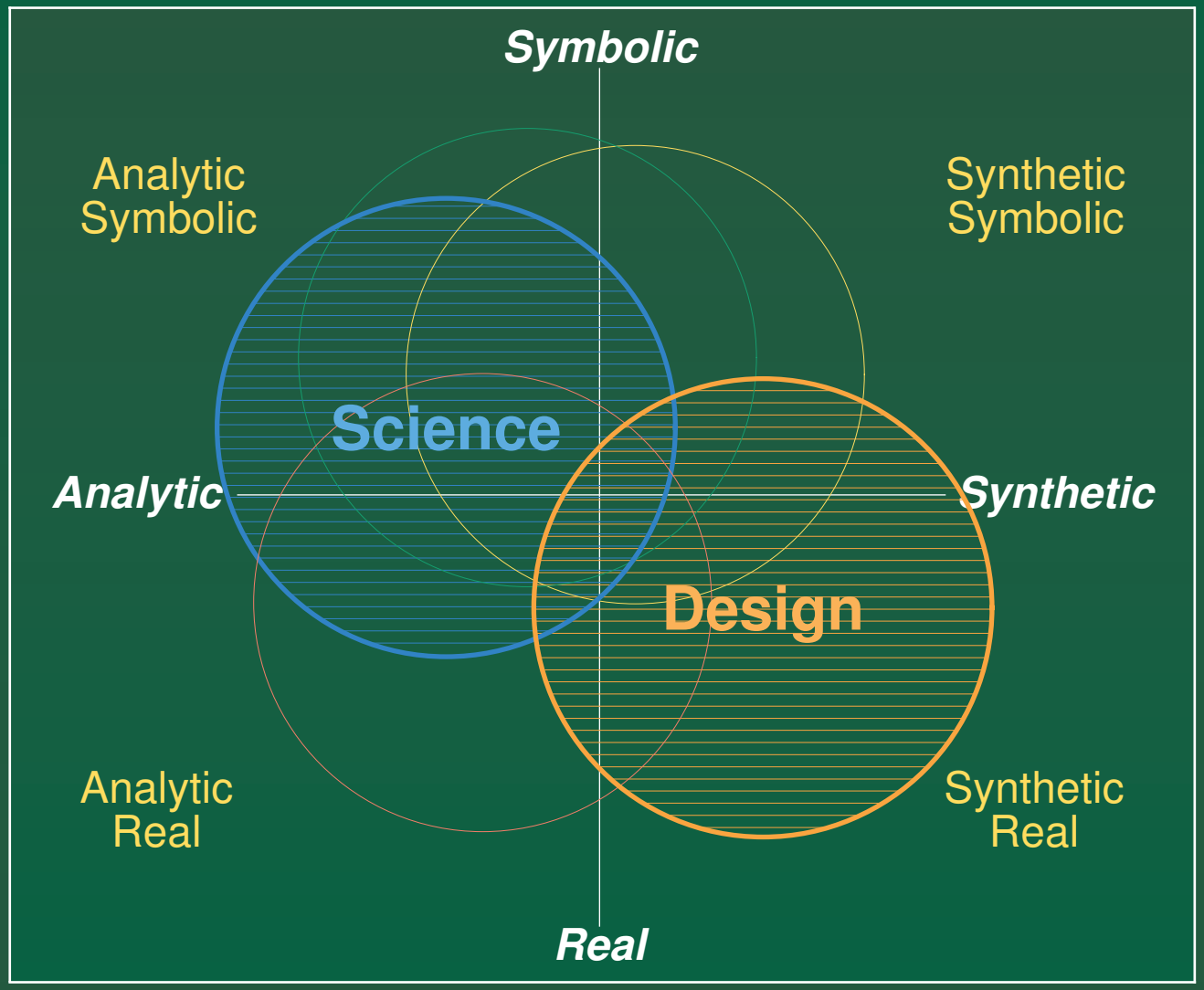
Complementary Fields

Science/Design: high-value complements

Science
- ***Analytic/Symbolic***

Design
- ***Synthetic/Real***

- *Together: critical* **Finding** *and* **Making** *resources*



Foundations

Knowledge Building and Using

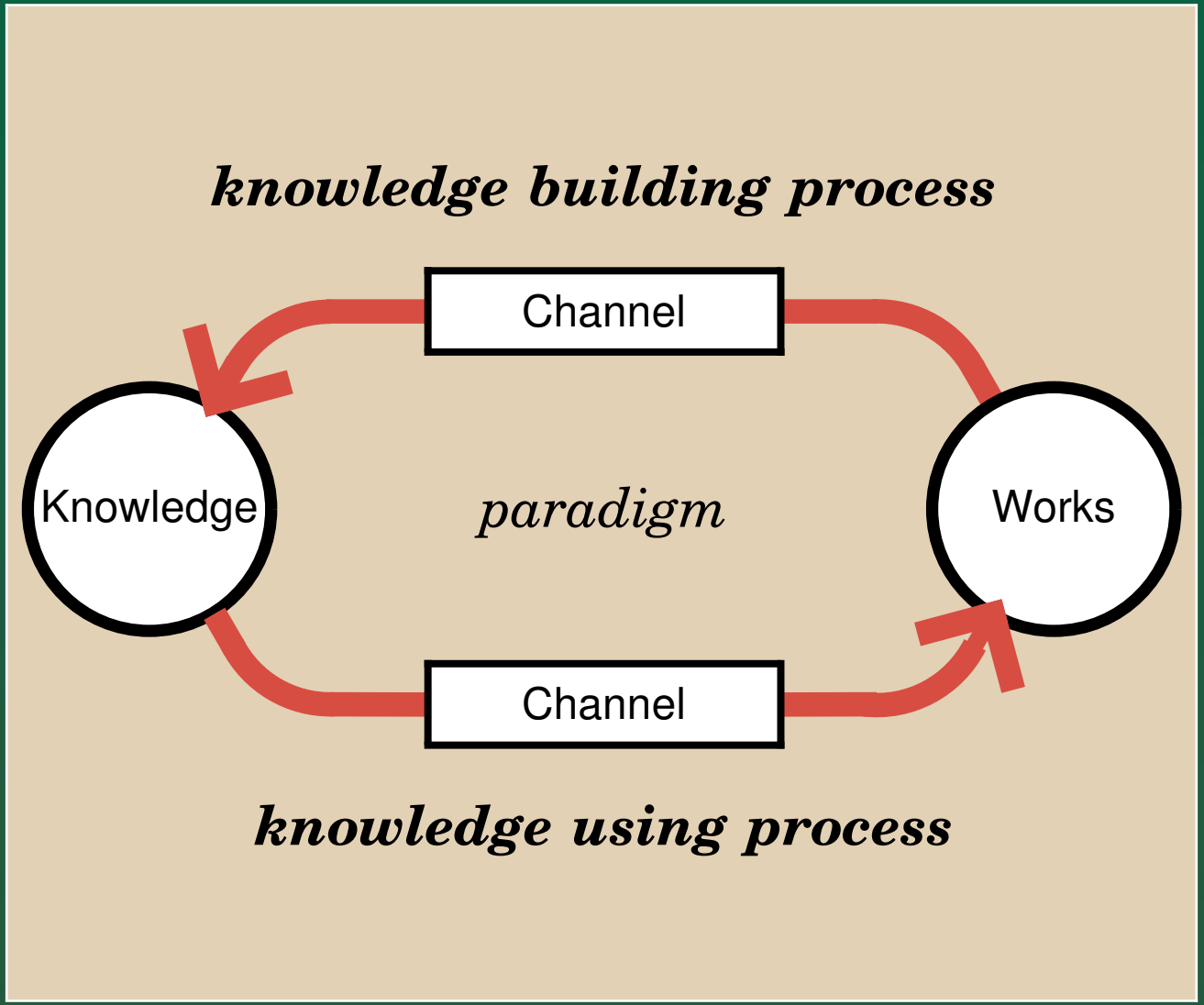
Knowledge is *generated* and *accumulated* through *action*

Doing something:

- *Using knowledge to create works*

Judging results:

- *Evaluating works to build knowledge*



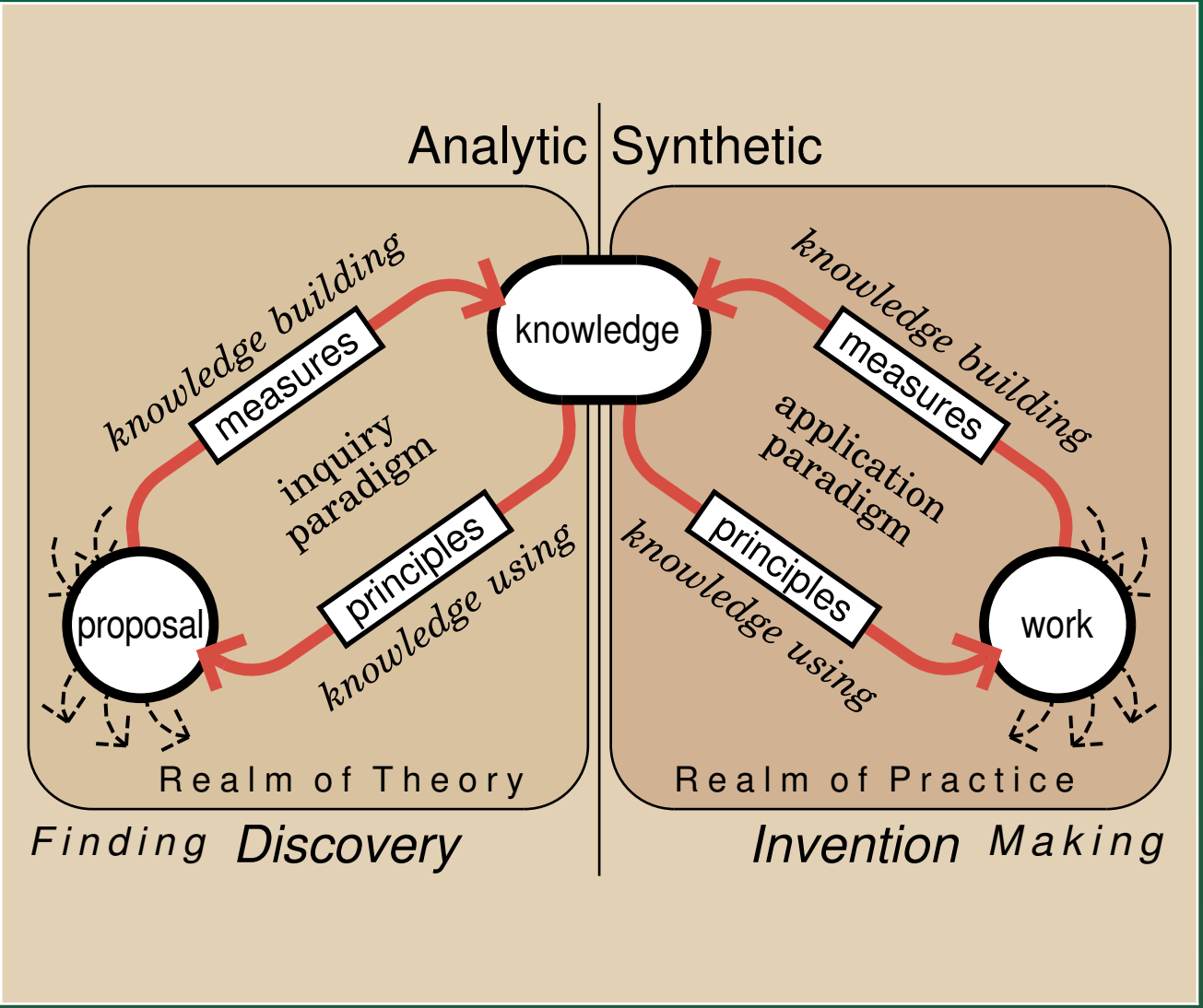
Foundations

Knowledge Building and Using

Building/Using:
dual *Realms*
dual *Paradigms*

Realm of Theory:
- ***Inquiry*** *paradigm*

Realm of Practice:
- ***Application*** *paradigm*



Foundations

The Value-based Structure of Fields

Foundations dictate structure and process

Need/Goal

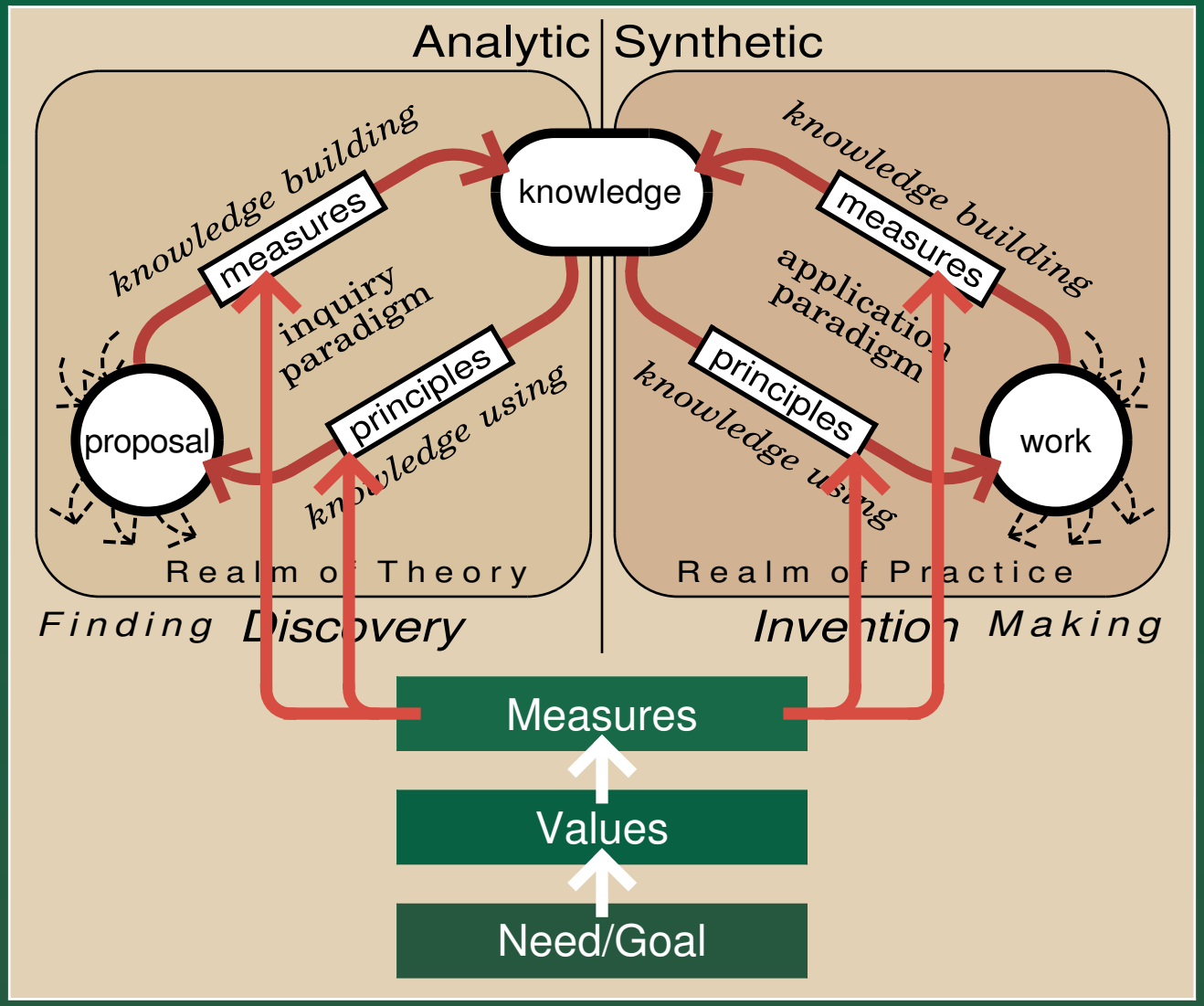
- *Generates a field*

Values

- *Identify the qualities important to fulfilling the need*

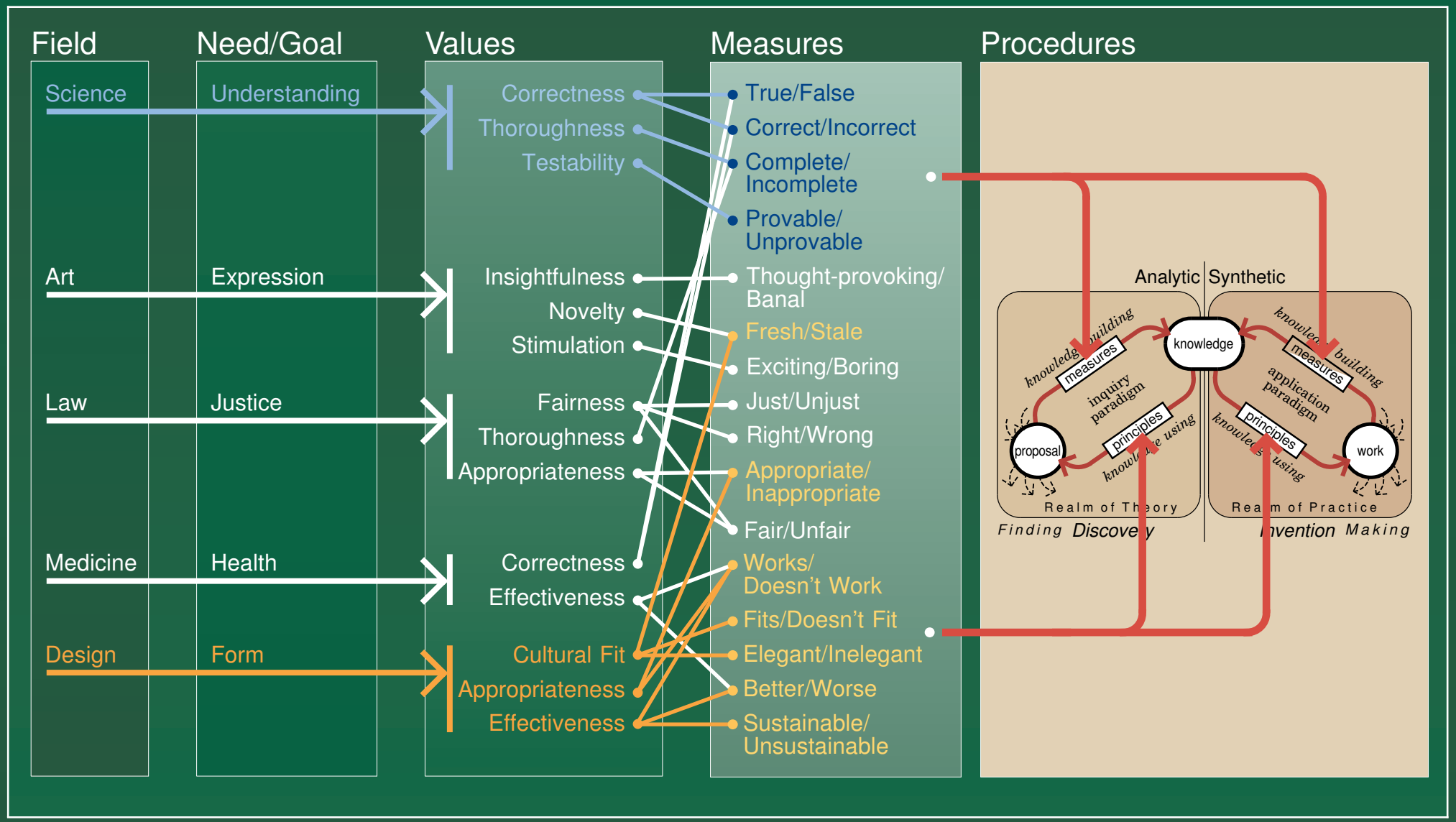
Measures

- *Guide the creation of instruments to manage knowledge using and building*



Foundations

Value Chains for Five Fields



Education for Design

The Recruiting Problem

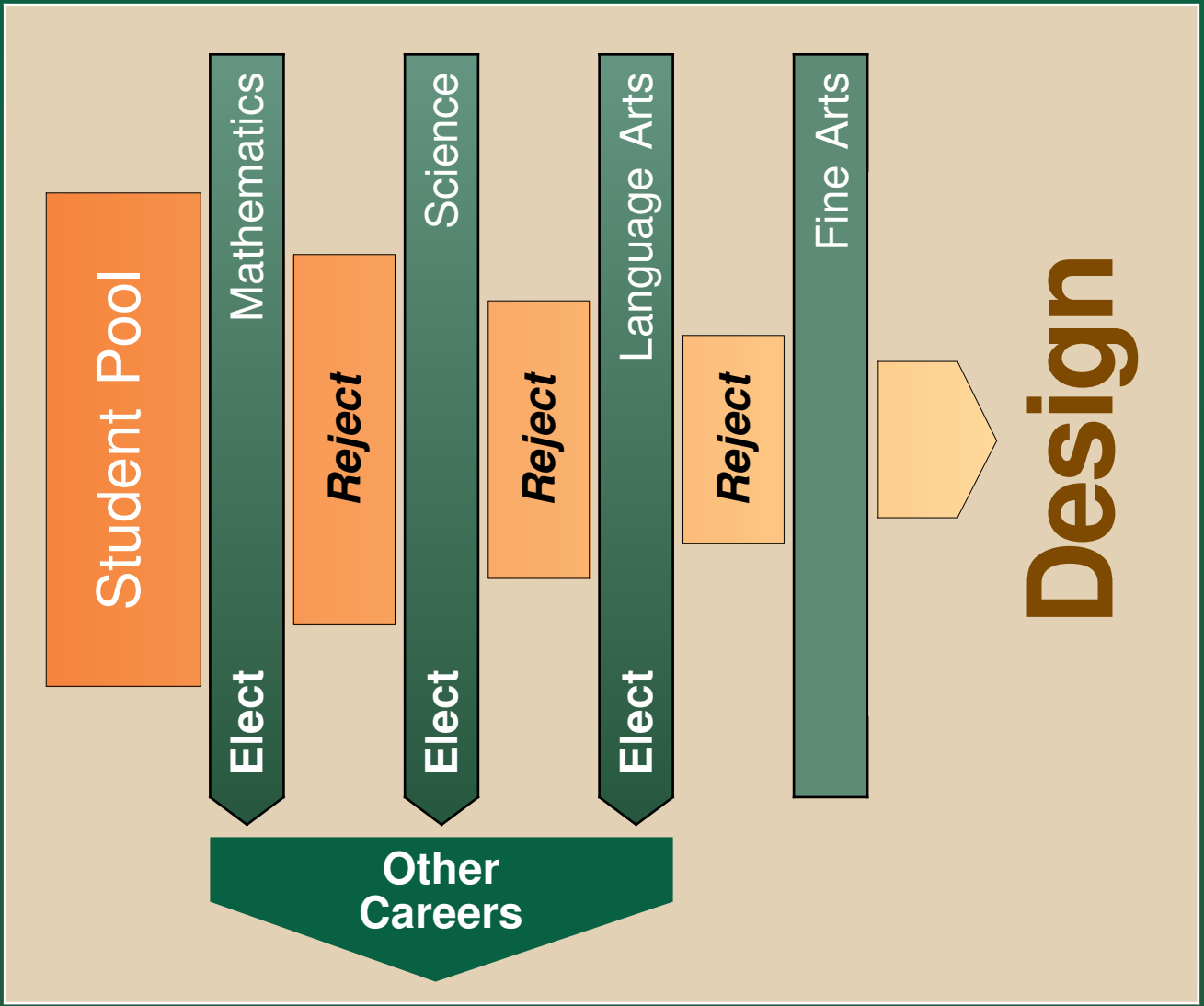
Selection by Rejection

Counseling filter

- *Reject what you're not good at*

Bad/no information

- *Fine arts as path of least resistance*
- **Design** *as option with jobs*



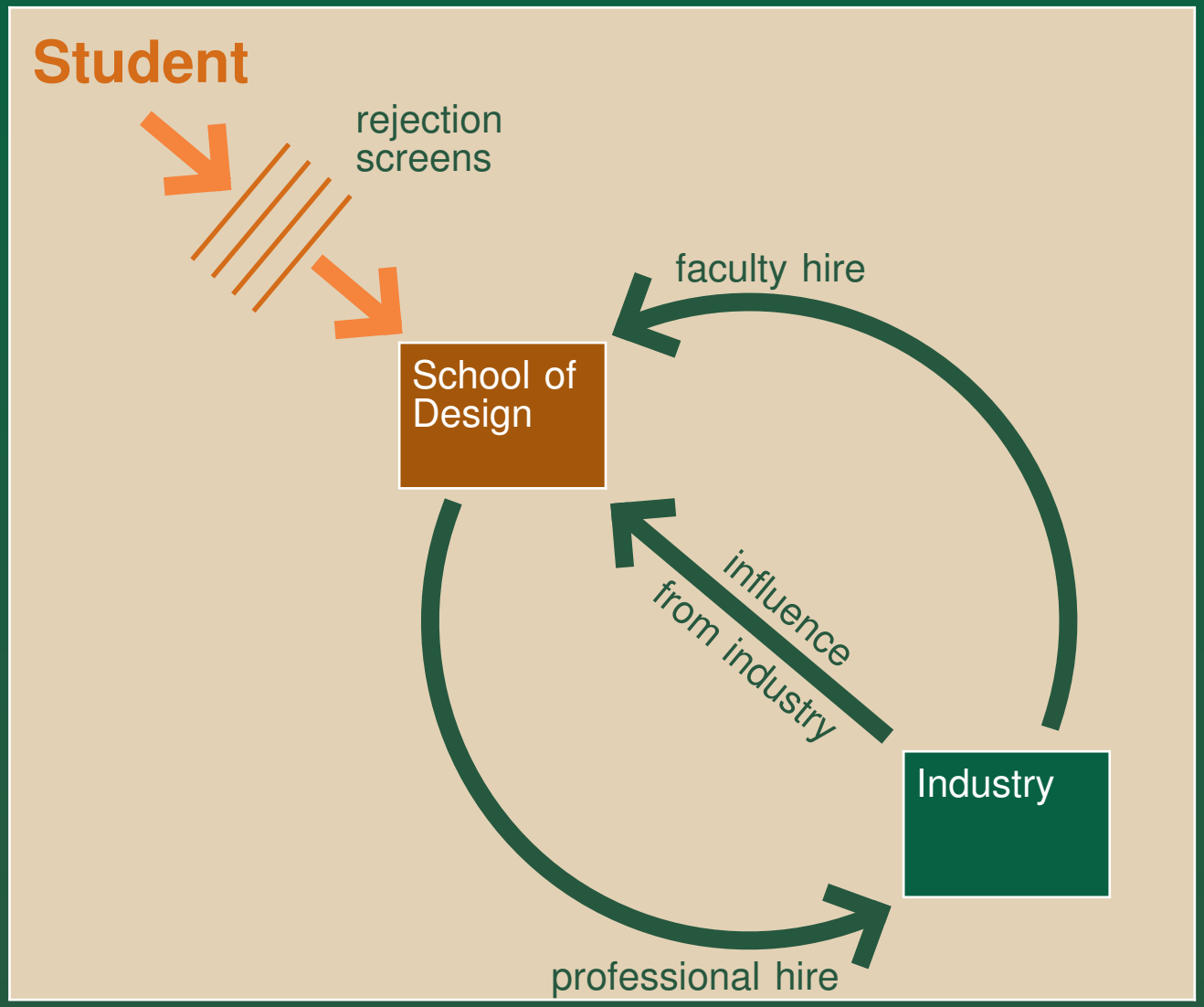
Education for Design

The Development Problem

The incestuous loop

Built-in resistance to change

- *Student enters – running "away from"*
- *Faculty teach with similar biases*
- *Graduates move to industry*
- *School hires faculty from industry*
- *Faculty teach with unchanged bias*



