Designing Intelligent Lighting Systems

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TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

Designing Intelligent Lighting Systems

Structure presentation:

A. Designing Intelligent Systems
   - Ambient Intelligence: interaction technology of the future
   - Interaction design challenges
   - New directions

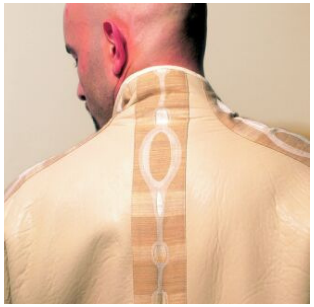
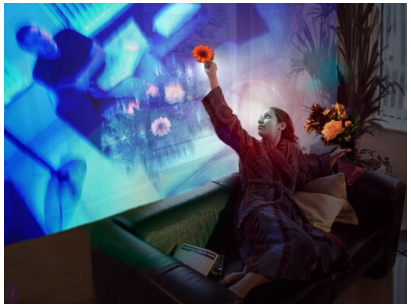
B. Designing Intelligent **Lighting** Systems
   - Buildings without switches
   - Awareness systems
   - Light as transformational agent

C. Conclusions

Designing Intelligent Lighting Systems

Ambient Intelligence: interaction technology of the future

- **Embedded Technology**: information and communication technology gets more powerful, faster and smaller and can ‘disappear’ in the environment
- **Smart Environments**: electronic environments become sensitive and responsive to the presence of people

Designing Intelligent Lighting Systems

Early design explorations: insights

- Enriched experiences – beyond utility & usability
- Design for personal experiences (not: of)
- Fit rhythms, patterns, and cycles of everyday life
- Smooth transitions from subliminal awareness (background) to direct interaction (foreground)
- Applications should be trustworthy e.g. take privacy issues into account
- People should always be in control
- Experience prototyping is crucial

Designing Intelligent Lighting Systems

Mission: creating intelligent systems, products and related services

BUSINESS (BPD)
new industrial product creation processes

DESIGN (DQI)
integration of personal, aesthetic and socio-cultural values

dept. Industrial Design

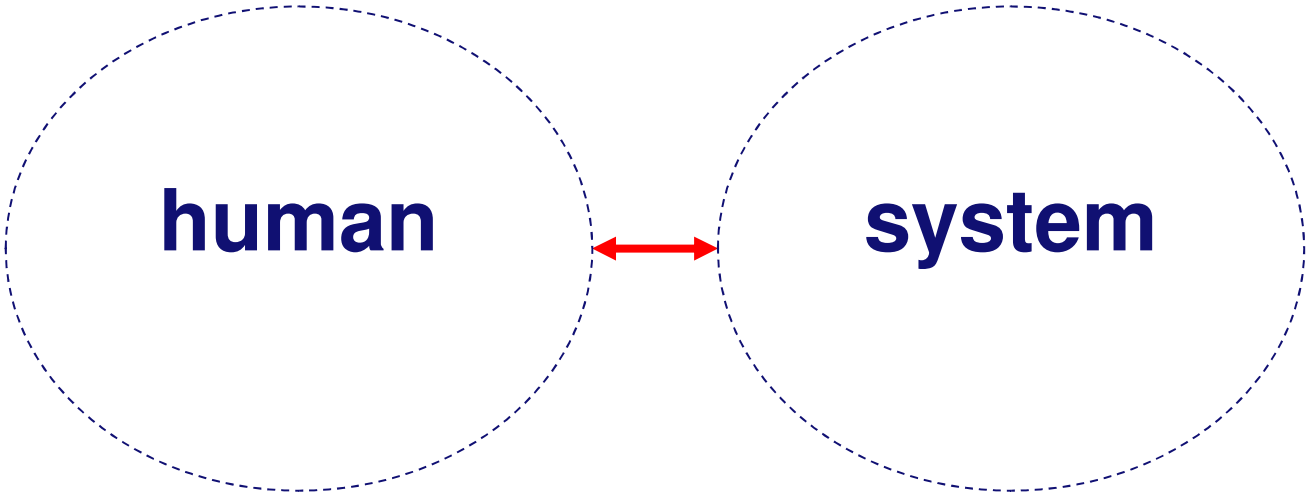
TU/e
MSc
IDE

PEOPLE (UCE)
creation and exploration of concepts for natural interaction

TECHNOLOGY (DI)
application of embedded software and communication technology

Designing Intelligent Lighting Systems

Interaction design challenges: ‘traditional’



