

# GENERATING RESEARCH IDEAS

- AN EXPERIMENTAL COMPUTER SCIENCE PERSPECTIVE

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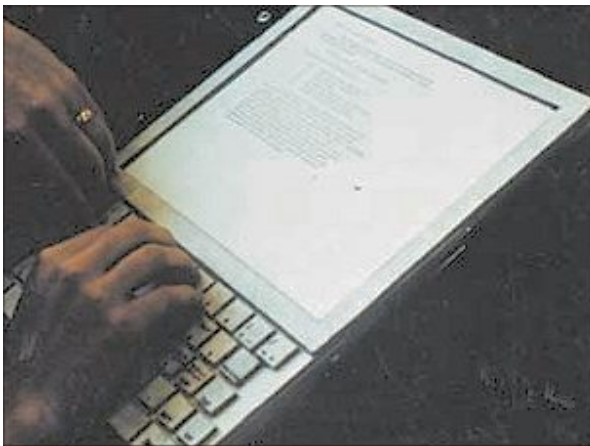
<http://cs.au.dk/research/areas/ubiquitous-computing-and-interaction/>

[www.interactivespaces.net](http://www.interactivespaces.net)

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”The best way to predict the future is to **invent** it”

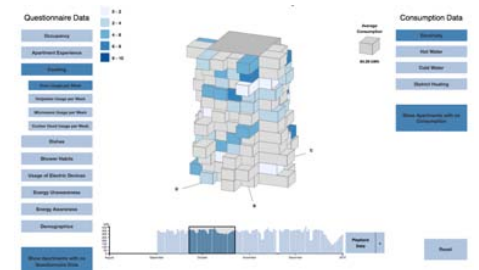
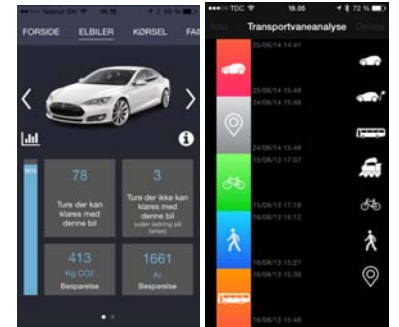
*(Alan Kay 1971, at Xerox PARC)*



KAY PROPOSED THE DYNABOOK AND  
OBJECT-ORIENTED PROGRAMMING WHILE  
COMPUTERS WERE CLOSET SIZED AND  
FORTRAN/COBOL WERE *THE* LANGUAGES

# UBI GROUP – RESEARCH TOPICS

- › Interaction Design
- › Interactive Spaces
- › Kinesthetic Interaction
- › Sensor actuator based interaction
- › Augmented Reality
- › Ubiquitous and Pervasive Computing
- › Positioning (GPS, WiFi,...)
- › Context Awareness
- › Crowd and Participatory Sensing
- › Mobile Computing
- › Peer-2-Peer computing,
- › Hypermedia, Web, and Social Media



# EXPERIMENTAL COMPUTER SCIENCE RESEARCH APPROACH

# EXPERIMENTAL COMPUTER SCIENCE

Real world challenges

State-of-the-art

Analysis



Generalizable results



Advanced State-of-the-art

Industrial deployment

Evaluation



*Some iterations*

Design



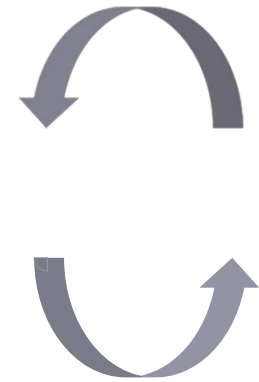
Prototype

# DEEPER LOOK AT EXPERIMENTAL APPROACH

- › Formulate the idea and expected results in terms of hypothesis and/or success criteria
  - › Investigate state of the art!!
- › Create relevance by involving real world partners
- › Early prototypes are important vehicles
- › Deploy prototypes in real world settings
  - › Evaluate by means of technical benchmarking
  - › Evaluate by means of field studies with the users
- › Conceptualize, reflect and publish

**Ideas may change in the process!**

**DEMO OR DIE!**



# RESEARCH RESULTS

- › Prototypes are only research vehicles and not the final result
  - › Some prototypes move into industrial deployments
- › Contributions are: theoretical concepts, design concepts, interaction techniques, algorithms, infrastructures, methods, software frameworks,...
- › Evaluation in lab and in real world settings
  - › Both technical benchmarking and usability evaluations
- › Publishing the results
  - › New types of interaction or system concepts (Figure 1 before abstract ;-)
  - › Evaluation needed
  - › The state-of-the-art papers are the baseline for comparison

# QUICK EXAMPLE OF CYCLE:

## ECOSENSE

Macroscopic analysis and collective sensing for  
understanding and reducing climate impact