Education for Design

The Recruiting Solution

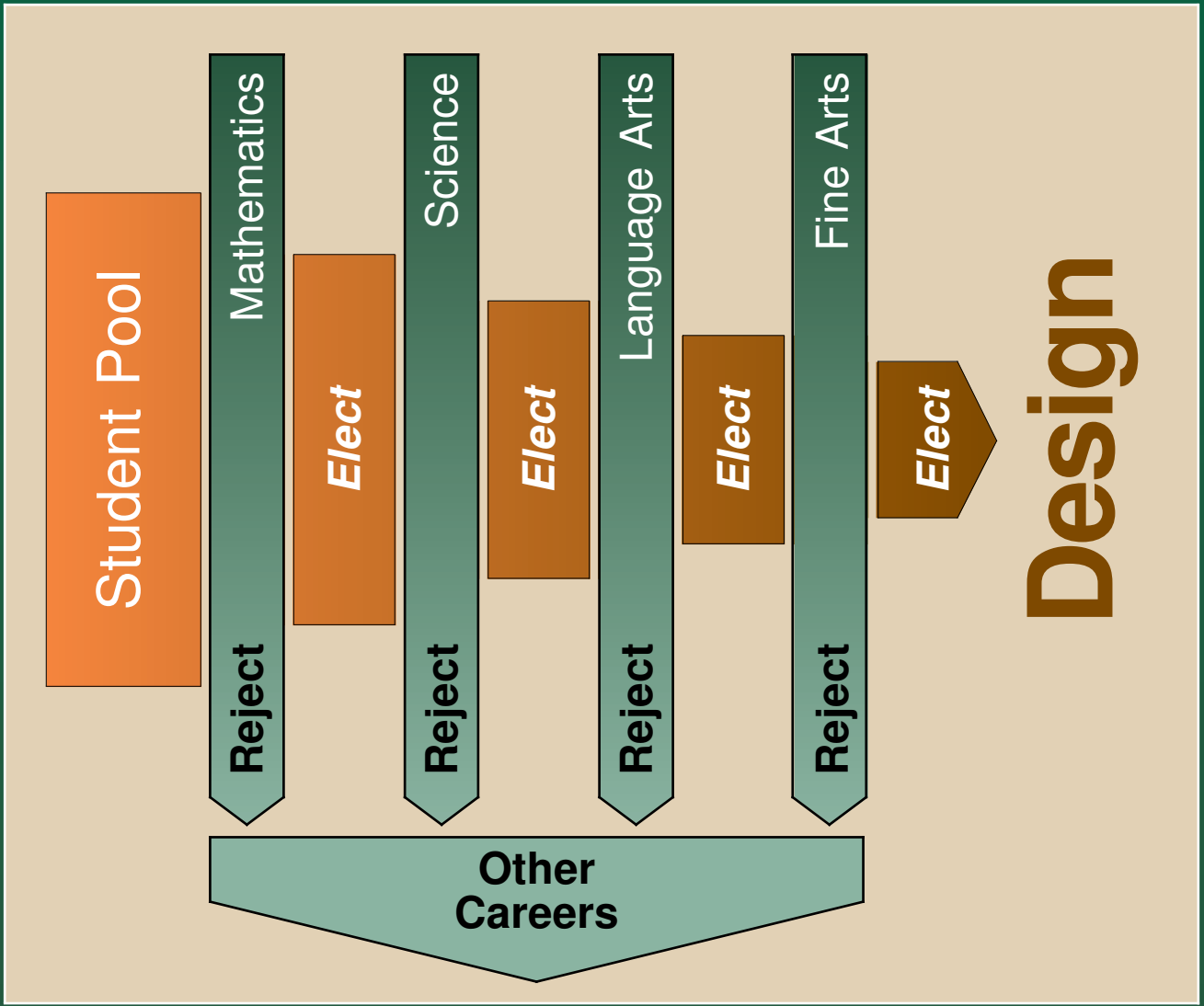
Selection by Election

Counseling filter

- *Elect what you're* **good** *at*

Good information

- **Design** *as an inclusive option*
- **Design** *as option for those who want to* ***do it all***