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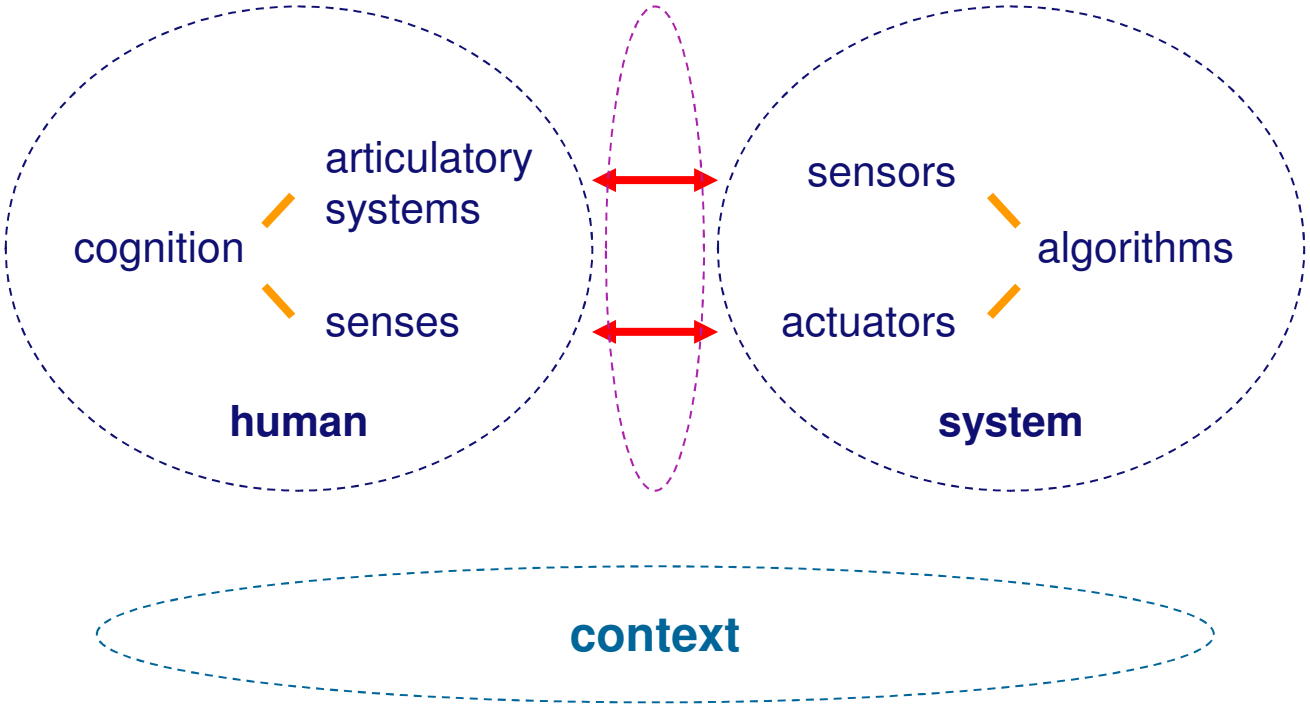
Interaction design challenges: ‘traditional’