# COLLECTIVE SENSING AND ETHNOGRAPHIC INQUIRIES IN COMMUNITY HOUSEHOLDS

- › Grundfos Dormitory as a Living Lab
- › 3000+ energy and climate sensors installed
  - › Water usage and indoor climate
  - › Inferring electricity activity based on powerline sensing
- › Qualitative analysis of inhabitant energy awareness and behavior
- › Analyzing and visualizing data
- › Interventions to stimulate green living and smart grid participation



# STATE OF ART MACROSCOPIC

- > See patterns in large networks
- > Based on InfoViz
- > Employed e.g. for energy networks

## The AffinityViz Method for Interweaved Analysis of Resource Consumption and Occupant Data in Buildings

Matthias Nielsen, Robert S. Brewer, Kaj Grønbaek

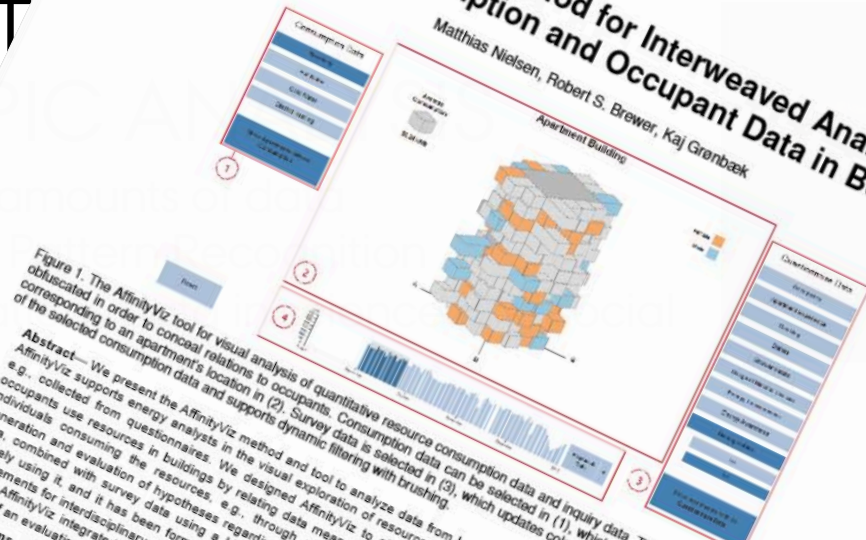


Figure 1. The AffinityViz tool for visual analysis of quantitative resource consumption data and inquiry data. The data represented has been obfuscated in order to conceal relations to occupants. Consumption data can be selected in (1), which is visualized as extruded columns corresponding to an apartment's location in (2). Survey data is selected in (3), which updates color in (2). (4) provides a temporal overview of the selected consumption data and supports dynamic filtering with brushing.

**Abstract**—We present the AffinityViz method and tool to analyze data from large buildings in an affine visualization. In particular, AffinityViz supports energy analysts in the visual exploration of resource consumption data, combined with data about occupants e.g., collected from questionnaires. We designed AffinityViz to aid energy and indoor climate analysts in understanding how occupants use resources in buildings by relating data measured by sensors and data describing the activities and habits of the individuals consuming the resources, e.g., through questionnaires or other inquiry methods. AffinityViz supports the rapid generation and evaluation of hypotheses regarding patterns and anomalies in district heating, electricity, and water consumption data, combined with survey data, and it has been formally evaluated with 10 external experts. The contributions of the paper are: 1) the design and active use of it, and 2) a detailed use case demonstrating AffinityViz's applicability for energy analysis. 4) requirements for interdisciplinary visual analysis of interweaved building consumption and occupant survey data. 3) the architecture for the AffinityViz integrated visualization. 5) a detailed use case demonstrating AffinityViz's applicability for energy analysis. 4) results of an evaluation with 10 energy management experts. Finally, we discuss the future perspectives of AffinityViz.

### INTRODUCTION

Information visualization and visual analytics possess the potential for creating new data insights in many different application domains [1]. In this paper, we investigate the domain of energy and resource consumption in buildings, and it emerges that in order for energy managers and users to understand or

shift consumption we need to include characteristics of the occupants of buildings in analysis [2, 3], which in turn requires new specialized visual analytics methods for this domain. Residential and commercial buildings consume a large portion of the world's energy (as much as 40% in the United States). Reducing building resource usage (water, electricity, heating) can reduce greenhouse gas emissions and the cost of building operations. Motivating residents to reduce their resource consumption has been one promising direction in this area. However, motivating reduction or change in the resource consumption of individuals requires not only an understanding of everyday practices of residents that result in energy consumption. Many interdisciplinary studies (including anthropologists, sociologists, designers, and computer scientists) address this challenge and use ethnographical, psychological inquiries, or other, sociological methods [4-9] to understand everyday practices and how those practices affect energy consumption. This is where novel methods like the AffinityViz method proposed in this paper (See Figure 1) are needed.