Education for Design

The Development Solution

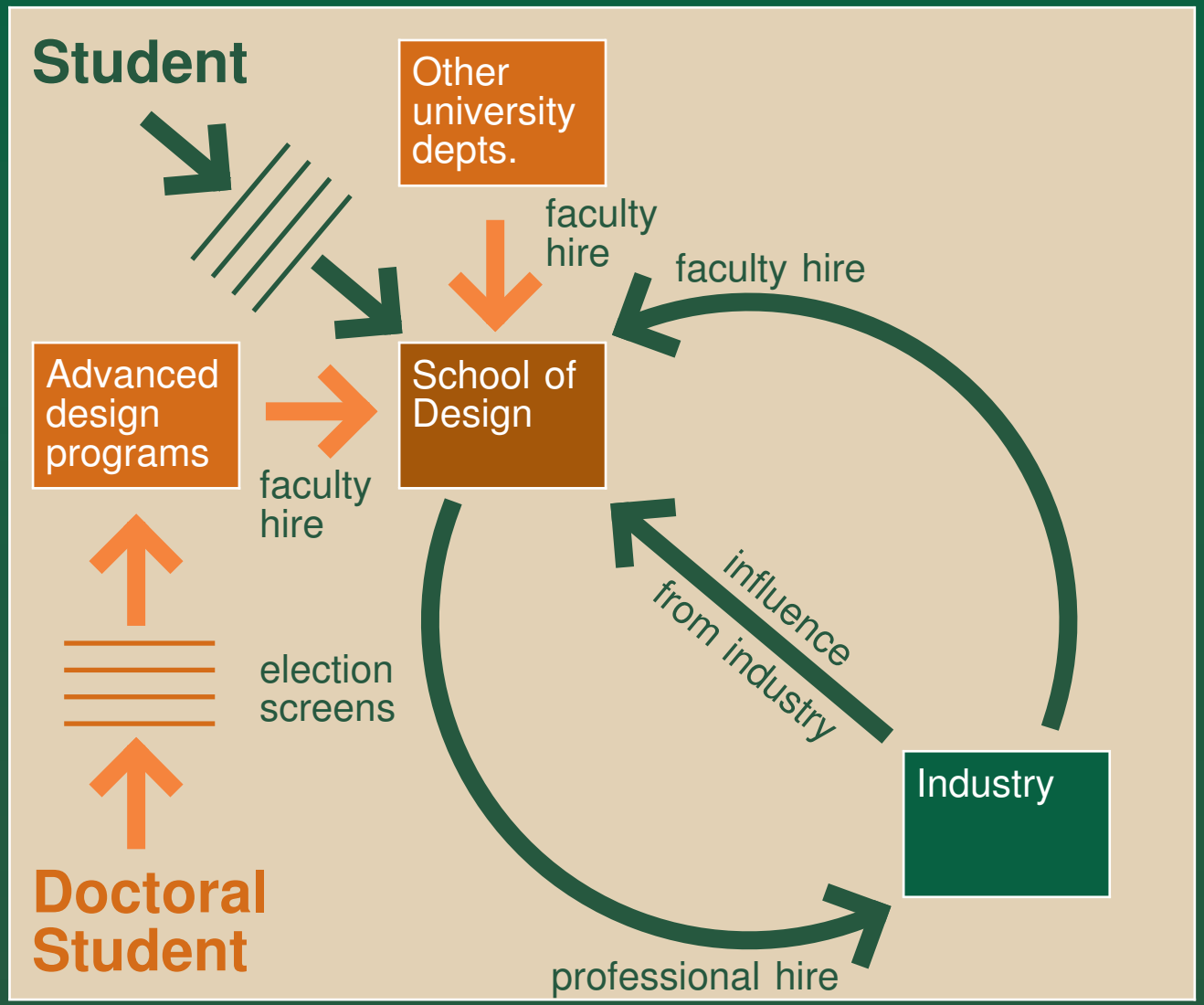
Breaking the loop

Faculty augmentation

- *Kindred spirit departments*
- *Specialists with general interests*

Internal development

- *PhD research and teaching programs in* **Design**



Education for Design

Energizing Development

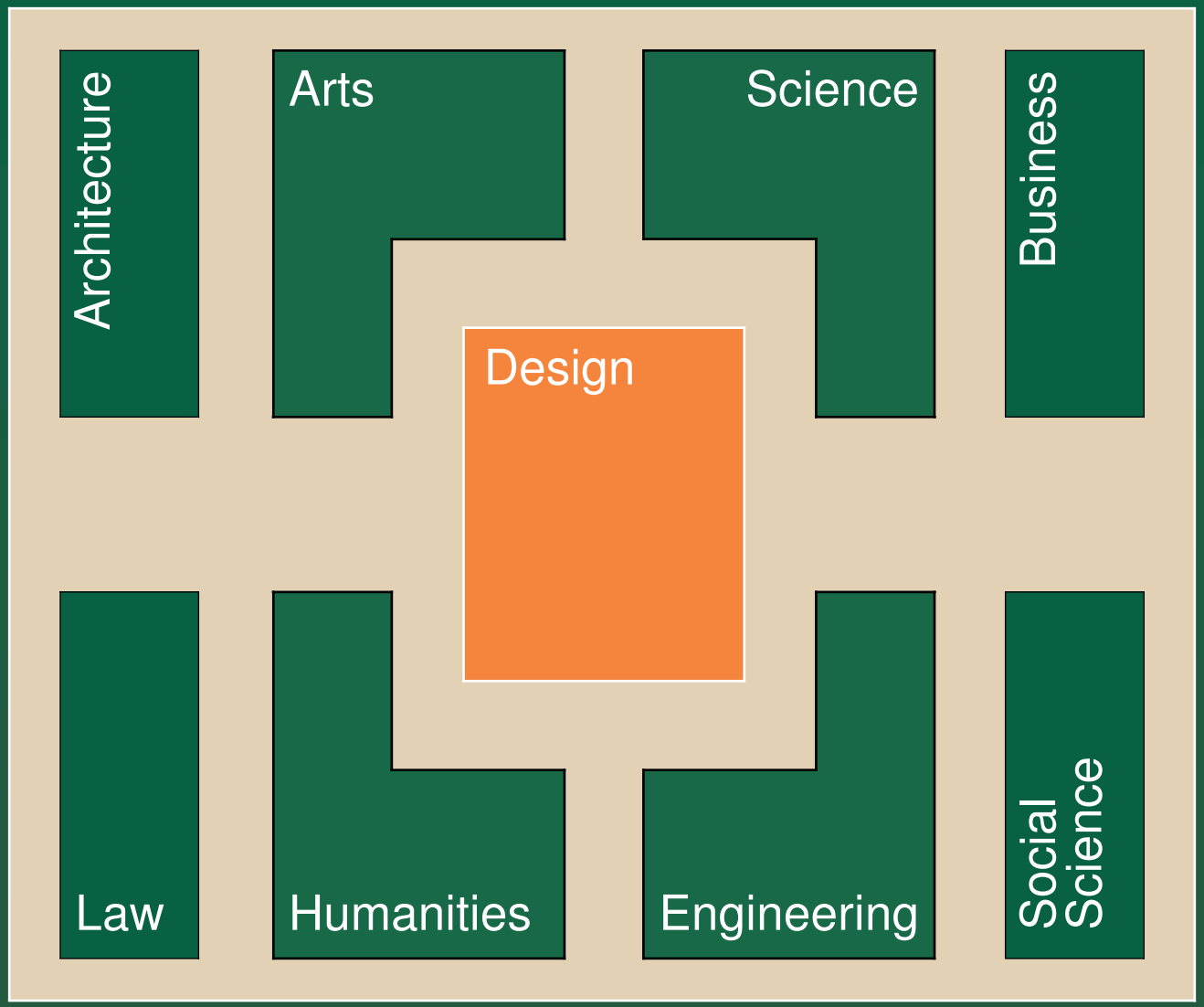
Positioning for interaction

Responsibility accepted

- *Design is its own field*
- *Design operates best in its own college*

Communications reinforced

- *Design needs and enhances other fields*



Education for Design

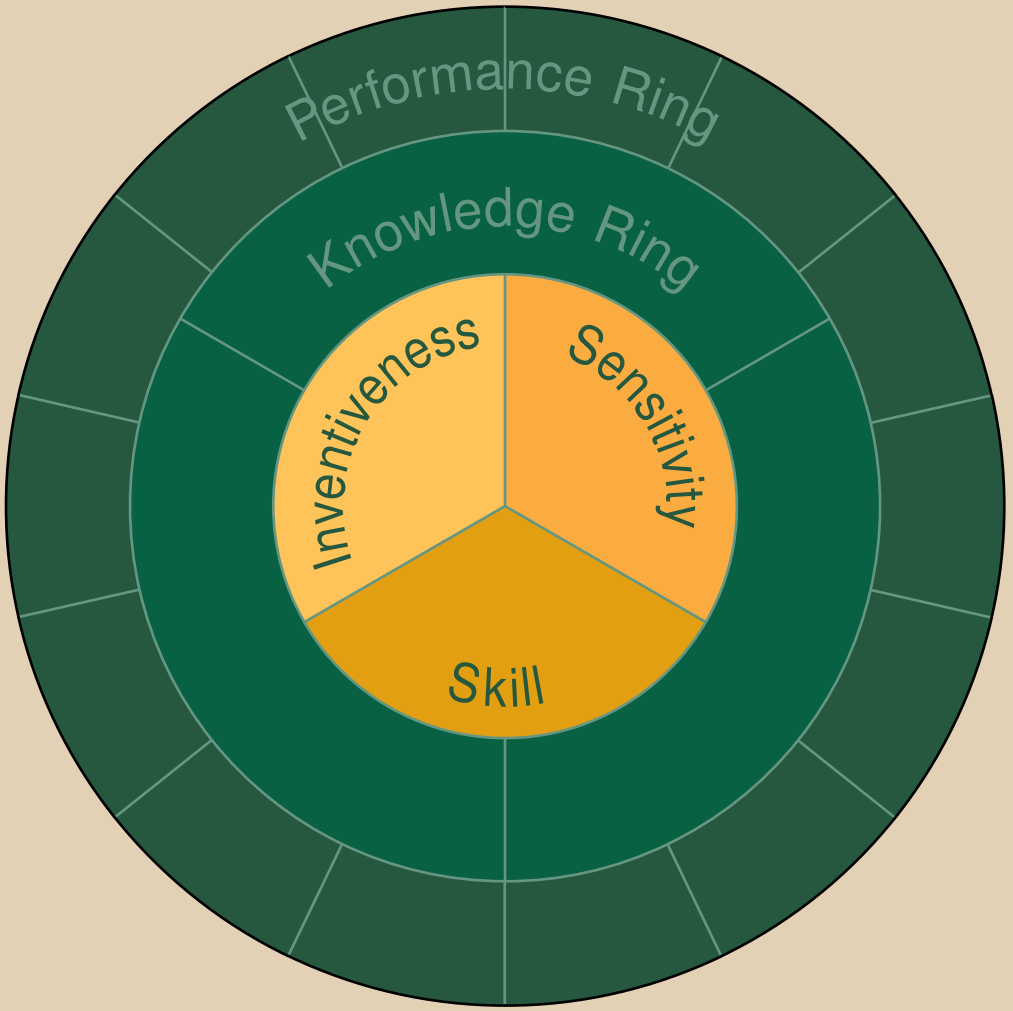
Curricular Components

Foundation Core

Inventiveness
- ***Making*** *as a creative act*

Sensitivity
- ***Seeing*** *and* ***Sensing*** *critically*
- *The* ***Feel*** *of good and bad*

Skill
- *Mental skills*
- *Motor skills*



Education for Design

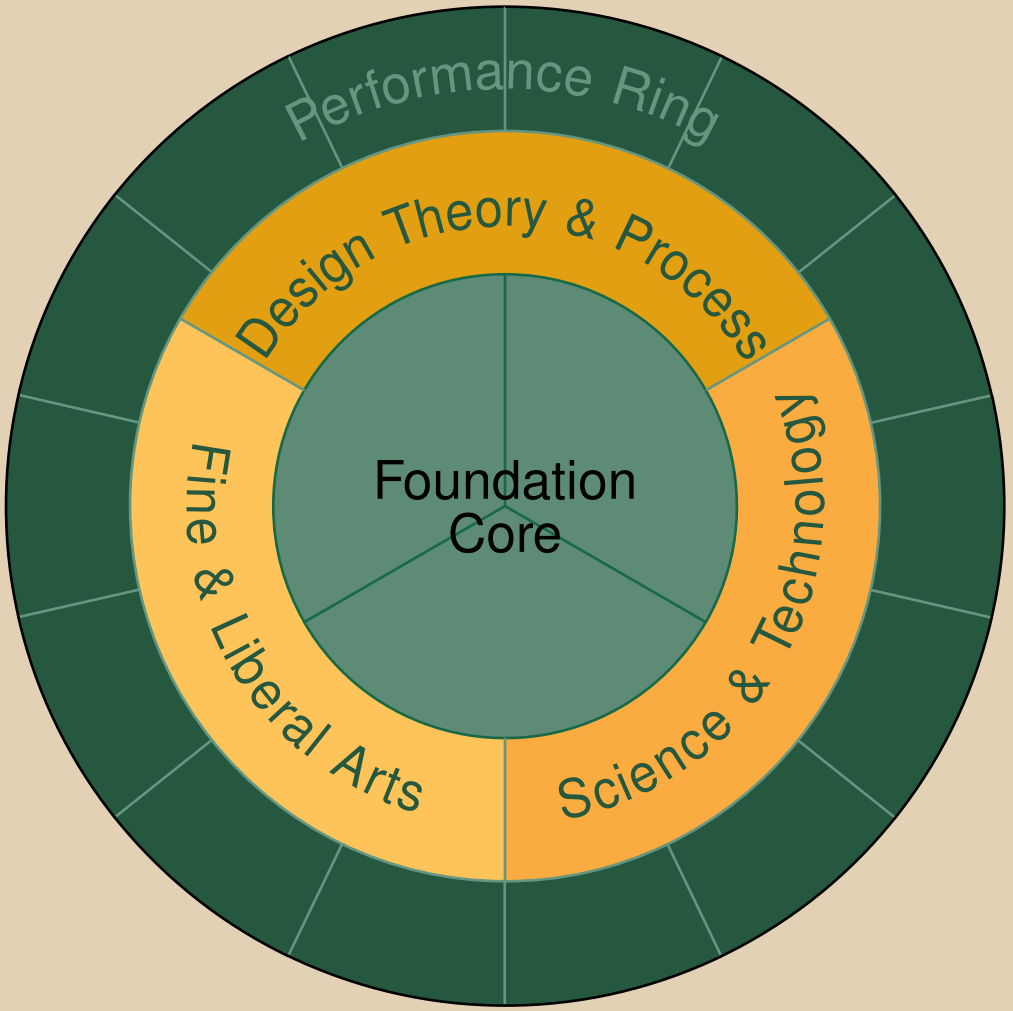
Curricular Components

Knowledge Ring

Fine & Liberal Arts
- *The social and cultural world*

Science & Technology
- *The natural and physical world*

Design Theory & Process
- *The means to effect constructive change*



Education for Design

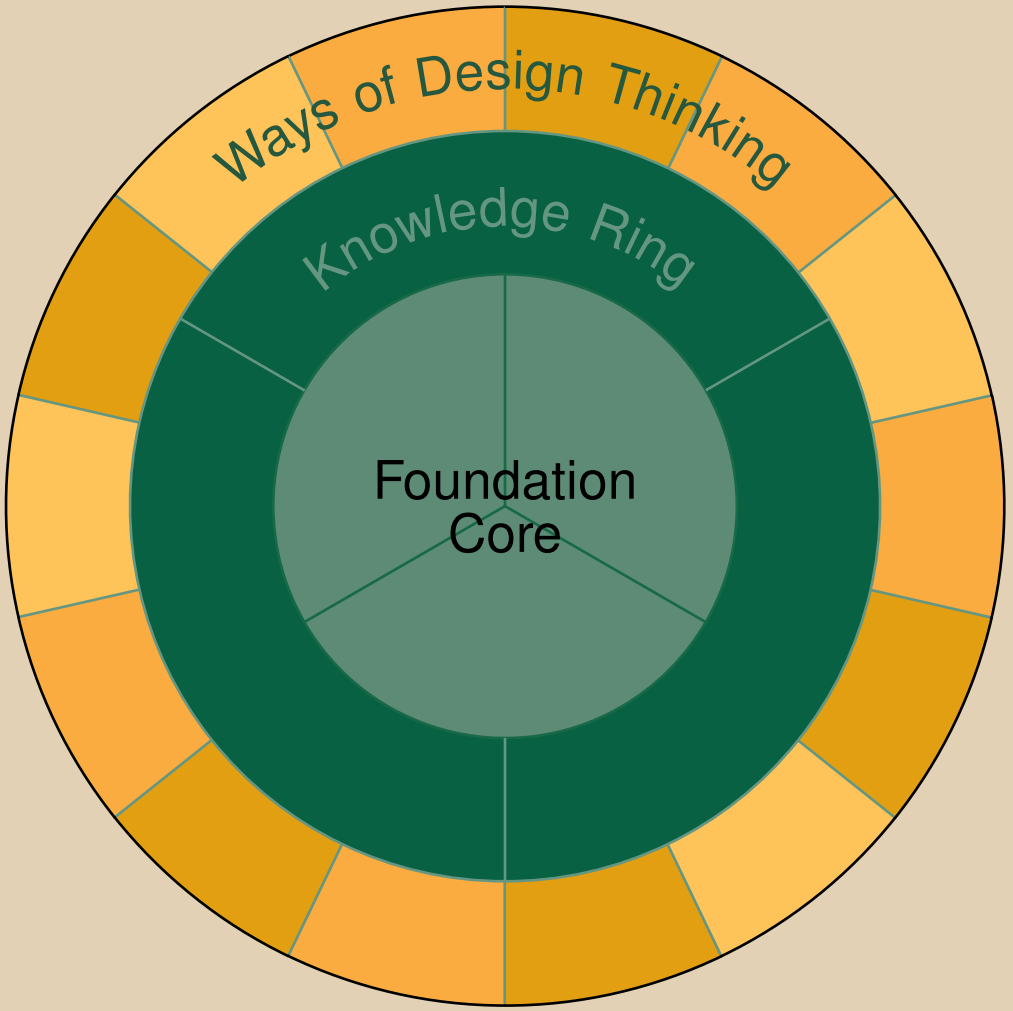
Curricular Components

Performance Ring

Concerns
- *Guidelines*
- *Principles*

Attitudes
- *Approaches*
- *Frameworks*

Strategies
- *Ways of thinking*
- *Ways of working*
- *Capabilities*



Education for / Design / for Education

Ways of Design Thinking

Conditioned inventiveness

Specialized creativity

- **Invention** *rather than* Discovery

Inventiveness within limits

- **Not** *free-form innovation*
- *Invention for* **clients**
- **Client-directed** *rather than designer-directed*

How learned?

- *Project finding*
- *Phased reviews*

Education for / Design / for Education

Ways of Design Thinking

Human-centered focus

View of the *User*

- *Interactions between user and system*
- *User-artifact vs artifact-artifact*

Fundamental value

- *Good = better for individuals and society*

How learned?

