Can IT Enhance Creativity?

or

Can Creativity Enhance IT?

Defining a CreativeIT Research Program

Mary Lou Maher
Program Director, NSF
Professor of Design Computing, University of Sydney
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Keynote Talk, DCC08

Outline

- ***Definitions:***
  - ***What is CreativeIT?***
  - ***What is creativity?***
- *Sampling of CreativeIT projects*
- *The CreativeIT program at NSF*
- *Details of Creative IT projects*
- *CreativeIT Research*

CreativeIT Research

***New theoretical models**: computational and cognitive models of creativity in the context of specific problems and solutions.*

***New modes of research**: understanding the roles of creative processes or creative professionals in research in computing, for example, including artists in research groups.*

***Innovative educational approaches**: new computational learning environments that reward creative thinking.*

***Creativity enhancing tools**: computational systems that support and enhance creativity in problem finding as well as problem solving.*

What is Creativity?

- *"popular" definition:*
  - *the use of imagination or original ideas esp in the production of artistic work. (Wikipedia)*
  - *is a mental process involving the generation of new ideas or concepts, or new associations of the creative mind between existing ideas or concepts. (Dictionary)*
- *creative person, creative artifact, creative process, ...*
- *"operational" definition for research purposes:*
  - ***novel***
  - ***useful***
  - ***unexpected***

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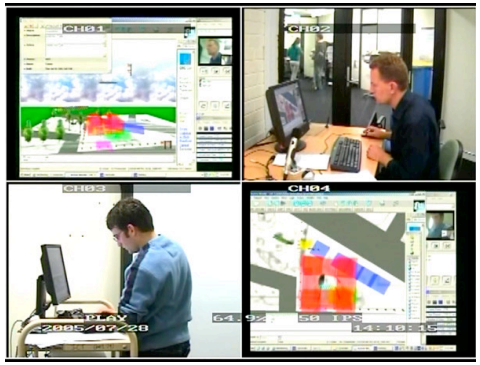
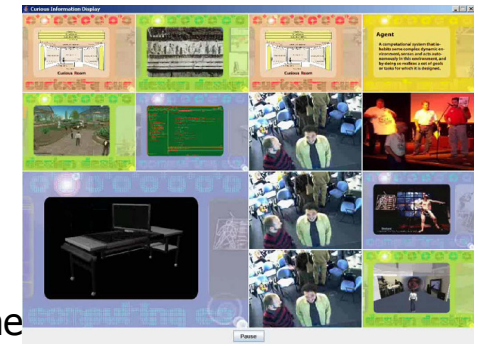
A study of the impact of tangible Interfaces to 3D digital models shows that people produce more exploratory modifications to the design model and experience more unexpected discoveries.