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For information on obtaining reprints of this article, please send e-mail to: rvcg@computer.org

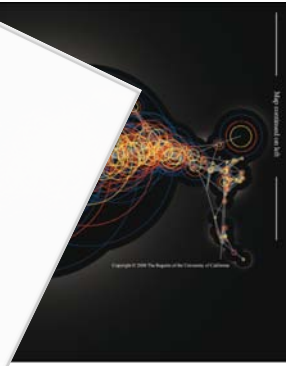


Chart:	All Elementary Events
Apply:	Color Label Size
Buckets:	Event Count
LARCENY/THEFT	6032
OTHER OFFENSES	5605
VEHICLE THEFT	4173
ASSAULT	3420
NON-CRIMINAL	3295
DRUG/NARCOTIC	2822
WARRANTS	2371
VANDALISM	1695
BURGLARY	1616
SUSPICIOUS OCC	1053
MISSING PERSON	1023
ROBBERY	808
FRAUD	791
FORGERY/COUNTERFEITIN	576
PROSTITUTION	440
WEAPON LAWS	341
TRESPASS	310
DISORDERLY CONDUCT	229
SEX OFFENSES, FORCIBLE	209
DRUNKENNESS	169
STOLEN PROPERTY	164

# GENERATING IDEAS

# MOTIVATION

- › Creating a research career in a niche with open opportunities?
- › Get the next grant?
- › Make a difference to the world?
- › Get an idea to become an entrepreneur and become rich?
- › ...

# IDEA GENERATION: DISNEY METHOD

- › Three creativity phaser from fantasy to reality
- › **1. Dreamer "Want to" Phase:**
  - › State the specific goal in positive terms
  - › Establish payoffs of the ideas
- › **2. Realistic "How to" Phase:**
  - › Ensure progress is testable through sensory experience
  - › Establish time frames and milestones for progress
  - › Make sure it can be initiated and maintained by the appropriate person or group.
- › **3. Critic "Chance to" Phase:**
  - › Define the context in which it is workable and problematic
  - › Make sure it is ecologically sound and preserves any positive products of the current way(s) of achieving the goal.
- › The three phases take place in different physical spaces

# IDEA GENERATION: SIX THINKING HATS AND MANY MORE...

## Edward de Bono

- › **White Hat:**  
With this thinking hat you focus on the data available. Look at the information you have, and see what you can learn from it. This is where you analyze past trends, and try to extrapolate from historical data.
- › **Red Hat:**  
'Wearing' the red hat, you look at problems using intuition, gut reaction, and emotion. Also try to think how other people will react emotionally. Try to understand the responses of people who do not fully know your reasoning.
- › **Black Hat:**  
Using black hat thinking, look at all the bad points of the decision. Look at it cautiously and defensively. Try to see why it might not work. This is important because it highlights the weak points in a plan. It allows you to eliminate them, alter them, or prepare contingency plans to counter them.
- › **Yellow Hat:**  
The yellow hat helps you to think positively. It is the optimistic viewpoint that helps you to see all the benefits of the decision and the value in it. Yellow Hat thinking helps you to keep going when everything looks gloomy and difficult.
- › **Green Hat:**  
The Green Hat stands for creativity. This is where you can develop creative solutions to a problem. It is a freewheeling way of thinking, in which there is little criticism of ideas. A whole range of creativity tools can help you here.
- › **Blue Hat:**  
The Blue Hat stands for process control. This is the hat worn by people chairing meetings. When running into difficulties because ideas are running dry, they may direct activity into Green Hat thinking. When contingency plans are needed, they will ask for Black Hat thinking.

# POSSIBLE SOURCES OF IDEAS

- › Societal challenges
  - › Typically not IT-research from the outset
  - › Formulated by politicians or funding sources ☺
  
- › Empirical studies
  - › Analysis of real life problem from a certain perspective,
  - › Typically multidisciplinary and with collaborating partners
  
- › The bright idea: A new UBI or application concept
  - › Experimental solution to problem
  - › Proof of concept prototype implementation + evaluation
  
- › Theoretical Work
  - › Survey of a research area or problem, propose new perspective

# H2020 SOCIETAL CHALLENGES

1. Health, demographic change and wellbeing;
2. Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy;
3. Secure, clean and efficient energy;
4. **Smart**, green and integrated transport;
5. **Climate action, environment**, resource efficiency and raw materials;
6. Europe in a changing world - inclusive, innovative and reflective societies;
7. Secure societies - protecting freedom and security of Europe and its citizens.



