AHRB/EPSRC Designing for the 21st Century Research Cluster: Embracing Complexity in Design (ECiD)

Hierarchical Structure and Multilevel Systems in Design Tutorial
15 June 2005, Room 102, Statistical Science Department, UCL

Co-ordinator: Jeff Johnson, The Open University
Participants: Katerina Alexiou, UCL
Labi Ariyo, Cambridge University
Chris Bell, Cambridge University
Claudia Eckert, Cambridge University
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David Wynn, Cambridge University
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The tutorial on Multilevel (ML) Systems delivered by Jeff Johnson was divided in three parts (1) Order, equivalence, relations, trees, lattices, and diagrams, (2) Logic and Meaning in Hierarchical Set Definition and (3) Hierarchical and heterarchical multilevel structure in design. The tutorial included a short presentation by Labi Ariyo on "Using hierarchies to support product change impact analysis", and the projection of a videotaped discussion with David Lane. The meeting generated a lot of discussions about the strengths and weaknesses of using ML structures and representations as well as about potential future research directions.

The discussion took off with a question from Jeff directed to the participants on why they thought ML systems were important and why they were interested in them. Here are some the replies

- To design ML logistic systems (George)
- To represent the hierarchical structure of the design process (David)
- To draw boundaries, decompose the design product to facilitate impact analysis (Labi)
- To exemplify the different levels of analysis needed (Chris)
- To cope with complexity (Rene)
- To understand static and dynamic aspects of complex systems such as traffic (Alec)
- To characterise/model design (Katerina)
- To develop a design theory of complex systems (Theodore)
- To manage enormously big structures (pragmatic reason) and to investigate human cognitive aspects of design (theoretical reason) (Claudia)
- To organise huge amount of data (Joan)
- To organise the design team to fit a specific design task (Shengfeng)

One of the main issues immediately highlighted was that there is a lot of confusion about ML systems: hierarchical structures mean different things for different people; are interpreted in different ways according to different purposes; and it is difficult to come up

with a unified way to deal with them. In general, hierarchies can be defined in two rather complementary ways: as inclusion of sub-subsystems, or as order of sub-systems. In the former case, hierarchy implies a decision process that decides if a given structure is a member of a system or not. In the later, hierarchy implies the more general concept of ordered structures. In the meeting the meaning of transitivity was questioned without however any specific conclusion. From the discussion three different types of hierarchies were also recognized: hierarchies of construction; hierarchies of control; and hierarchies of description (cognitive).

Although there was no disagreement on the importance of ML representations, there were various concerns expressed about our interpretations and the purposes we use them for. For example, various questions were discussed throughout the meeting such as: are hierarchical structures really out there or are they our invention, how does the chosen ML representation bias the final product/design, do all design practices (e.g. art) fall into the ML “paradigm”, do ML systems and hierarchies offer a theory for complex systems design, etc.

The final part of the tutorial included a review of the participants’ insights from the day and an explicit effort to draw different views together to identify research questions for ML systems and future directions. These were:

- ML systems are useful in analysis. Also interesting to investigate how does simulation-based design work (Chris)
- ML systems useful to do descriptions, but clarification/consensus is needed (Labi)
- How do you define levels/different perspectives? (Rene)
- Use to represent multiplicity (David)
- Investigate how people reason about ML systems and also get an understanding about causality, how things influence each other (Claudia)
- Explore the problem of subjectivity, how to build the representation (Joan)
- Hierarchical structures may help link different experiences/views of complexity in design in a specific way, allows to talk about fundamental questions such as abstraction-instantiation or grouping-independency, and offers a framework to investigate emergence (Katerina)
- Need to investigate the problem of constructing ML representations and making the transition between different levels (Theodore)
- ML representations are useful in that are empirically grounded, they are theoretically rigorous and encourage simulations (Jeff)

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