Mary Lou Maher, Yohann Daruwala,
Mi Jeong Kim
Digital Workbench 2006

Tangible Interfaces for Creative Thinking

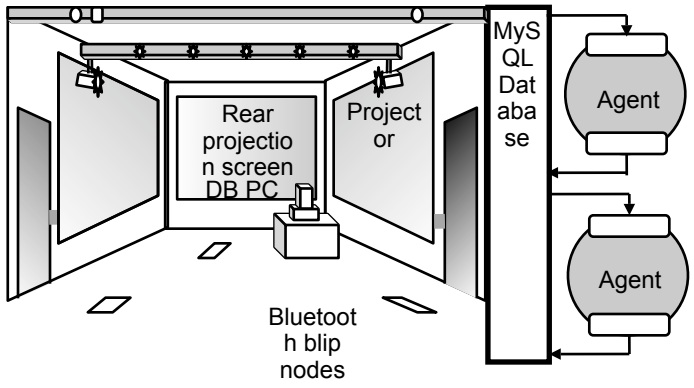


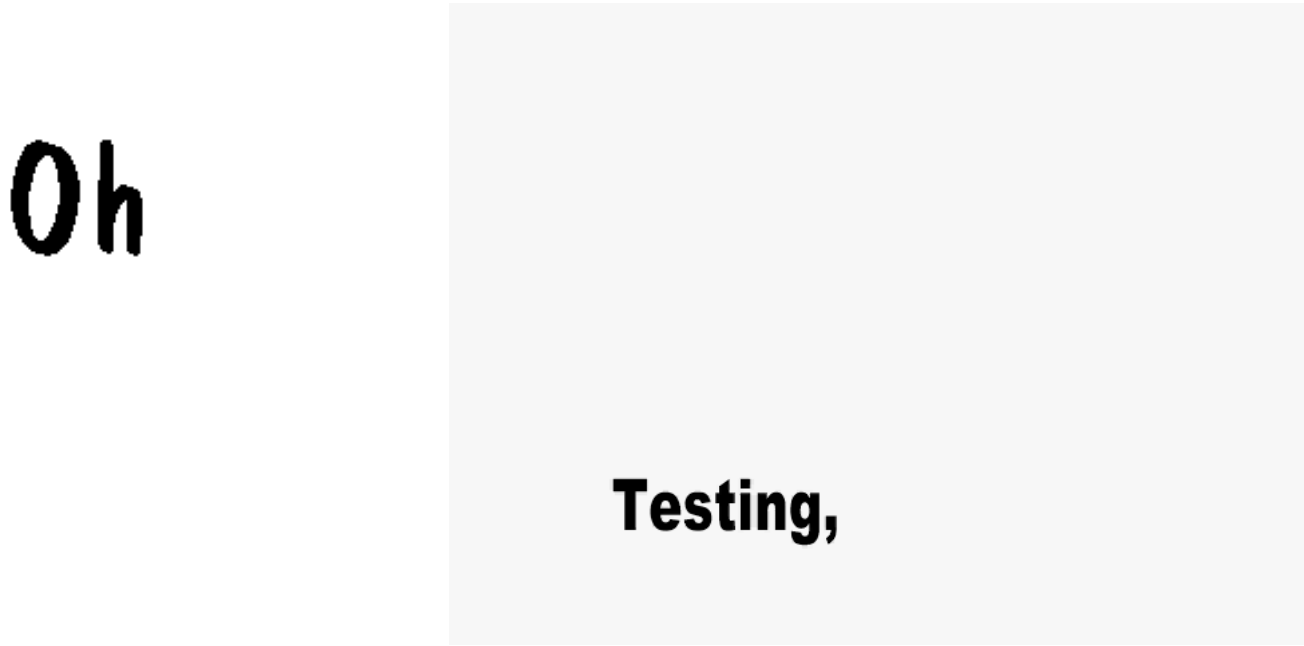
A computational model of curiosity coupled with a reinforcement learning algorithm is motivated to learn to change the display to attract people to read the information display.



Mary Lou Mahe
Kathryn Merrick
Curious Information Display 2006

Computational Creativity





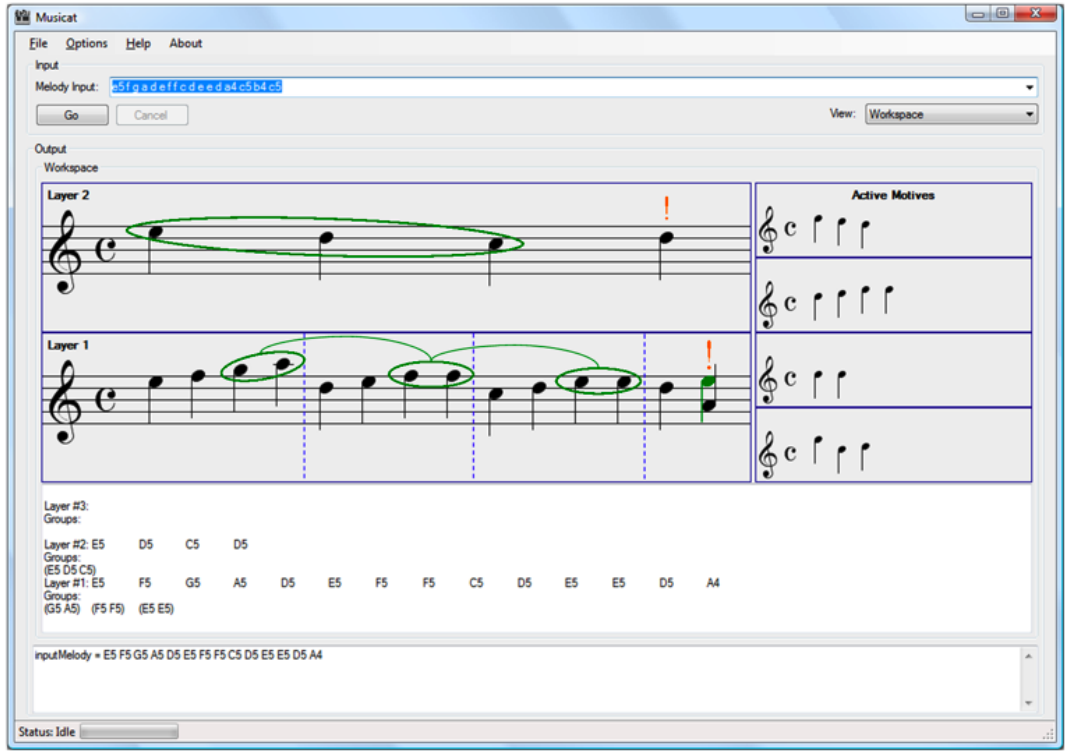
Jodi Forlizzi
Scott E. Hudson
Soojin Jun
Joonhwan Lee
Carnegie Mellon University, 2002