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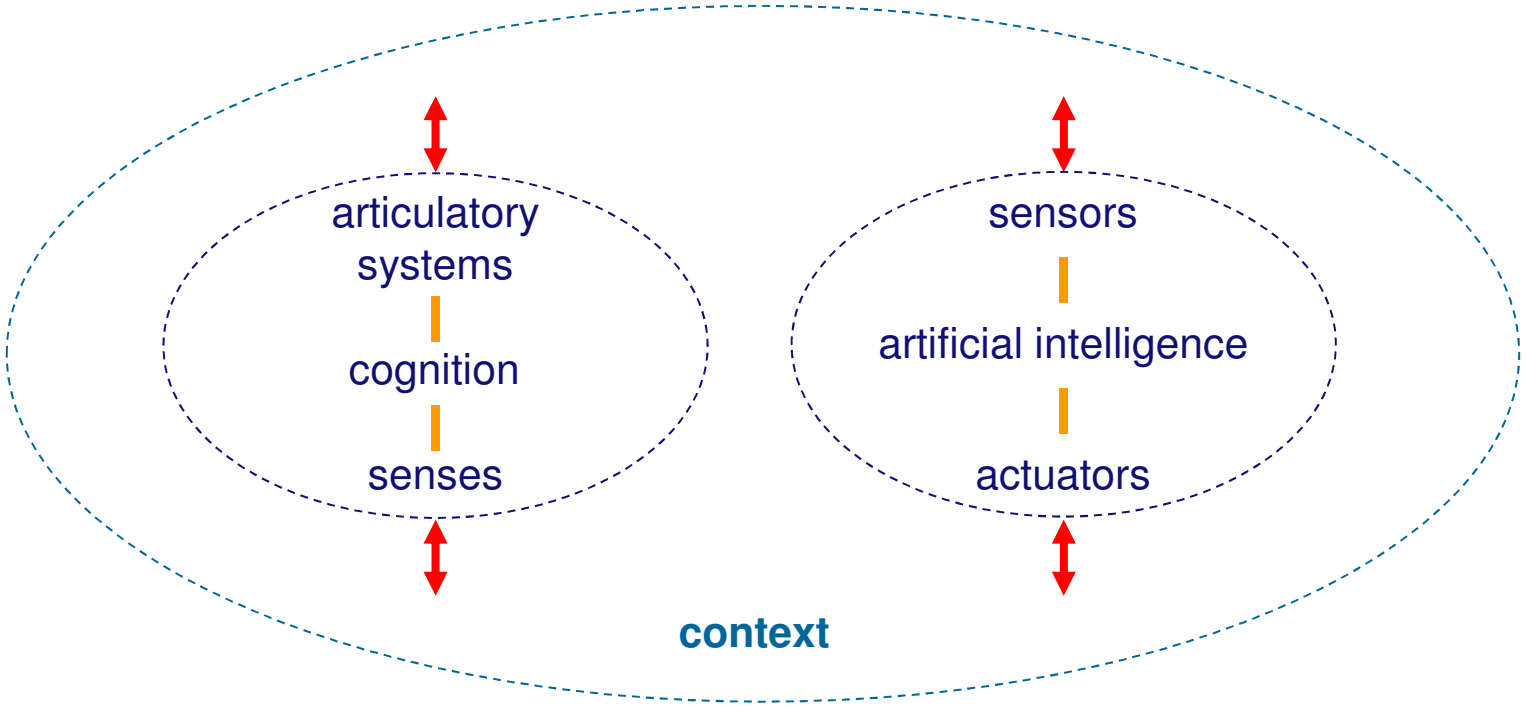
Interaction design challenges: ambient intelligence



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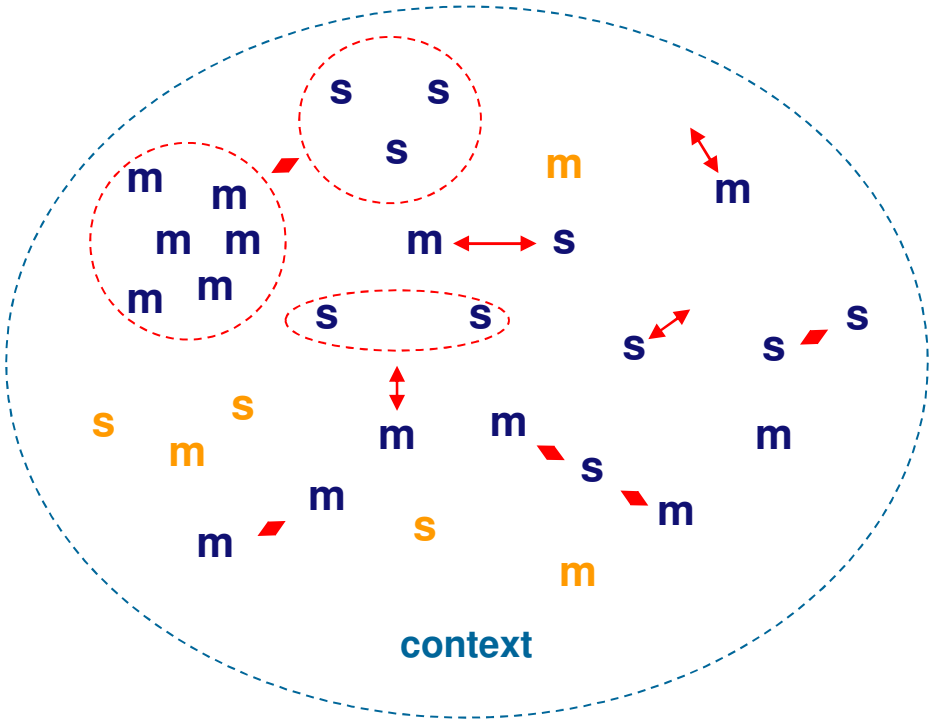
Interaction design challenges: ambient intelligence



