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# Sustaining Sustainable Design through

# Systemic Thinking

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# systemic thinking

## as a key tool to develop sustainable design

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level 3: **systemic thinking**

level 2: **systems thinking**

level 1: **systematic thinking**

# sustainable design

nonlinear

interactions

hidden costs

emergent results

dilemmas, trade-offs

# background experiences

1. multidisciplinary studio courses
2. design studio beyond products
3. sustainable innovation seminar

# assessment framework

*"The pattern of consumption of oil as a main source o energy, is unsustainable in the long-term... A sustainable decision consists on selecting a path to substitute finite energy sources by renewable sources"*

# 72 student respondents

47% industrial designers and
53% electronic engineers

All < 25 years old

36.8 % systemic thinking
(previous experiences?)

54.4 % systems thinking

8.7% systematic thinking
(male, engineering)

**Creation**

"we all should consider the users and the society at large, beyond the technical issues"
"within a multidisciplinary team, the sky is the limit"
"I'd suggest that our curricula is updated to include this type of pressing problems"

**Simulation**

"we should aim to simulate new scenarios that would emerge with new energy sources"
"energy sources should suit the climate factors of each country including their natural resources"
"one should be careful that future consequences of these solutions do not turn into subsequent problems"

**Explanation**

"solutions are available, we just have not implemented them due to insufficient infrastructure and knowledge"
"surely there are cheaper and more expensive solutions, we must compromise"
"energy sources should be compatible with our lifestyle"

**Evaluation**

"we should apply different energy sources depending on the context"
"we can select a specific solution depending where we live and what we will use the energy for"
"the best solution will be a combination of different solutions based on their main advantages"

**Analysis**

"it is fundamental to analyze the basis of the problem"
"we should identify the alternative that is more simple and easier to implement"
"specifically analyze all relationships between issues at hand"

**Understand**

"we need to understand how all energy sources work and how we could improve them"
"comprehend pros and cons of all energy sources"
"we should go beyond analyzing the problem and should investigate and propose solutions and strategies"

**Recognition**

"consider cost-benefit of all possible implications"
"the best solution would be found after considering all advantages and disadvantages"
"take into account all possibilities in order to optimize the solution"

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| Systemic thinking | Educational goals<br>A systemic thinker at this level should: | Types of activities |
|---|---|---|
| Recognition | - Acknowledge system interactions<br>- Consider the role and importance of parts<br>- Recognize system composition (structure) | Analyze system by means of mind-mapping.<br>Define the list of components of a mockup or a prototype.<br>Elaborate a mock-up or a prototype.<br>Elaborate a story board and a use-case diagram.<br>Analyze features from a social perspective.<br>Elaborate a conceptual map (stakeholders and interactions) |
| Understand | - Understand system behavior<br>- Aim to explore causal relationships<br>- Recognize system cycles and levels | Elaborate a use-case diagram.<br>Understand the first prototype as the first generation of the system<br>Recognize how emergence affects behavior |
| Analysis | - Break apart causal chains<br>- Define functional roles in the system<br>- Construe and prioritize opportunities | Make a decision about the main functionality to be developed i the prototype.<br>Conduct causal and functional analysis |
| Evaluation | - Identify units of analysis at different levels<br>- Diagnose trade-offs<br>- Establish contextual (situational) criteria | Specify from a technological point of view.<br>Life-cycle analysis<br>Quality Function Deployment |
| Explanation | - Advance new interpretations<br>- Apply conceptual models and principles<br>- Revise existing generalizations | Make and analyze the state of the art in three dimensions: benchmarking, patents and scientific articles.<br>Generate and explain analogies |
| Simulation | - Visualize n-order effects and relationships<br>- Build and test models<br>- Validate assumptions | Present the mock-up, prototype, journal and posters to a wide- class of people in fairs.<br>Design and conduct experiments |
| Creation | - Generate creative interventions<br>- Adopt a holistic worldview<br>- Turn variables into constants and vice-versa | Elaborate presentations and documents (articles, reports, etc.)<br>Interpret stakeholders' opinions<br>Exploration and exploitation of design spaces |

# "systemic reflection in action"

to support the meta-reflection that is necessary t
move across the different levels of thinking

# ongoing work

sustainable innovation course for all engineering degrees: fall semester '09

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