Kinetic Typography

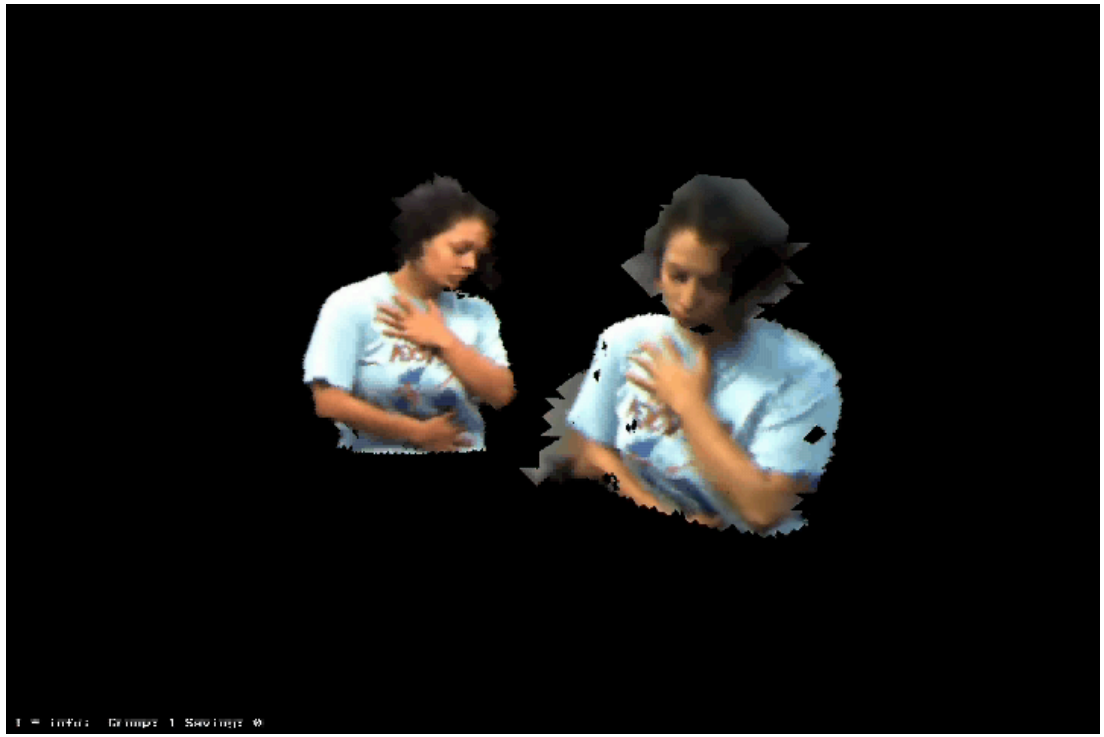
Rethinking Text Communication : The combination of text and movement extends expression to enhance emotive content. This project considers tools that make it easier to create kinetic typography and to **enhance the creativity of the author**.

Musicat

Eric Nichols
Douglas Hofstadter
Indiana University, 2008



Drawing from the experience with CopyCat and knowledge of music composition, this project develops a **computational model of creativity** based on expectation and surprise. The input music here is a slightly varied version of the opening melody of Stückchen, from Schumann's Kinderszenen, Op. 15. cut off to show a point of mild surprise in the music; Staff 2 is generated by the system and shows some important larger-scale structure of the melody. The green note at the right of Staff 2 shows what Musicat expected to "hear" next, but the black note below shows the note actually played.