- *Activity analysis*
- *Prototype evaluation*

Education for / Design / for Education

Ways of Design Thinking

Environmental concern

Whole system sensitivity

- *Sustainable development*
- *Light-touch disturbance*

Less is more

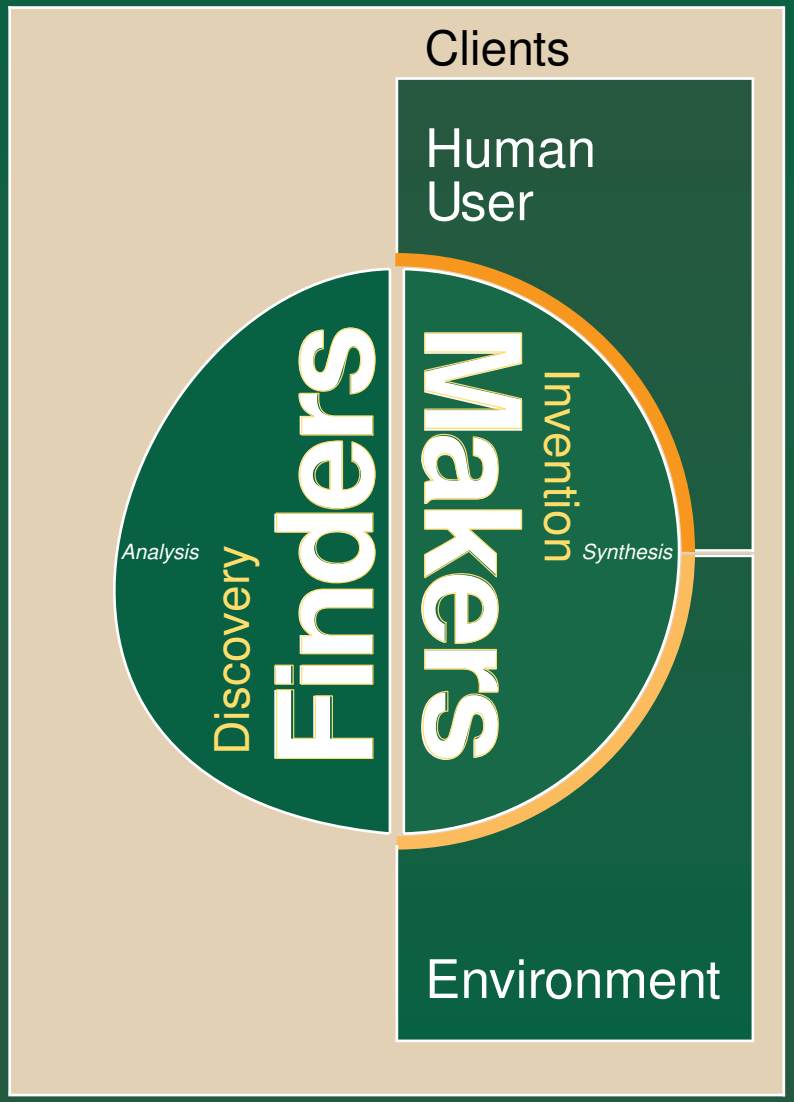
- *Achieving more; using less*

Fundamental value

- *Good = harmless or good for the environment*

How learned?

- *Environmentl impact analysis*
- *Environmental impact critique*



Education for / Design / for Education

Ways of Design Thinking

Ability to visualize

Concepts as diagrams

- *Manipulable elements*
- *Crystallized relationships*
- *Big picture overview*

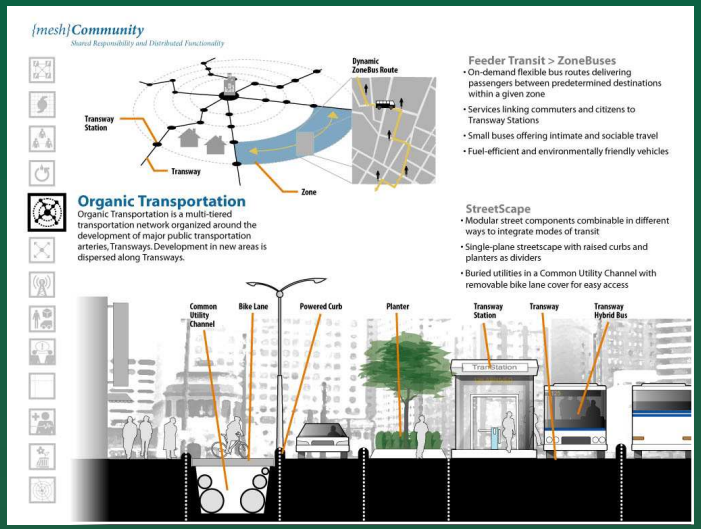
Form for ideas

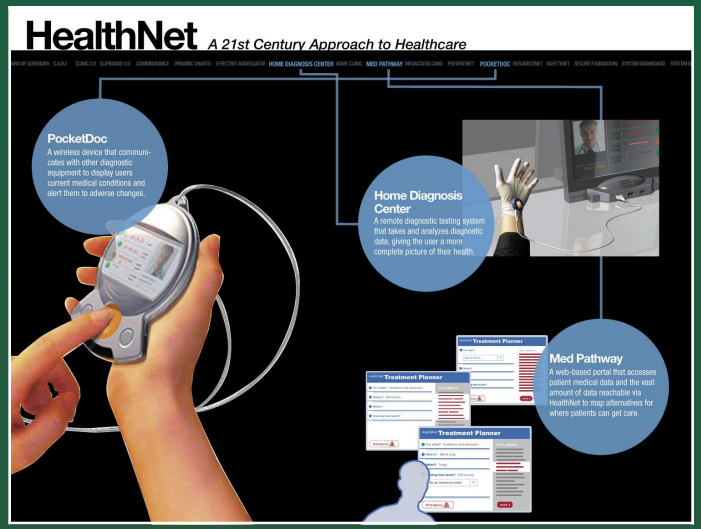
- *Conjectural images*
- *Mock-ups, models and prototypes*

The elephant for the blind men

How learned?

- *2D skill development*
- *3D skill development*





Sources: MeshCommunity, 2004; HealthNet, 2003. Institute of Design, IIT.

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Ways of Design Thinking

Tempered optimism

Dampened peaks and valleys

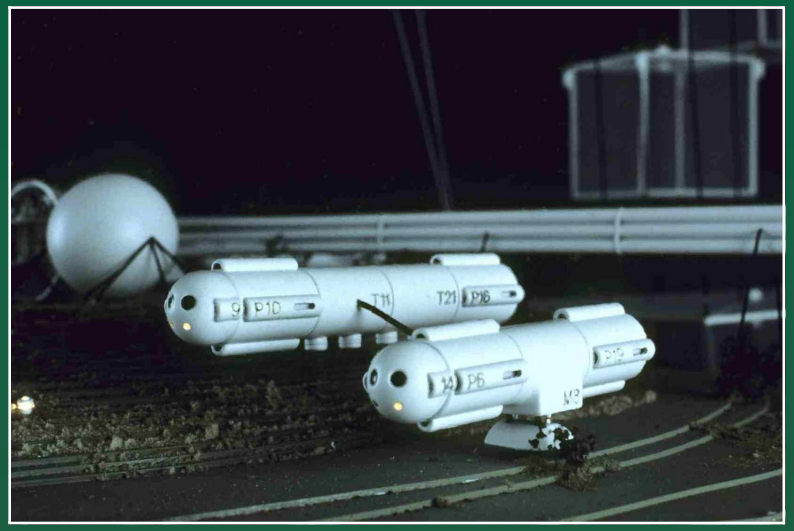
- *Successes taken in stride*
- *Failures accepted as incentive*

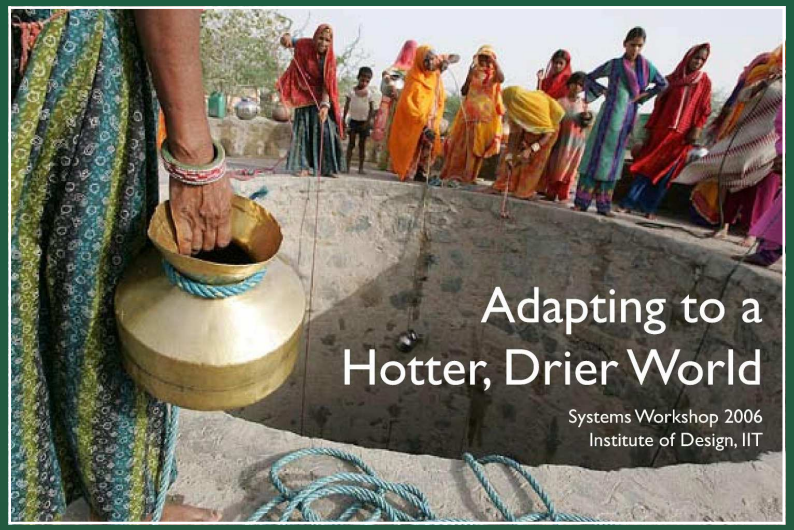
Enthusiasm on demand

- *Depression blocks creativity*
- *Optimism restores enthusiasm*
- *Tempered optimism supports professionalism*

How learned?

- *Project review*
- *Competition*





Sources: Hydrospace, 1969; Massive Change, 2006. Institute of Design, IIT.

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Ways of Design Thinking

Bias for adaptivity

Adaptivity in production

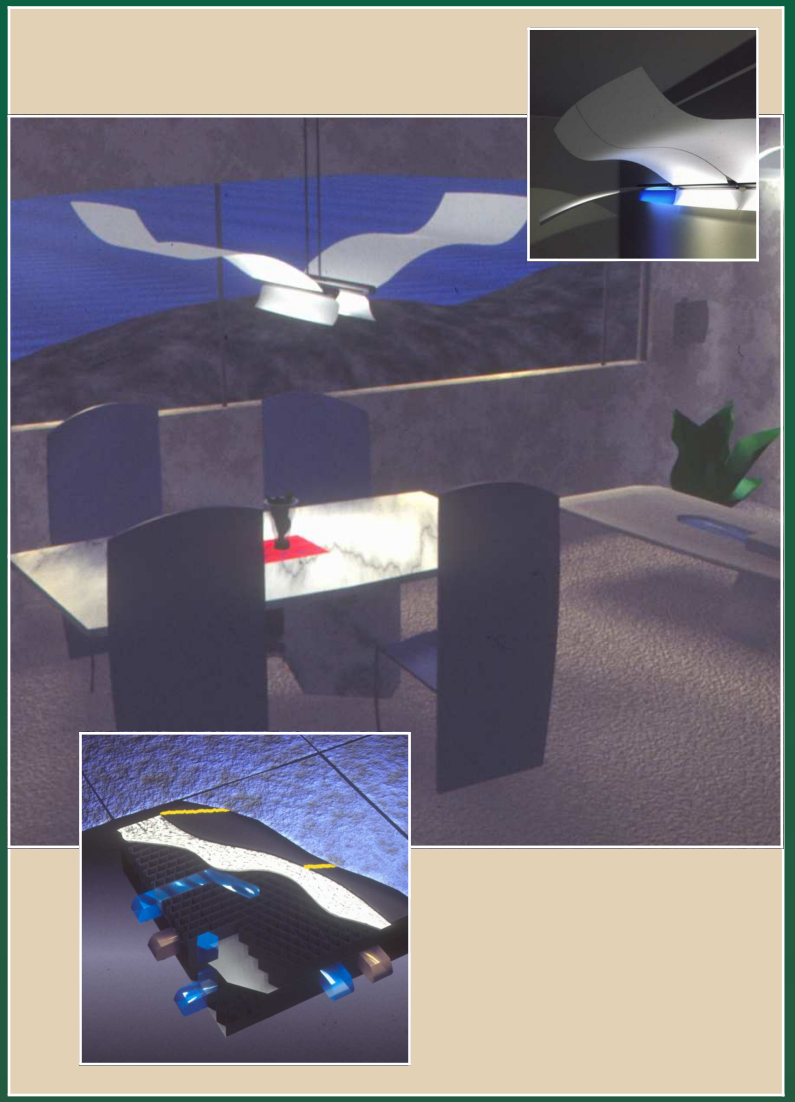
- *Adapted by the producer*
- *Custom fit to users' needs*

Adaptivity in use

- *Adapted by the user*
- *Adjustable to evolving needs*

How learned?

- *Project charter*
- *Review and critique*



Source: Nanoplastics: A Home System, 1993. Institute of Design, IIT.

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Ways of Design Thinking

Predisposition toward multifunctionality

Multi- vs _Mono-_ functionality

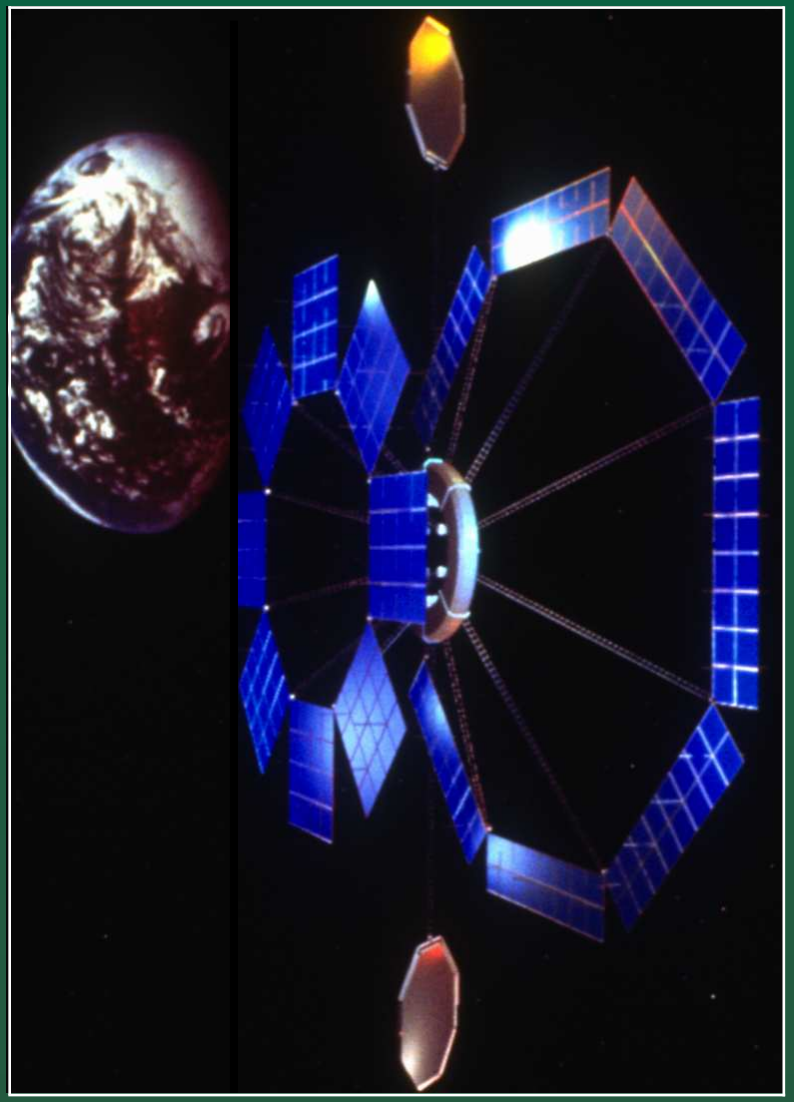
- *Multiple benefits from single projects*

Problem solving _should_ bring rewards

- *The reward intended*
- *Economic rewards where value is added*
- *Social rewards where society is benefited*

How learned?