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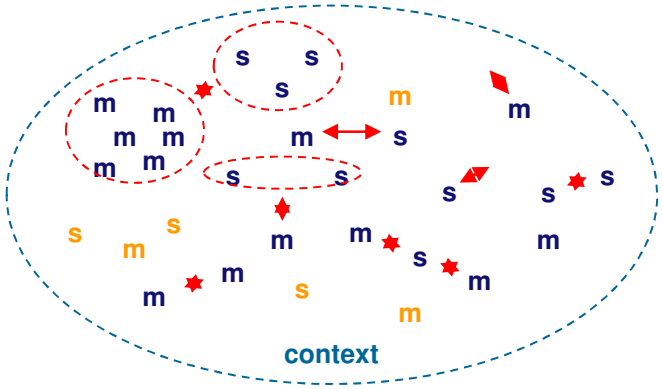
Interaction design challenges

Designers of intelligent systems should go beyond ‘form giving’;

they need to design system behavior; relationships between:

- end-users and (smart) products
- end-users and (smart) environments
- mutual products, that are part of a larger system



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New directions: **multi-modal interaction**

People perspective

- broaden bandwidth of user-system interaction
- bring naturalness to user-system interaction by capitalizing on everyday human communication skills

System perspective

- rich input from environment necessary for truly intelligent (i.e. meaningful and appropriate) behavior
- multimodal output to communicate embedded potential for possible actions

Designing Intelligent Lighting Systems

New directions: **ambient culture**

Decentralized systems

- several ‘smart’ objects linked into a network giving rise to emergent functionality
- everyday objects teaming up with people to create a desired experience

Ambient culture defines quality of people-system relationship

- communication between ‘smart’ objects and between ‘smart’ objects and people facilitates and shapes an emergent set of shared attitudes, values and goals

