



**dib**

Dipartimento di Informatica

## A Human-Centred Design approach to the design of educational games

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# Outline

- Introducing myself and the IVU Lab research group
- Some educational games designed at the IVU Lab
  - The Human-Centred Design approach adopted
- End-user Development
  - Tools to allow end users to create their own software applications

# Bari (Italy)



- Bari is the capital city of the Apulia region
  - population of about 400,000 (the urban area counts 653,028 inhabitants)





# Other attractions



- HCI research group involved in research on
  - Usability Engineering
  - User Experience
  - End-User Development
  - Information Visualization
  - Ubiquitous systems
  - E-learning systems
- Multidisciplinary team, with different background
  - computer science, design, communication sciences, pedagogy...



**Maria Franc.  
Costabile**



**Paolo  
Buono**



**Rosa  
Lanzilotti**



**Antonio  
Piccinno**



**Carmelo  
Ardito**



**Giuseppe  
Desolda**

# IVU Expertises (1/2)

## Multiplatform pervasive systems



## Composition platforms

Environments for end-user creation of applications by composing online services



## HCD methods transfer to industry

Integration of methods of human-centered design and usability and UX practices in the design cycle, development and use of software



Investigating and promoting UX practice in industry:  
An experimental study

Carmelo Ardito<sup>a</sup>, Paolo Buono<sup>a,b</sup>, Danilo Caivano<sup>a,c</sup>, Maria Francesca Costabile<sup>a</sup>,  
Rosa Lanzilotti<sup>a,d</sup>



# IVU Expertises (2/2)

## Visual analytics tools and techniques

To synthesize information, assist in the identification of models and patterns found in large amounts of data, provide decision support in various application domains



## End-User Development

Infrastructures and framework to support users to adapt (or even create) - by simple direct manipulation techniques - the functionality of software systems to their needs



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# **EDUCATIONAL GAMES FOR VISITING CULTURAL HERITAGE SITES**



# Explore!

## ■ Excursion-game

- Similar to a treasure hunt, played by groups of students
- Each group plays the role of Gaius, a Roman citizen who just arrived in Egnazia with his family and has to carry out some missions
  - Mission example: “You have to find a job for your son. Look for the Trajan Way where many coaches travel. Someone could need your son’s help to fix a coach wheel.”

## ■ Easily adaptable to different sites

Ardito C., Costabile M.F., De Angeli A., Lanzilotti R. 2012. Enriching exploration of archaeological parks with mobile technology. *ACM Transaction on Computer-Human Interaction (TOCHI)* 19, 1-30