- *User analysis*
- *Economic/social impact review*



Source: Project Phoenix, 1989. Institute of Design, IIT.

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Ways of Design Thinking

Systemic vision

Holistic thinking

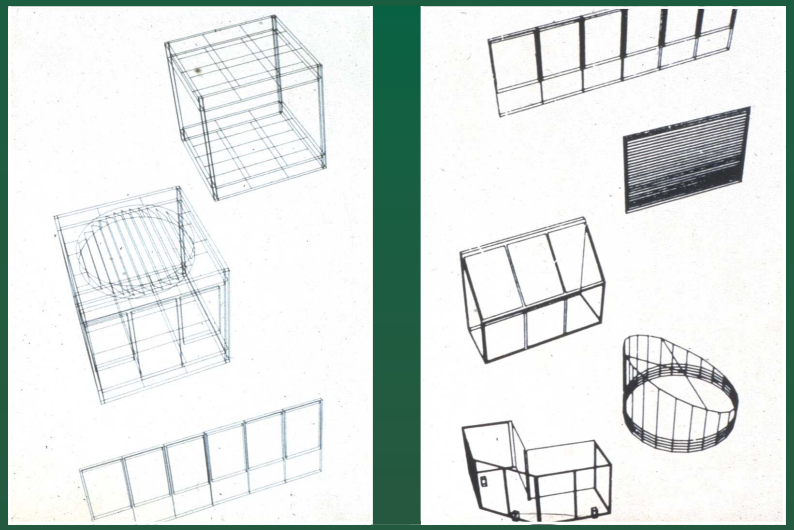
- *Broad range of problem inquiry*
- *Solutions as* **Systems** *rather than artifacts*

Hierarchical system structure

- *Multiple organized components*
- *Components as subsystems, entities, procedures, services, organizational constructs, policies ...*

How learned?

- *Project charter*
- *Multi-user analysis*



Source: House of the Future, 1983. Institute of Design, IIT.

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Ways of Design Thinking

View of the generalist

Generalist vs Specialist

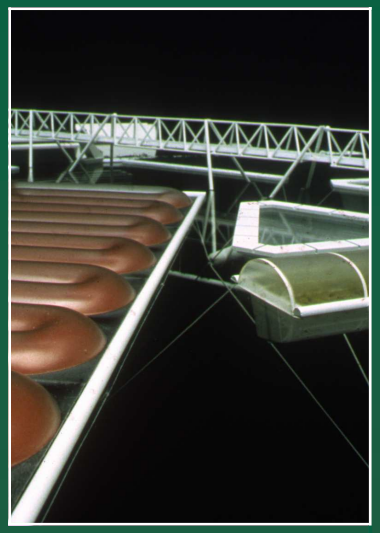
- *The more general the knowledge, the greater the diversity of ideas*

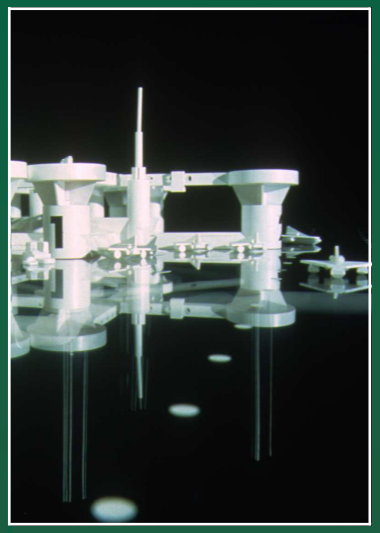
Special roles of the generalist

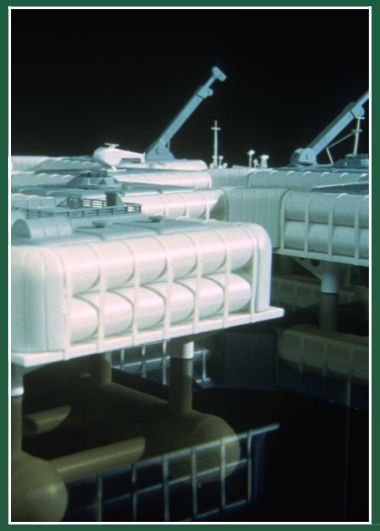
- *Communication across disciplines*
- *Coordination and leadership*
- *Methodological expertise*

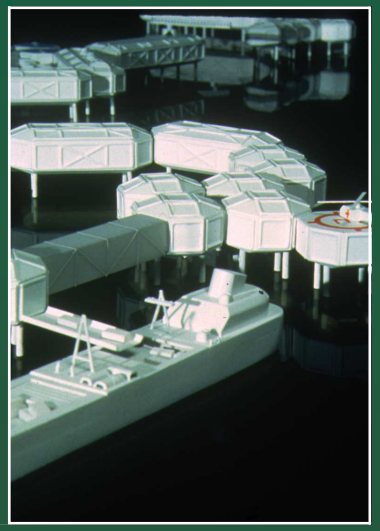
How learned?

- *Broad education*
- *Structured planning*









Source: Aquatecture, 1987.
Institute of Design, IIT.

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Ways of Design Thinking

Ability to use language as a tool

Mathematical language

- *Exploring "what if's" by approximation*

Visual language

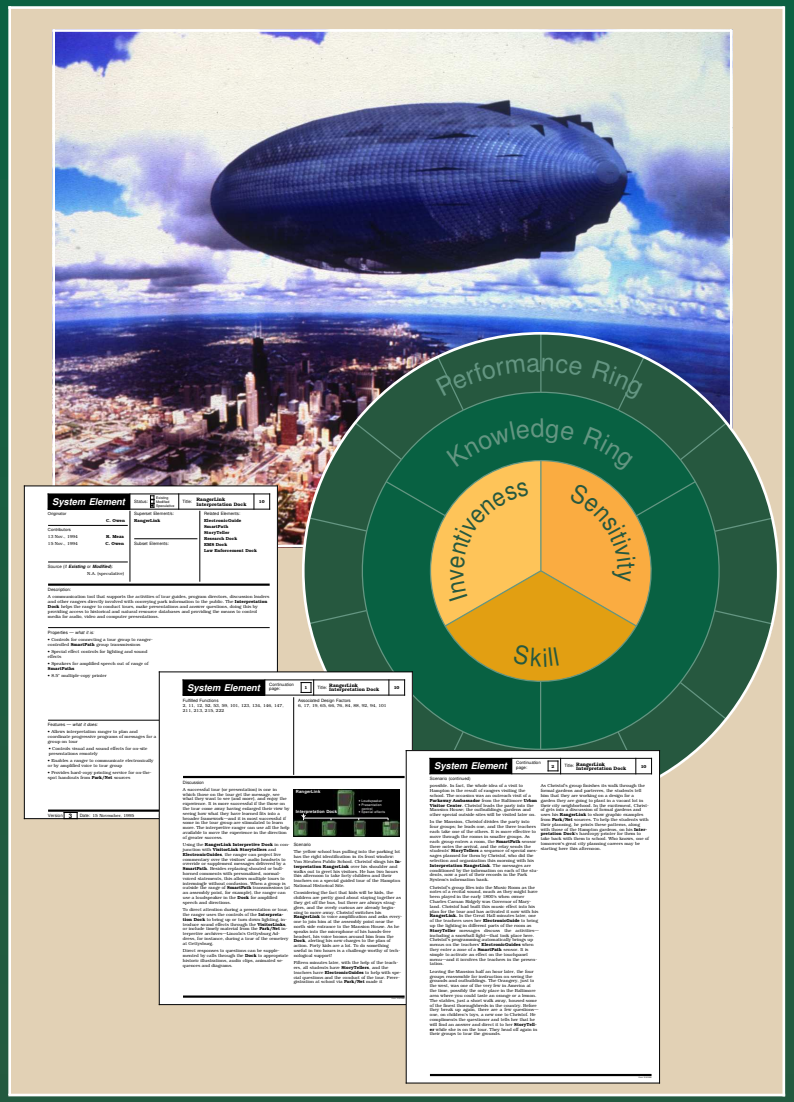
- *Abstracting the essence of concepts*
- *Revealing and explaining patterns*

Verbal language

- *Developing detail not apparent visually*

How learned?

- *Qualitative calculation*
- *Diagramming*
- *Descriptive writing*



Sources: Aerotecture, 1993; National Park System, 1994. Institute of Design, IIT.

Education for / Design / for Education

Ways of Design Thinking

Affinity for teamwork

Multidiscipline design teams

- *Concept development*
- *Members from relevant function groups*

Design contributions

- Planning methodology
- Translation between special and general
- Communication across disciplines
- Work with qualitative information
- Visualization of concepts

How learned?

- *Team projects*
- *Leader and member evaluations*

Source: Space Station, NASA, 1985.
Institute of Design, IIT.

Education for / Design / for Education

Ways of Design Thinking

Facility for avoiding the necessity of choice

Choice as a last resort

- *Choosing: A* **Losing** *as well as winning proposition*

Avoiding the choice

- *"Have your cake and eat it too!"*
- *Search choices for essential characteristics*
- *Reformulate in a new configuration*

How learned?

- *Ends/means synthesis*
- *Project competitive reviews*

Source: Project Argus, 1991. Institute of Design, IIT.

Education for / Design / for Education

Ways of Design Thinking

Self-governing practicality

Governed flights of fantasy

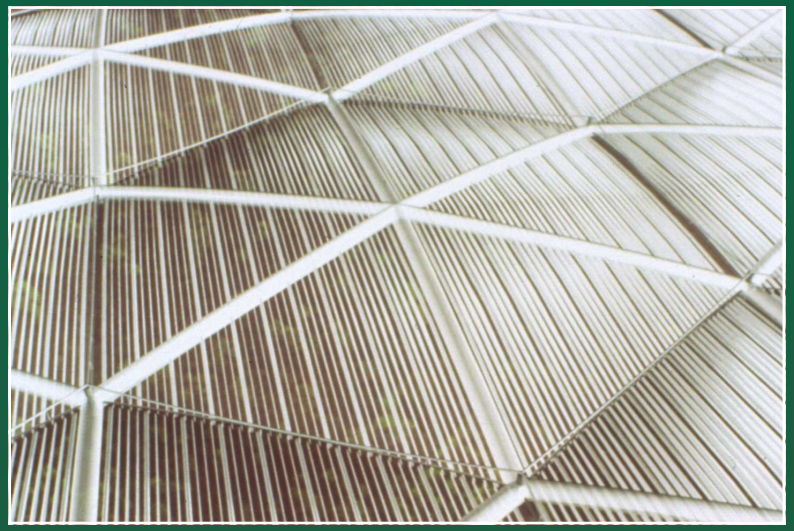
- *Flight to the limits of what can be conceived*
- *Tether to ways the conceivable can be realized*

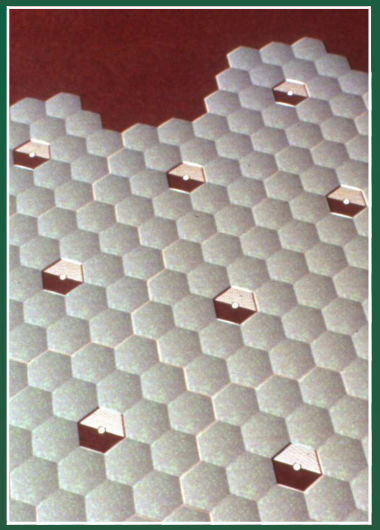
Style of self-governed thinking

- **Foreground:** *free exploration*
- **Background:** *realistic appraisal of costs/functionality*

How learned?

- *Ends/means synthesis*
- *Conjectural/evaluative resolution*





Source: Project Phoenix, 1989. Institute of Design, IIT.