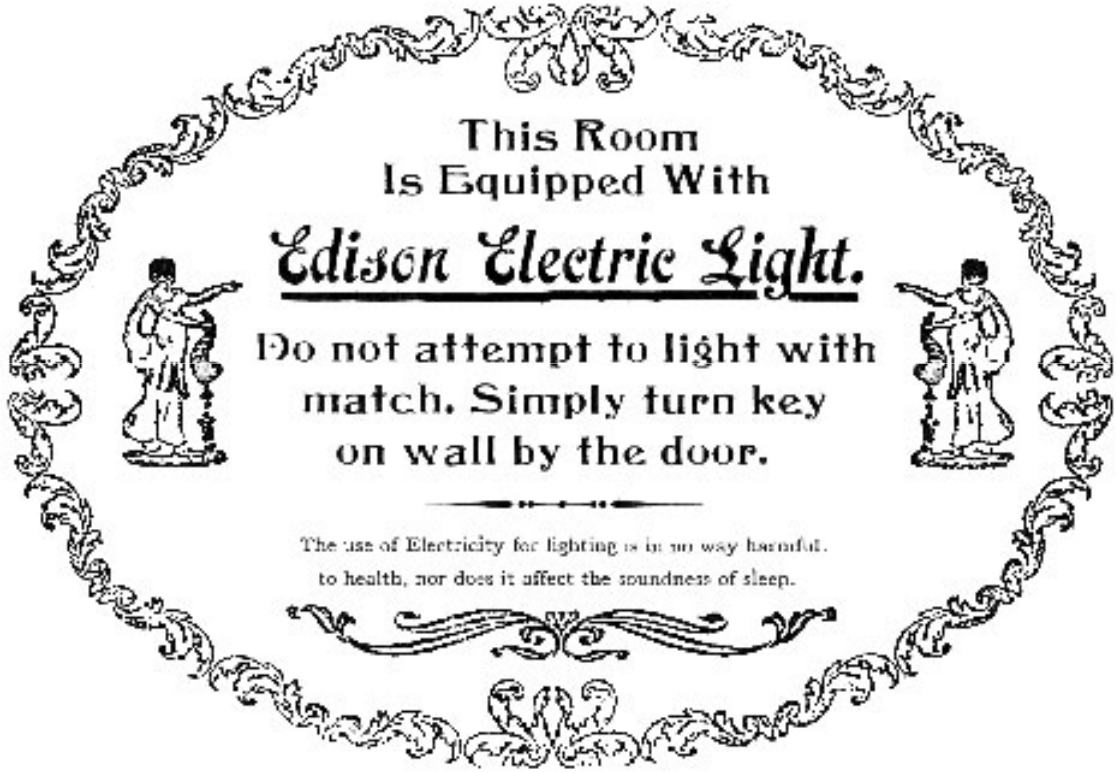
Designing Intelligent Lighting Systems

New directions: **user-centered design**

- user-centered design: match technological possibilities to people's needs, abilities and desires
- social and cultural aspects of intelligent product environments should be explicitly taken into account
- ethno-methodology: study of common-sense routines used by people to manage and organize everyday behavior
- Wizard-of-Oz-like approach to the design of decentralized systems

Design research on intelligent lighting systems

Buildings without Switches



Buildings without Switches

[TTIL: Philips; Cofely; NXP; TU/e; …]

current practice: advanced lighting system aimed to optimize performance of office workers; based on dedicated *use cases* tuned to specific individuals, groups, and/or spaces

today's reality: the lighting system is functioning sub-optimally due to

- physical changes of workspace
- changes in daily office rituals
- new use case scenarios

solutions

[*ST*]: flexible lighting system that can be re-configured and re-programmed to meet changing user needs

[*LT*]: modular, adaptive, interactive, intelligent

economic benefits: asset efficiency, productivity, human comfort, energy efficiency

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Buildings without Switches

[TTIL: Philips; Cofely; NXP; TU/e; …]

Technological challenges

- development of distributed sensor systems that can accurately map the office space
  - at the physical level: room configuration, discrimination objects and people, localize people
  - at the contextual and cognitive level: recognition of persons, what they do, and what they want

- and a concomitant modular networked ICT infra-structure that is wireless and that preferably does not use batteries

Buildings without Switches

[TTIL: Philips; Cofely; NXP; TU/e; …]

Human-system interaction challenges

(no switches ≠ no interaction)

- new interaction styles to communicate lighting needs to the system (explicit vs. implicit; mixed initiative interfaces, embodied interaction)
- end-user programming: specify new or adapt existing lighting programs
- new ethnographically-inspired research methods to identify and model human rhythms, patterns and rituals

Designing Intelligent Lighting Systems

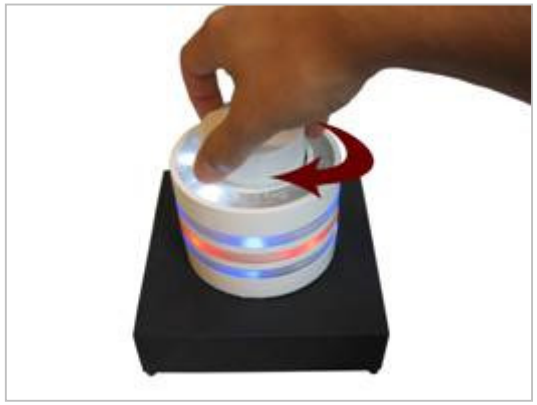
Auditory and Visual Interacton Modalities

	TIME	SPACE
SOUND	**Sound exists <u>in</u> time.** • Good for display of changing events. • Available for a limited time.	**Sound exists <u>over</u> space.** • Need not face source. • A limited number of messages can be displayed at once.
VISION	**Visual objects exist <u>over</u> time.** • Good for display of static objects. • Can be sampled over time.	**Visual objects exist <u>in</u> space.** • Must face source. • Messages can be spatially distributed.

