Measuring Complexity in a Design Environment

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Why Measure Complexity

- Decisions made early in the design process often fail to deliver expected outputs
- Costly changes and rework
- Lack of understanding of complexity
- Ability to measure complexity could provide better understanding of a project and help reduce it

Overview

- Report on the findings of 3 separate research projects carried out by the ECiD Scottish sub-cluster
  - Complexity within design projects
  - Complexity within design teams
  - Design complexity within a CAD environment
- Overview, methodology and findings
- Generic lessons and findings

A Framework for Measuring Complexity of Design Projects

Average cost overuns
97 – 151%

Average schedule overuns
41-256%

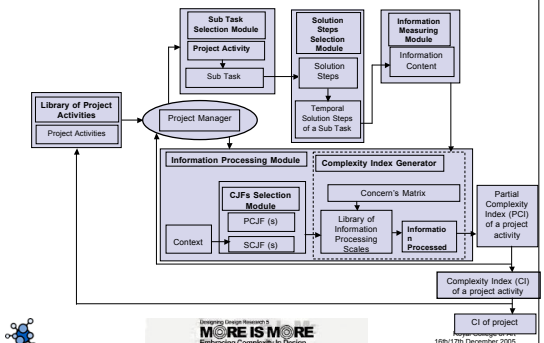
Lack of understanding of complexity leads to poor planning and management

A Framework for Measuring Design Complexity

- Tool to help Project Manager identify the manifestation of complexity within a project process
- Plan resources in order to minimise its impact
- Generating a CI is an interactive process between project manager and framework
- Subjective and based on the experience of the project manager

A Framework for Measuring Design Complexity

- Generates a Complexity Index (CI) and Partial Complexity Indices for project activities
- Development of Shannon's theory of information- equation on entropy
- Complexity Generating Factors (CGF's)are taken in to account as causes of complexity



A Framework for Measuring Complexity of Design Projects

- Primarily developed to support engineering design projects – but felt to have general application in Project Management
- Validated well against real scenario's in case studies
- Time consuming, many iterations
- Subjective (purposeful), complexity related to the subjectivity of the observer

Design Complexity Map

- Overall aim to optimise design performance and productivity
- Identify the factors and issues influencing and contributing to complexity in design teams
- Not intended to identify a "numeric" measure of complexity

Design Complexity Map

Main factors are described as:

- The artefact being designed
- The design activity itself
- The actors involved
- The decision making process
- The considerations impinging on design
- Knowledge and sources used and generated

Measuring Complexity in a CAD Environment

- An abundance of literature available on complexity – relatively little relevant to CAD
- CAD complexity is dependant upon two key factors:
  - Design Complexity: appearance of the object being modelled
  - CAD Complexity: the actual CAD embodiment of the design

Sources of CAD Complexity

- CAD data – information content of the CAD model
- CAD Structure – associated with the models file organisation
- Application Software – associated with application software functionality

CAD Complexity - Experiment

- Seven individuals
- CAD models of four buildings
- Data extracted and compared from resulting 28 CAD models
- Measurements taken on a number of variables I.e. layers, colour styles, file size, number of objects etc
- Ratios of these values provided a crude metric of CAD complexity

Complexity in a CAD Environment

- Ability to measure CAD complexity at the beginning of a project offers the following benefits:
  - Greater understanding of CAD organisation during project planning
  - Deeper understanding of CAD model organisation
  - Accurate matching project complexity to knowledge and skills
  - Control modulation of complexity throughout a project

Summary & Conclusions

- Three methods for evaluating and measuring complexity in design environments are presented
- Common themes:
  - Factors causing complexity
  - Project Planning
  - Match resources
  - Maximise or improve performance

Summary & Conclusions

- Complexity Generating Factors v's Design Complexity Map
- Application of Shannon's theory in CAD environment \
- Allow direct comparison of accuracy of measures

Thank you