Education for / Design / for Education

Ways of Design Thinking

Ability to work systematically with qualitative information

Information processing

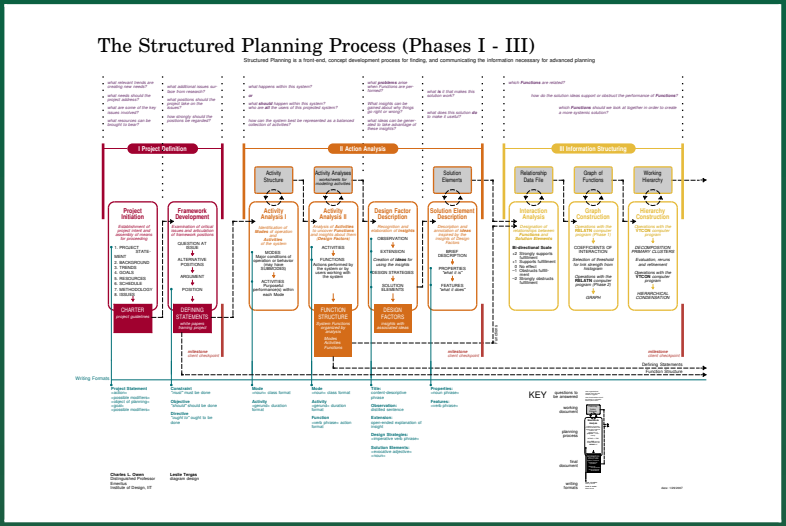
Methodology for finding, distilling, organizing, using and communicating information

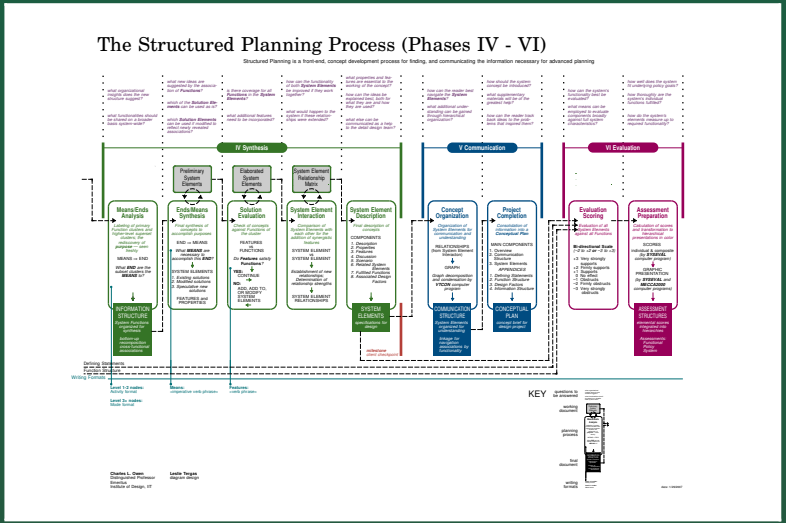
Structured Planning

Toolkit for conducting projects
Accessible to any discipline
Tuned to the goals of design/planning

How learned?

Project theory/exercise workshop
System design project





Source: Structured Planning. Institute of Design, IIT, 2007.

Design for Education

Where and When to Begin Learning

Ways of Design Thinking

Sensitivity

Inventiveness

Visual mental and motor skills

Ability to visualize

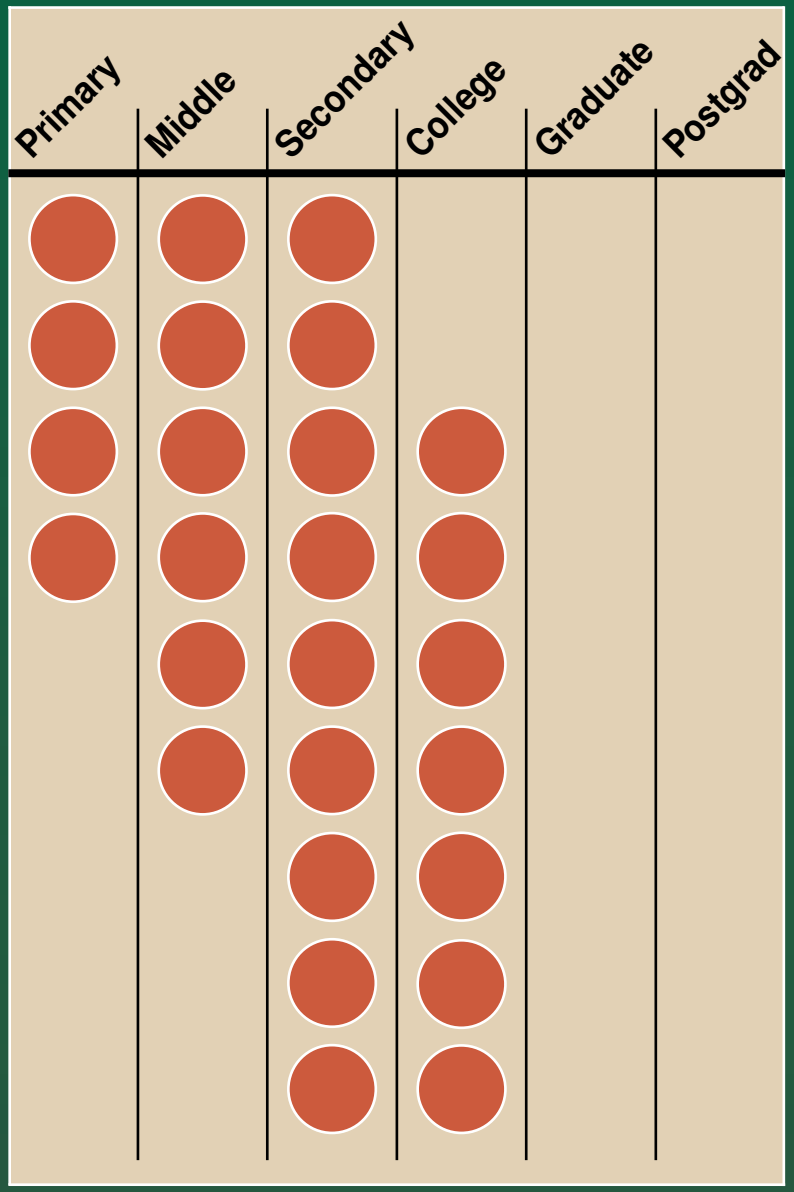
Affinity for teamwork

Systemic vision

Conditioned inventiveness

Environment-centered concern

Human-centered focus



Design for Education

Where and When to Begin Learning

Ways of Design Thinking

Ability to use language as a tool

Design theory and process

Bias for adaptivity

Predisposition toward multifunctionality

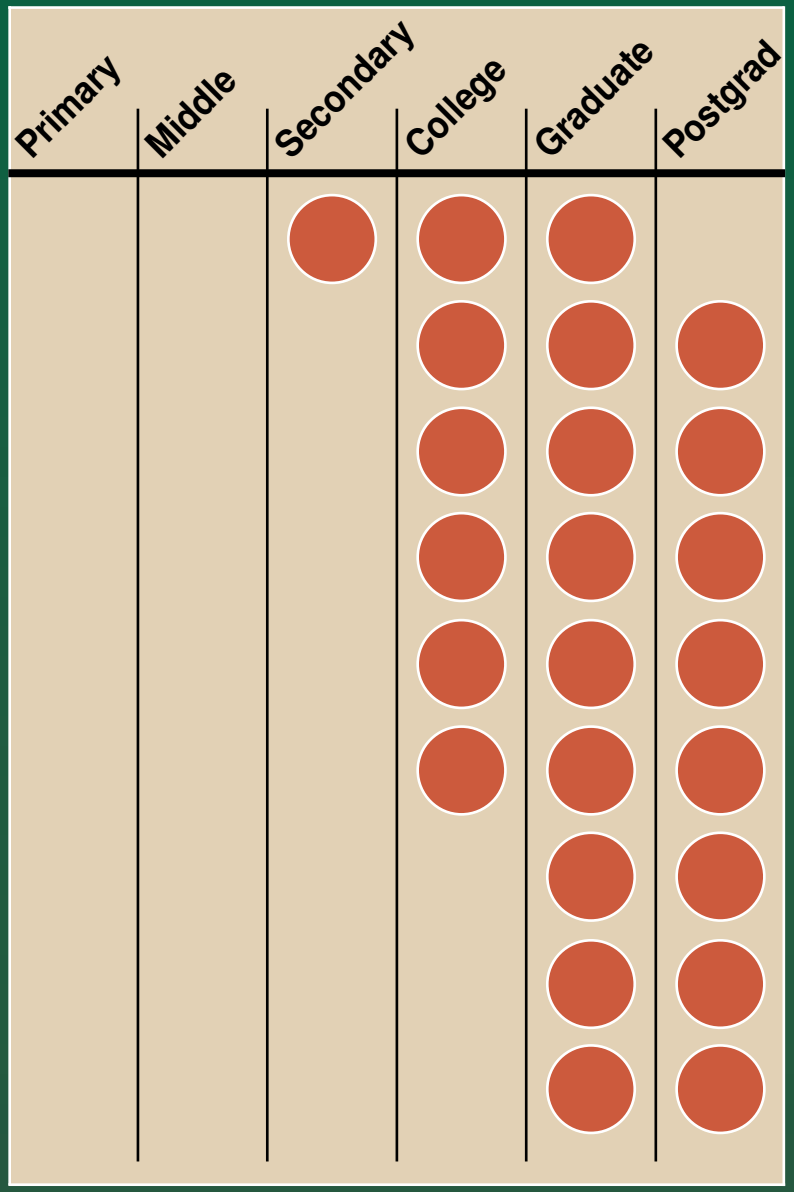
View of the generalist

Tempered optimism

Facility for avoiding the necessity of choice

Self-governing practicality

Ability to work systematically with qualitative information



Design for Education

Thoughts for Next steps: *Post-graduate Level*

Policy Design Synthesis

Professional program

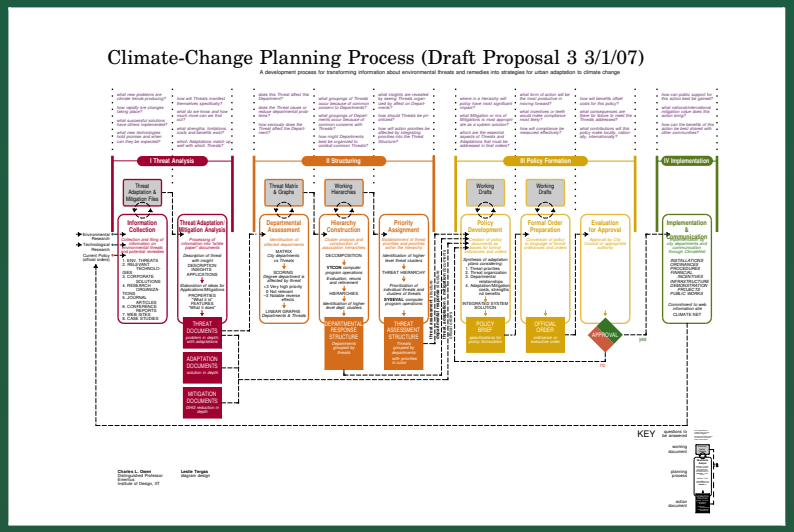
Combined studies in **Policy Planning** *and* **Design Thinking**
Designed to enhance policy-making capabilities for governmental staff

Eligible Students

Graduates of graduate level programs in **governmental studies**
Graduates of graduate level programs in **design**

Design thinking

Ability to work systematically with qualitative information
View of the generalist



Sources: Design Thinking, 2005.; Climate Change, 2007. Institute of Design, IIT.

Design for Education

Thoughts for Next Steps: *Graduate/Undergraduate Level*

Inter-professional Projects

Interdisciplinary research/ development projects

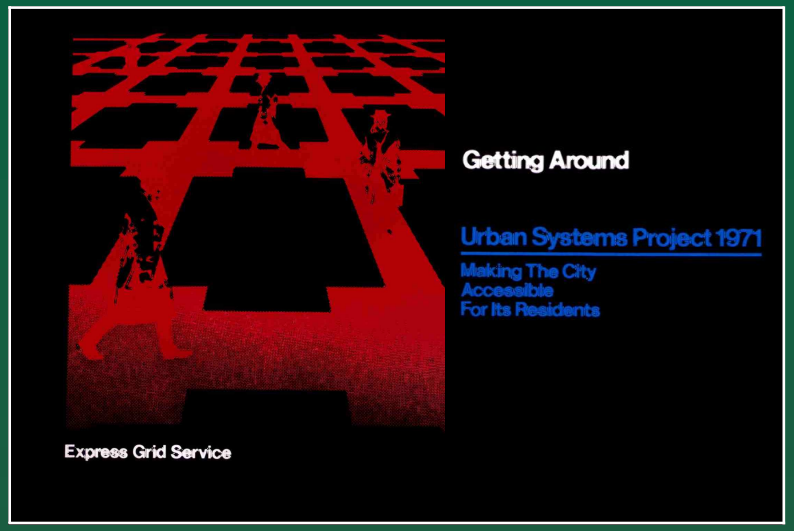
- *Projects applying academic knowledge to professional purposes*
- *Designed to apply project-oriented learning across the curriculum*
- *Faculty-generated and recruited*

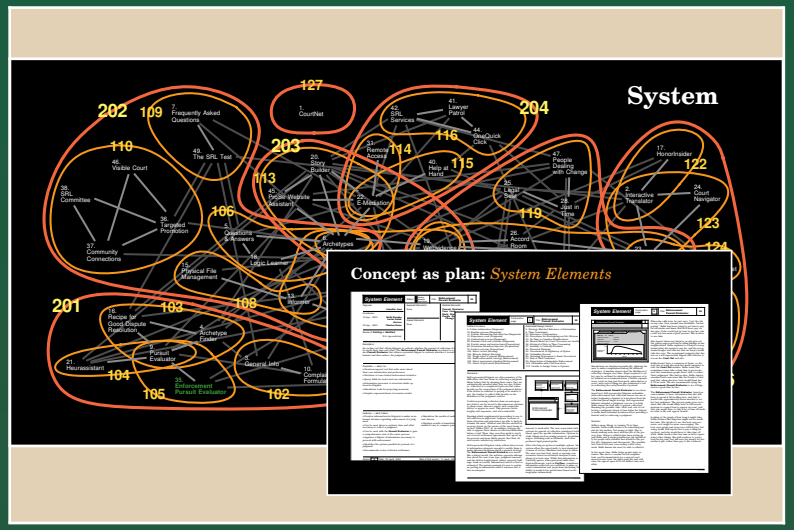
Eligible Students

- *Graduate and undergraduate students throughout the university*
- *Students apply to course leaders*

Design thinking

- *Pre-disposition toward multifunctionality*
- *Facility for avoiding the necessity of choice*





Sources: Getting Around, 1971; Access to Justice, 2001. Institute of Design, IIT.