Ruzena Bajcsy
U of California Berkeley
Klara Nahrstedt
U Illinois Urbana Champagne

Tele-immersive Dance

Remotely located dancers aware of their partners presence through 3D capture and reconstruction. By capturing their movements as a Laban Movement Graph, we can better understand novelty, value, and expectation. This study shows the **impact of different digital conditions on creative dance**.

Decoding the Human Conducting Gesture

Roger Dannenberg
Dan Siewiorek
CMU

Daniel Meyer
Assistant Conductor,
Pittsburgh Symphony

Daniel Meyer, assistant conductor of the Pittsburgh Symphony, recording data with the eWatch, a wearable computer with multiple sensors. Conducting gestures communicate style, emotion, and phrasing. This project develops a system that can recognize gestures from sensor data for a better understanding of how affective communication can be recognized and to produce a model of human conducting.

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NSF CreativeIT Program

Synergy Between Creativity and IT

Focus on research that improves our understanding of creativity while producing simultaneous advances in computer science and information technologies with digital arts, cognitive science, engineering design, and physical and life science.

CreativeIT: Art and Science?

- *Artists and Scientists – **Similarities***
  - *Exploration of the unknown*
  - *Experimentation*
  - *Observation*
  - *Openness*
  - *Analysis*
  - *Process of discovery*

- *Artists and Scientists – **Differences***
  - *Methodology*

Goals of CreativeIT

- *Understand creativity as cognitive and computational processes*
- *Understand information technology as a means for enhancing human creative thinking and vice versa*
- *Understand how design (creative) thinking develops new products, methods, organizations in the context of a perceived need or problem*

Links with other NSF Programs

- *International Office*
- *SBIR/SBTT - Errol Arkilic*
- *CPATH - Anita La Salle*
- *Science of Design - Alan Hevner*
- *Engineering Design - Judy Vance*
- *Cyberinfrastructure - Diana Rhoten*
- *Behavior and Cognitive Science - Betty Tuller*
- *Science of Innovation - Julia Lane*

CreativeIT Research Areas

Understanding Creative Cognition and Computation. *The development of new models of cognition and computation that explain or simulate creativity.*

Creativity to Stimulate Breakthroughs in Science and Engineering. *Understanding the role and performance of artists in developing new technologies, discovering new patterns in information, and in finding new ways of seeing, knowing, and doing computer and information science and engineering.*

Educational Approaches that Encourage Creativity. *Approaches to teaching that encourage creativity: multi-disciplinary teaching and learning, design studio teaching, and open-ended problem-based learning.*

Su ing Creativity with Information Technology. *Develops new software and use faces to support users in being more creative and evaluates their performance.*

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Examples of CreativeIT Research Projects

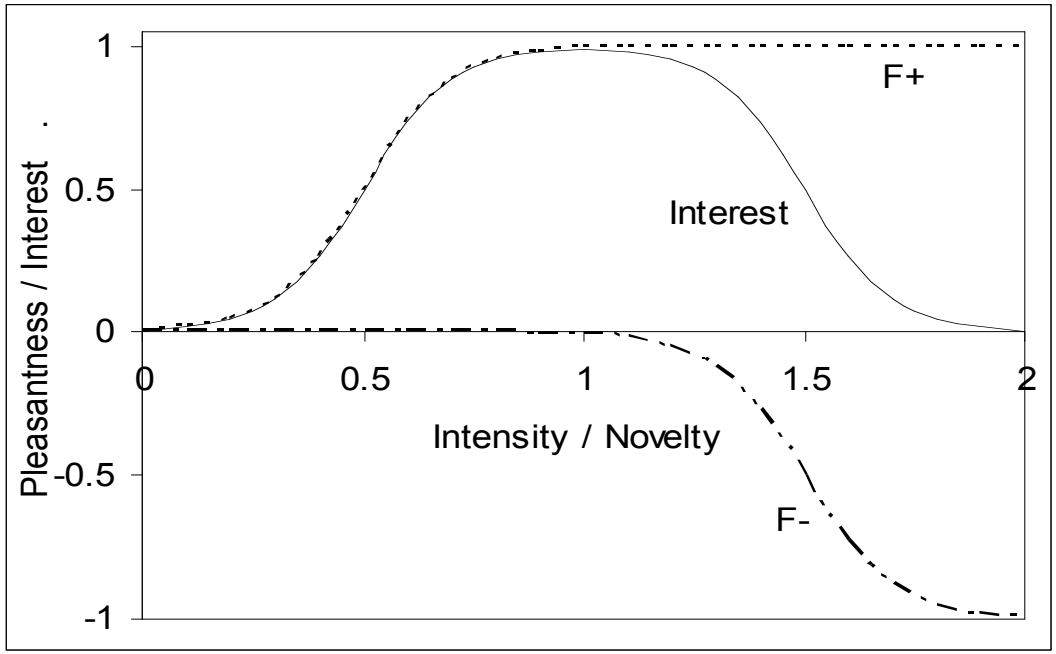
Computational Curiosity as a Model of Creativity