Cell phone 1  
- Game app  
- GPS  
- Sounds

Map

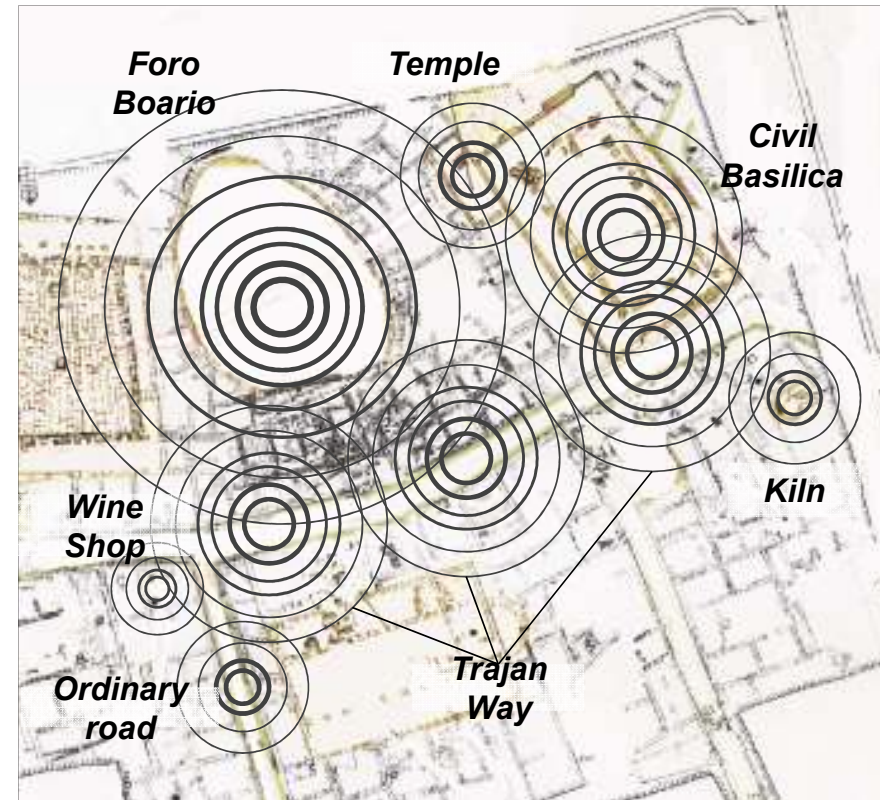
Cell phone 2  
- Hint app



Loudspeakers

# Virtual soundscape

- Contextual sounds at various locations
  - cows lowing in the **Foro Boario** (the animal market)
  - batons and discs played during ceremonies in the **Temple**
  - noise of people in the **Civil Basilica**
  - crackling fire near the **Kiln**
  - carts running on the **Trajan Way**
  - ...
- Attenuation depends on
  - Distance from the virtual source
  - Type of sound
- Cues for place identification
- Atmosphere of ancient times

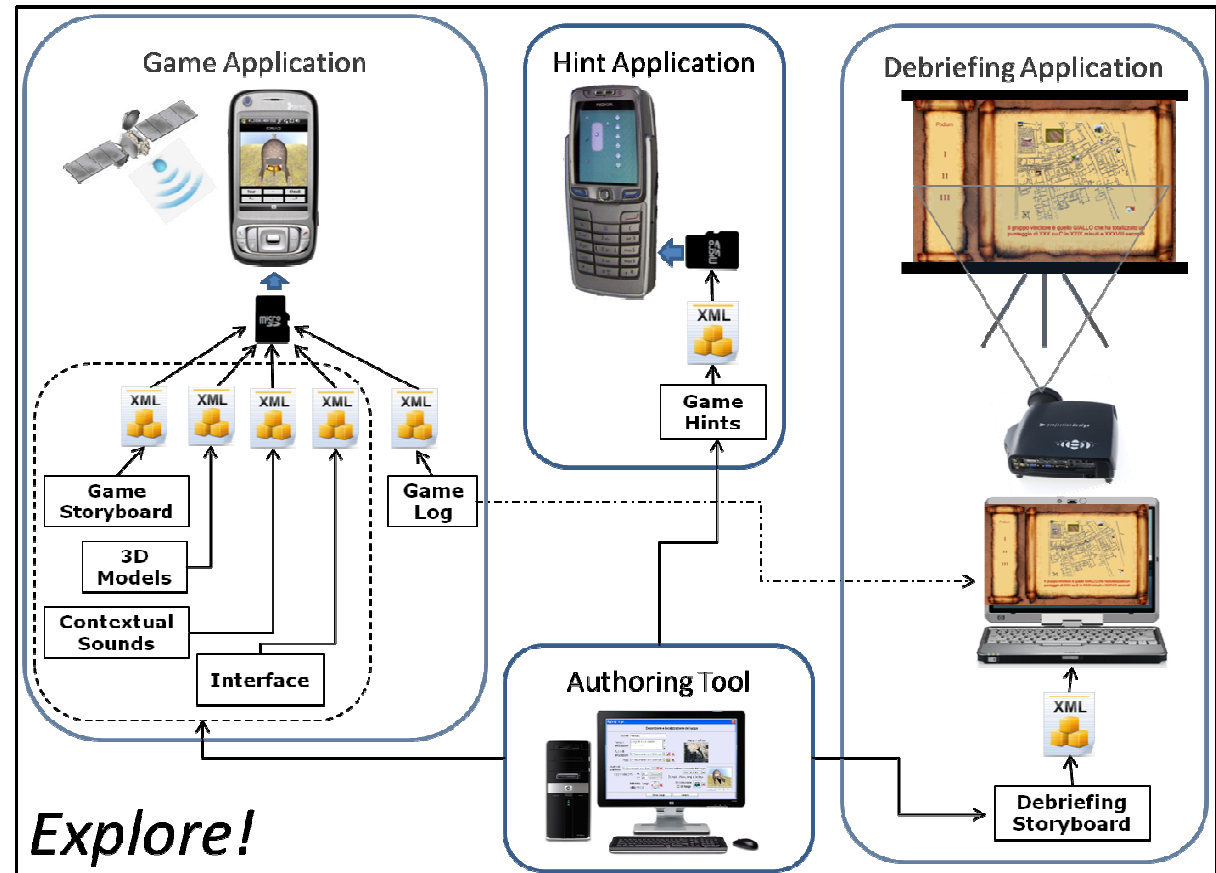


# Explore! architectural framework

Designed as a general framework to be adapted to different historical sites.