# INNOVATION FOUNDATION CHALLENGES

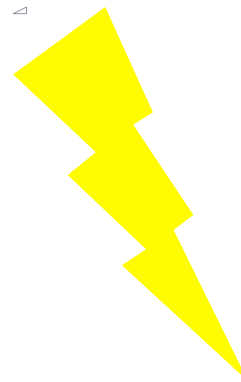
1. Bioresources, food, health and lifestyle
2. Future energy technologies and systems
3. Future welfare – social innovation
4. Competitive environmental technologies
5. Coastal tourism
6. Salmon stock
7. Production systems and strategic growth technologies
8. Psychiatry
9. Healthcare and clinical research
10. Transport, infrastructure and drones
11. Ecology

# RESEARCH IDEA EVOLVES (1)

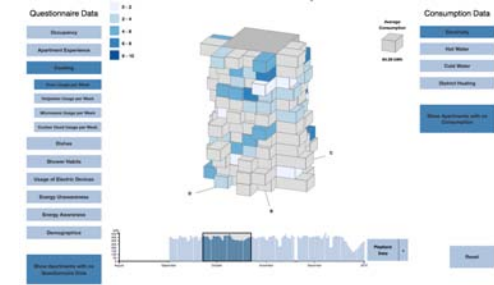
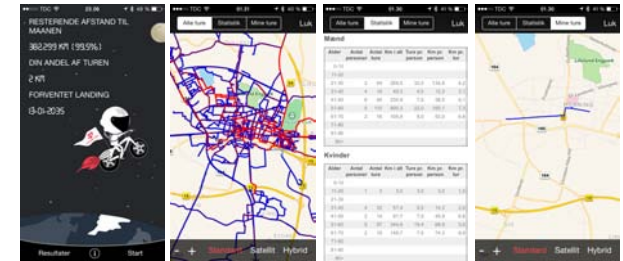
**Socceital challenges**



1. Smart transport
2. Better environment
3. Future energy tech



“EcoSense”  
type project  
Collect and analyse  
data to create  
energy awareness



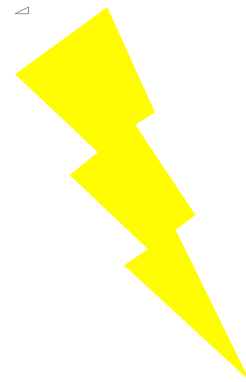
**State-of-the-**

1. Mobile Sensing
2. Internet of Things
3. Visual analytics

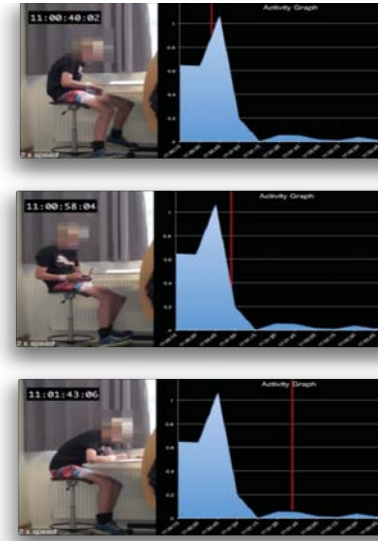
# RESEARCH IDEA EVOLVES (2)

**Socetal challenges**

1. Health and wellbeing
2. Healthcare
3. Future welfare



“Assistive Technology for ADHD”  
 Analyse child activity and invoke interventions to assist



**State-of-the-art**

1. Wearable Sensing
2. Physiological comp
3. Machine Learning
4. Cognitive training



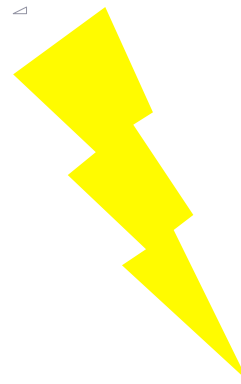
# RESEARCH IDEA EVOLVES (3)



**Societal challenges**



1. Health and wellbeing
2. Healthcare
3. Future welfare



“Interactive Ball Games”  
Advanced sensor technology for kinesthetic interaction



**State-of-the-art**

1. Sensor technology
2. Kinesthetic interaction
3. Game design

WRAP UP

## NOVEL RESEARCH IDEAS...

- › Require multiple disciplines to meet
  - › Often collective processes
- › Are grounded in empirical understanding
  - › Real world is an invaluable source of ideas
- › Based on strong IT-research competences
  - › Solid understanding of state-of-the-art
- › Require ability to generate disruptive ideas
  - › Brainstorming without barriers
  - › Being selective - 1 out 100 ideas are worth pursuing
- › Overall idea commenced in application phase
  - › Detailed ideas and research contributions evolves

# FOR GROUP WORK

Try to combine ideas from:

› Your deep technical research interest

with

› Some important societal challenges

› State some research ideas from this process!