Impact of Tangible Interfaces on Creative Design

Curiosity as a Computational Model of Creativity

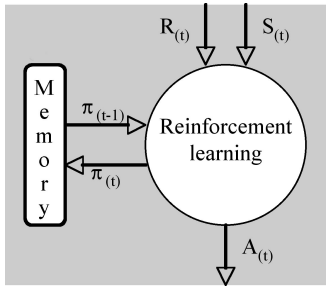
- A model for automatically focussing attention on novel, useful events.
- A model that develops a response based on an individual agent's experiences.
- A model for directing search or learning without specifying specific tasks.

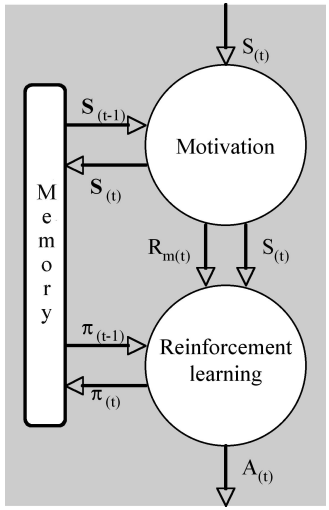
Curiosity, Novelty, and Interest to Focus Attention



The Wundt curve is the difference between positive and negative feedback functions

Curiosity to Focus Motivated Reinforcement Learning





Curiosity as a Computational Model

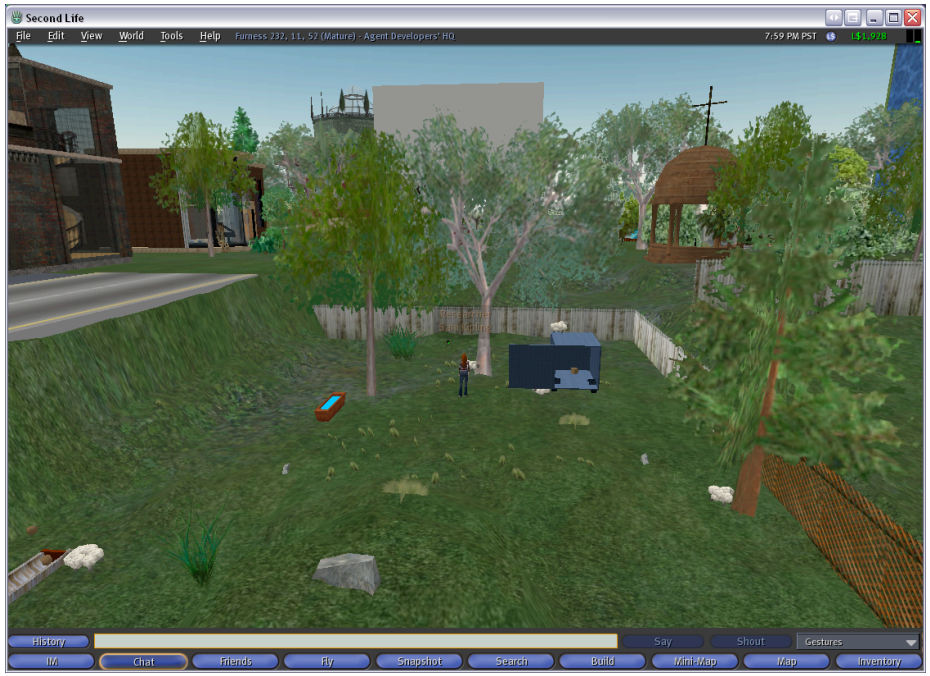
- All sensed states of the world are stored in a Self Organizing Map to determine novelty
- A new sensed state is novel if it is similar but different
- An state is interesting if it has occurred before but not too many times, using the Wundt curve
- Interesting states are rewarded when the reinforcement learning algortihm learns to repeat that state