Design for Education

Thoughts for Next Steps: *Secondary School Level*

Quantitative Reasoning

Mathematical Language As a Tool

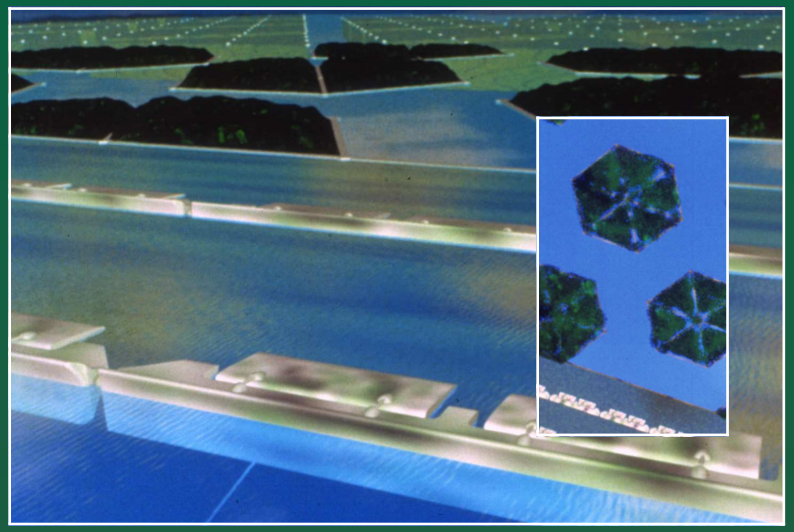
- *Projects using mathematics to estimate and verify projections*
- *Designed to support conceptual creativity with quantitative practicality*

Eligible Students

- *All secondary school students*

Design thinking

- *Ability to use language as a tool*
- *Self-governing practicality*



Sources: Project Phoenix, 1989; KORE Computer, 1990. Institute of Design, IIT.

Design for Education

Thoughts for Next Steps: *Primary/Middle School Level*

Integrated theme projects

Content supported by design

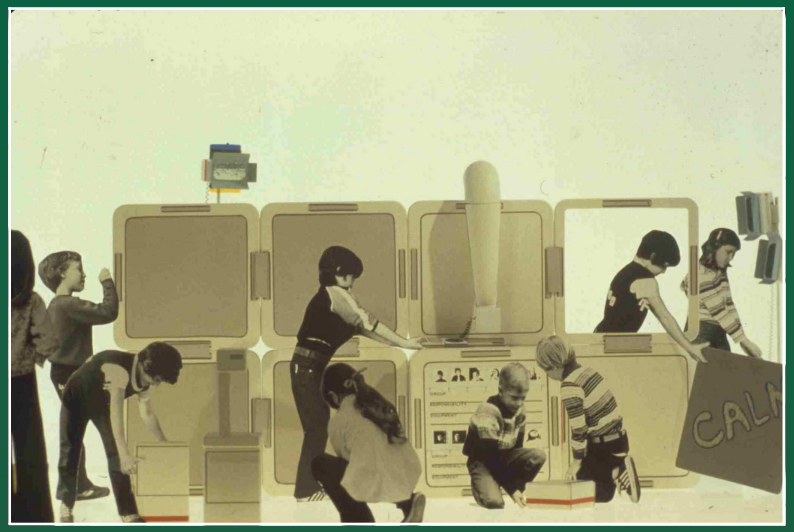
- *Teams with goals to visualize*
- *Opportunities for invention through representation and presentation*

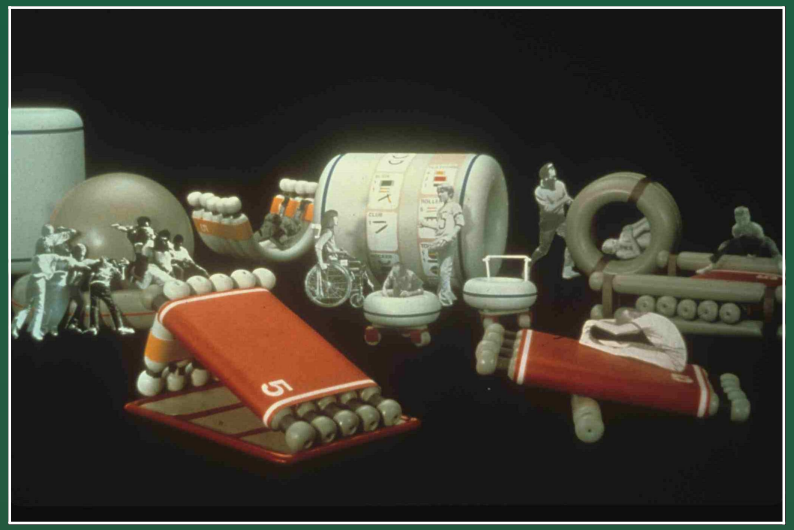
Eligible Students

- *Students in traditional subject courses: English, mathematics, science, social studies, etc.*

Design thinking

- *Ability to visualize*
- *Affinity for teamwork*





Source: Sensory Workshop; 1979. Playscape, 1979. Institute of Design, IIT.

Design for Education

Thoughts for Next Steps: *Primary School Level*

Learning to see and hear

Critical consideration of the sensory environment

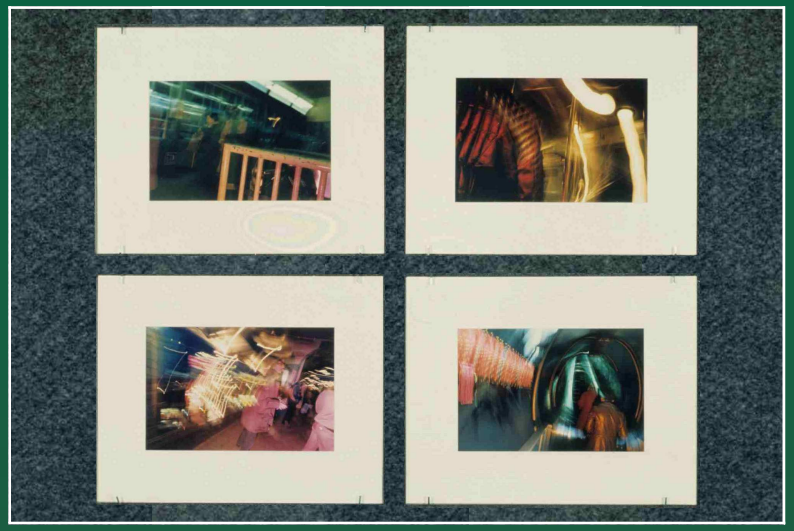
- *Sights and sounds placed in focus*
- *Digital photography as a framing tool*
- *Cell phone technology for sensory exploration*

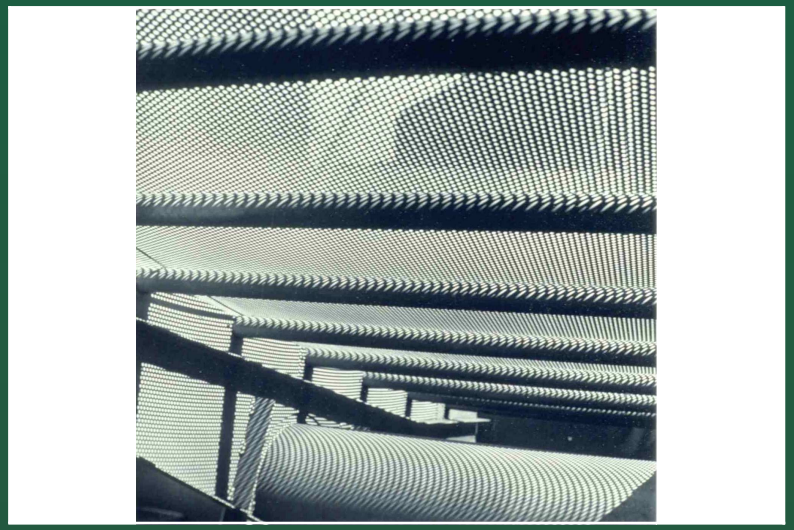
Eligible Students

- *Students in traditional art classes*

Design thinking

- *Sensitivity*
- *Visual mental and motor skills*





Sources: Institute of Design, IIT.

Action

We need to act. The problems will not wait.

Educators have responsibility

Leaders

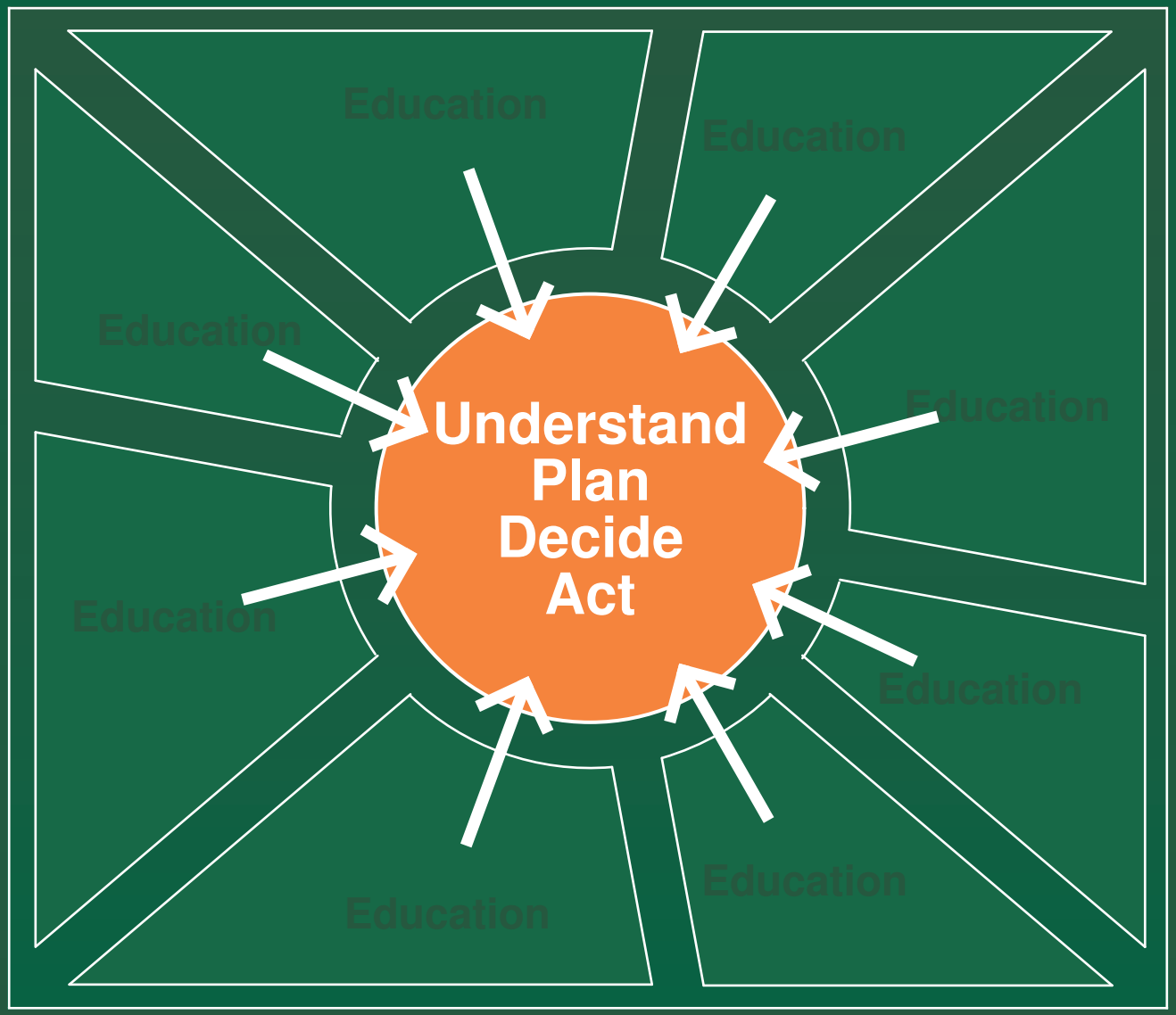
- *Leaders need more and better advice*

Citizens

- *Citizens need to* **see** *more critically,* **act** *more effectively*

Educators

- **Design** *needs better* **education**
- **Education** *needs better* **design**



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