Gaver (1989)

Awareness Systems

Awareness Systems



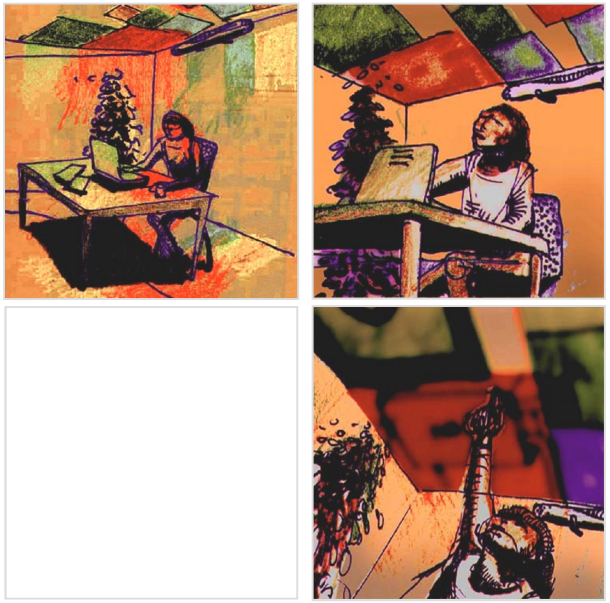
awareness:
an understanding of the status/ activities of connected other(s) or places that provides a context for your own activities and experiences

Dourish & Bellotti (1992)

privacy grounding (Romero & Markopoulos, 2008)

Awareness Systems

Calm Technology



the *periphery* is informing
without overburdening because
people can attune to information
without explicitly attending to it

Weiser & Brown (1996)

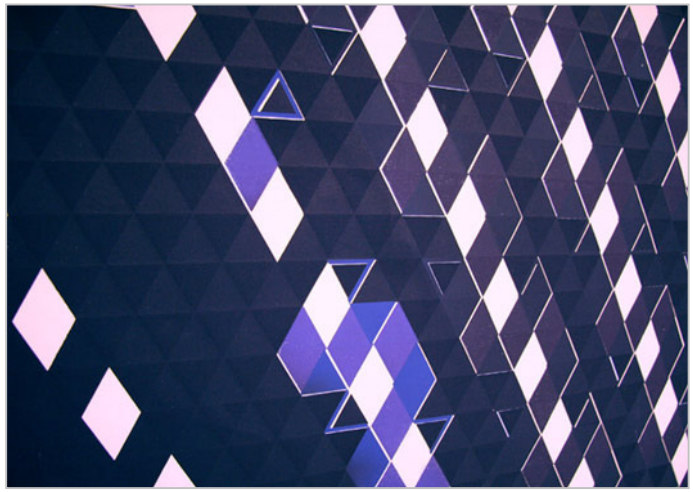
home radio (Eggen, Rozendaal & Schimmel, 2003)

Awareness Systems

Information Decoration

information decoration means seeking a balance between aesthetic and informational quality

Eggen & Van Mensvoort (2008)



wall agenda (Pieters & Van Mensvoort, 2009)

Designing Intelligent Lighting Systems

Light as Transformational Agent

lighting technologies are viewed
in terms of how they change
people's behaviors and
experiences in everyday life

Tomico, Rozendaal & Ross (2008)

Light as Transformational Agent

Magical interaction

Man's ability to control illumination is magical in itself but it is seldom experienced as such because light switches generally don not stir up imagination. I decided to redesign the mundane activity of switching on and off a light to bring out its potential to evoke wonder and surprise.

Joris van Gelder (2006)

Light as Transformational Agent

Eetmeet: changing eating patterns

An answer to the fast eating style that causes over-eating. Light guides the dinner meal towards a normal eating rhythm and a mindful eating experience.

Lissa Kooijman (2009)

Light as Transformational Agent

Aesthetics in Intelligent System Design

incorporating human values of specific people in the design process, and aiming to elicit behaviors that are compatible with these values

Philip Ross (2008)

Light as Transformational Agent

Adaptive Lighting Environments

intelligent closet: the lighting behavior adapts to the change in movements

Ross, Barakova, van der Aalst, ten Bhömer (2008)

Designing Intelligent Lighting Systems

Conclusions

- New lighting technologies and multi-disciplinary design approaches open up new opportunities for intelligent lighting systems: e.g. buildings without switches, light as information medium, light as transformational agent

- The impact of future intelligent lighting interaction styles shall be comparable to the effect that the introduction of the ‘turn-on-the-light’ interaction style had on people in the late-nineteenth century when the first electric lighting systems were installed.

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