Curious Non-Player Characters in Online Games

Can learn tasks by trying to repeat an interesting event

Curious Sheep in Second Life

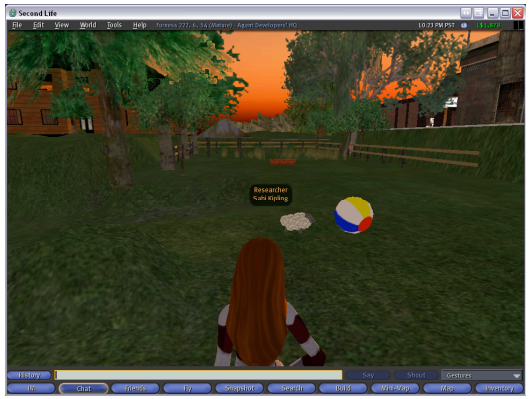
Sheep respond to new objects placed in the world by humans



Different Challenges for the Sheep

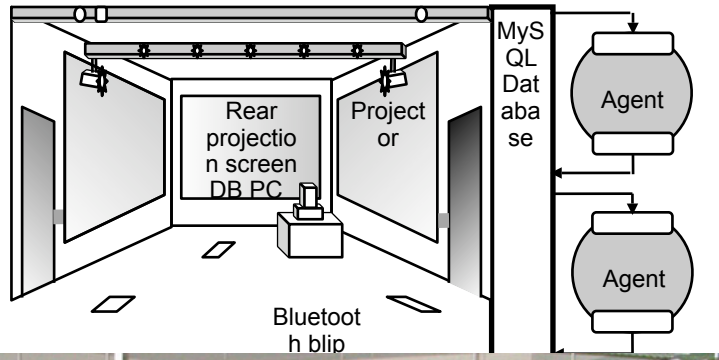
Food chute

Ball to kick



Changing walls

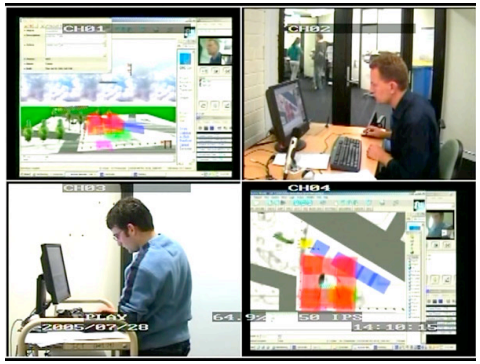
Curious Information Display

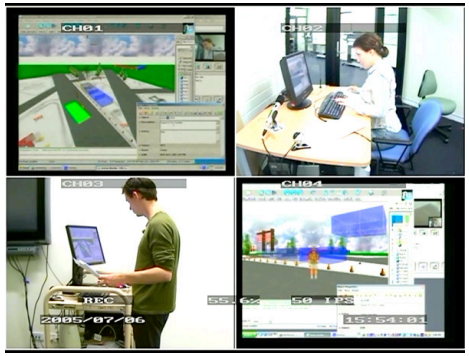


Role of Curiosity in Computational Creativity

- A model for automatically focussing attention on novel, interesting events.
- A model that responds to an individual's experiences.
- A model for directing search or learning without specifying specific tasks.

Enhancing Human Creativity
Studying Tangible Interfaces to Digital Models





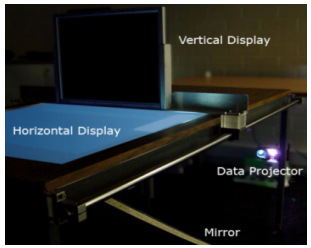
Assumptions and Questions

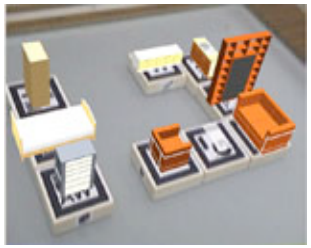
TUIs allow digital models to be easily and rapidly manipulated because of the natural interaction afforded by the physical artifacts.

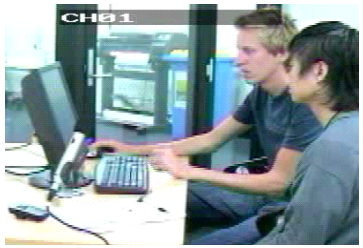
Does physical interaction with digital models change and possibly improve a designer's spatial cognition in a design task?

Does tangible interaction enhance creativity in 3D design tasks?

Experiments: TUIs vs. GUIs







	TUI session	GUI session
Interface	3D blocks	Mouse and keyboard
Hardware	Tabletop system	Desktop system
Display space	Vertical LCD screen/Horizontal table	Vertical LCD screen/ Vertical LCD screen
Application	ARToolKit	ArchiCAD
Training/ Design	5-10 mins/ 20 mins	5-10 mins/ 20 mins
Participant	Individual 2nd or 3rd architecture student	
Design Tasks	Home office or Design office renovation	

Protocol Analysis

- **Utterance-based Segmentation**
- **Spatial cognition coding scheme**

Our coding scheme comprises 3 categories:

- Action level
- Perceptual level
- Process level

Motor Actions of User Interfaces

Action level

Our hypothesis is that interfaces with manipulable physical objects may offer more opportunity for epistemic actions and possibly reducing cognitive load.

- **Pragmatic action**: exploratory motor activity
- **Epistemic action**: performatory motor activity

Designer's Spatial Cognition

Perceptual level

Our hypothesis is that interfaces with manipulable physical objects will affect which spatial and functional qualities of the 3D model the designer will perceive.

Design is a reflective interaction between the external representation and the designers' internal cognitive model of the problem-solution processed by **perceiving** and **reasoning** about visuo-spatial information.

Creative Design Process

Process level

Our hypothesis is that interfaces with manipulable physical objects will change the design process that facilitate unexpected discoveries.

- **Problem-finding behaviour**
  - S-invention
  - Co-evolution
- **Re-representation**: multiple representations

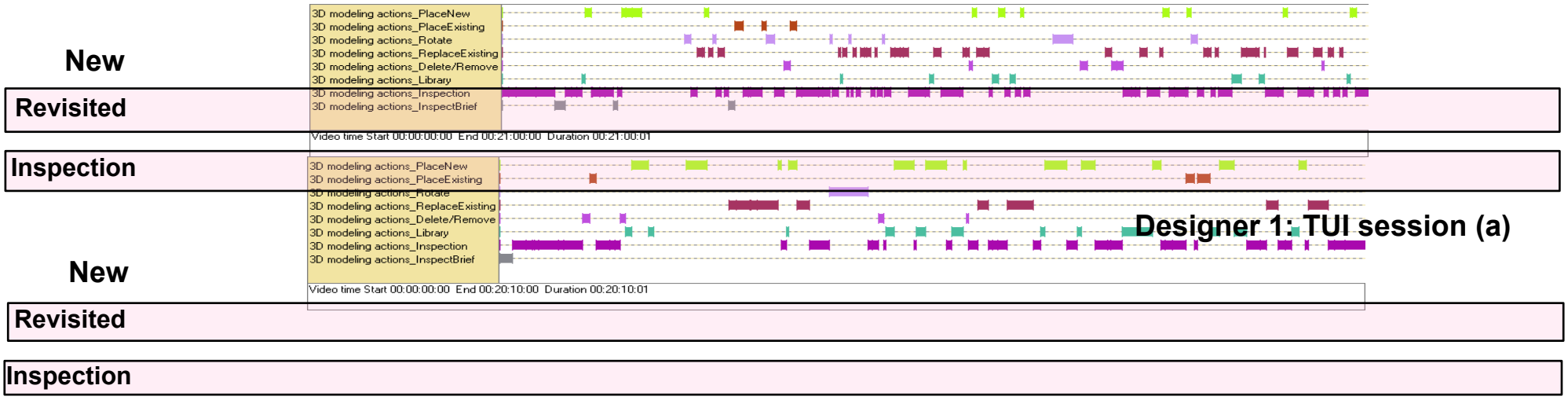
Codes for Analyzing Impact

Combined Codes	Individual Codes	Coding Categories
New	PlaceNew, PlaceExisting	**3D modelling actions**
Revisited	ReplaceExisting, Rotate	
Inspection	InspectScreen, InspectTable	
Existing	E-visual feature, E-relation, E-space, E-object	**Perceptual activities**
Creating	N-relation, N-space	
Discovery	D-visual feature, D-relation, D-space	
Object	E-visual feature, E-object, D-visual feature	
Space	E-space, N-space, D-space	
Spatial relation	E-relation, N-relation, D-relation	
S-invention	G-knowledge, G-previous, G-implicit	**Set-up goal activities**
Others	G-brief, G-repeat	

3D modeling actions

Results of Action level

- Produced more ‘movement’ 3D modelling actions.
- Produced more ‘revisited’ 3D modelling actions.
- Brought more discontinuities in the design thinking.
- Inspected 3D blocks on the horizontal table more frequently.



Perceptual activities

Results of Perceptual level

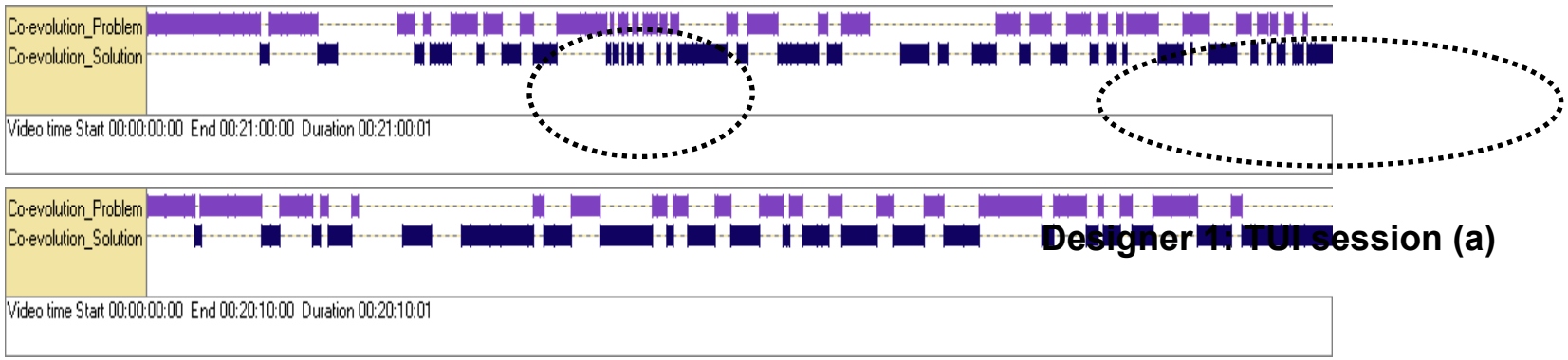
- Produced more perceptual activities.
- ‘Created and Perceived’ and ‘Discovered’ more new visuo-spatial features.
- Focused on ‘Spatial relationships’ among elements.

	Transcript (TUI)		**Transcript (**GUI)
TUI	A: It shouldn't be near the bathroom or I mean, I think it shouldn't be near the bedroom, sorry. It shouldn't have a kitchen sink. S: Yeah that's what I was thinking. Why is it next to the bed? A: It's a bit odd, and it's also just….not… normal	GUI	B: Kitchen and dining area A: Yep B: Which she does not yet have… well she has a sink [laugh] in her ba- bedroom, and then living/meeting area A: Yep… and a working area

Set-up goal activities and Co-evolution

Results of Process level

- Introduced more new functional issues as design requirements, implicitly or by the retrieval of explicit knowledge or experience.
- Produced more transitions between the ‘problem’ and ‘solution’ space.



Designer 1: TUI session (a)

Designer 1: GUI session (b)

Enhancing Human Creativity
Impact of Tangible Interfaces

Summary

The protocol analysis reveals that use of TUIs changed designers' spatial cognition, and that these changes affected the design process by increasing 'problem-finding' behaviours associated with creative design.

Future Studies

Do tangible interfaces to digital models off-load cognition when compared to standard keyboard and mouse interfaces?

Do tangible interfaces enhancing the sense of physical immersion in the design?

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Research in CreativeIT

- *Generally occurs in a specific context, although it can start with a theoretical claim*
- *Claim:*
  - *X is a creative process (in context C)*
  - *X is a research process that results from combining creativity and computing perspectives (in context C)*
  - *X is an educational approach that rewards creativity (in context C)*
  - *X will enhance human creativity (in context C)*
- *Develop, build, make X*
- *Evaluate X*
  - *perception: do people perceive the claim to be true*
  - *behavior: are people's behavior consistent with the claim*
  - *cognition: does the cognitive model match experimental results from cognitive studies*

Conclusions

- *Creativity is a highly valued process that can be incorporated into computing research.*
- *A focus on creativity can lead to new computing technologies, new modes of research, and new educational environments.*
- *Creativity is more than novelty, and includes value and surprise.*