To be as device-independent and modular as possible, with a clear distinction between game content and game structure

Patent  
n. 1401512



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# EXPLORE! HCD PROCESS

C. Ardito, P. Buono, M. F. Costabile, R. Lanzilotti, and A. Piccinno, "Enabling Interactive Exploration of Cultural Heritage: An Experience of Designing Systems for Mobile Devices," *Knowledge, Technology & Policy*, vol. 22, pp. 79-86, 2009



# Requirements for the User Experience

- Design team:
  - (a) HCI and software engineering experts
  - (b) members of Historia Ludens, who has developed the original paper-based version of the game
  - (c) experts in teaching history and archaeologists of the Department of Ancient History of the University of Bari
  - (d) the director and staff representatives of the Egnathia Archeological Park
  - (e) school students and teachers of the middle school “Michelangelo” in Bari

# User requirements collection

- A contextual inquiry technique
  - students' (11–13 years old) behaviour observation while executing the original paper-based version of the game
    - useful information on how the game about game execution and students' problem-solving strategies
- Interviews and focus groups involving Historia Ludens associates, students and teachers to capture more details on the game and on the whole experience
- Interviews to the archaeologists and experts of the park to capture the history of the park and discuss how to model the 3D reconstructions of meaningful sites for the electronic version of the game

# Developing and Testing Alternative Designs

- Different prototypes were developed, and several formative evaluations, some involving middle school students, were conducted throughout the interaction design process
- First evaluation with users
  - Wizard of Oz (WOz) simulation
  - After playing the game, the students were interviewed
  - Based on the results of the first WOz evaluation and the students' requests, we developed a running prototype of Explore!
- Second evaluation with users
  - direct observation of students interacting with a running prototype of Explore!
  - After playing the game, the students were interviewed

# Field Evaluation

## ■ Participants

- Six classes of a middle school in Bari were involved, for a total of 124 children (11–13 years old) and six teachers

## ■ Between-subjects design

- Explore! With vs. Without Sound

## ■ Procedure

- Two days at Egnathia archaeological park
  - Group observation (videotaping and shadowing)
  - Questionnaire to evaluate game experience
  - Multiple choice test to assess learning
  - Focus group
- Follow-up session one day later in school
  - Multiple choice test
  - Essay about “Life in Egnathia”



# Summary of the results

*Explore!* to support history learning in archaeological parks

1. Is the excursion-game able to provide an engaging experience?
  - Pupils were very involved in the game, independently of the presence of contextual sounds
  - Pupils remembered many places and their functions
  - Teachers confirmed pupils' involvement and learning outcomes
  
2. Can contextual sounds enrich exploration of historical sites?
  - Pupils enjoyed the sounds, which also helped to identify the places and to be more involved into the spirit of ancient times
  - Disorientation episodes occurred less frequently *With Sound* than *Without Sound*

# Large interactive displays



# Applications for conference attendees

	7 June 2011	8 June 2011	9 June 2011	10 June 2011
9:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
10:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
11:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
12:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
13:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
14:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
15:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
16:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
17:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
18:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology
19:00	Workshops and Doctoral Consortium	Invited Speaker: John	Papers: Infrastructure	Papers: Methodology

*Interactive\_Program*



*Taxi\_Sharing*



*Conference\_Photos*



# Serious games to learn history

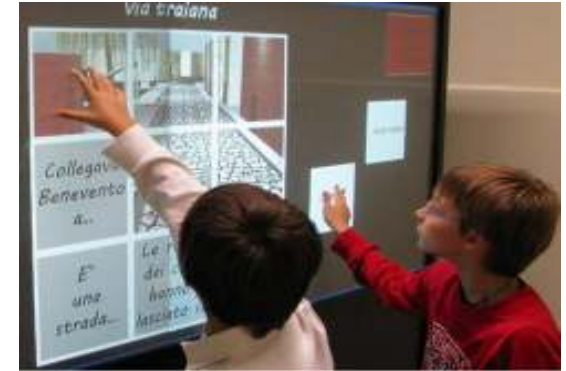
- *Time-Voyager*

Players have to organize photos chronologically according to different historical times



- History-Puzzle

Players have to complete puzzles of historical monuments



- ArcheoGame

Players have to perform an archaeological excavation





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# **END-USER DEVELOPMENT (EUD)**

# End-User Development (EUD)

*End-User Development is a set of activities or techniques that allow users of software systems to create or modify a software artefact at use time*

## ■ End Users

- People who use computer systems for their daily work activities. They could be not expert at all in Computer Science, nor are willing to be
- They want software environments that they can “tailor” to their needs, task and habits without being aware of programming

# Towards EUD

- Traditional life cycle of interactive systems
  - distinction between design time and use time
    - system developers create environments and tools, figuring out end users' needs and objectives. At use time, end users use the system
- User-Centered Design
  - Iteration of a design-implementation-evaluation cycle
    - end users only use the system and, at most, are involved in prototype evaluation
- Participatory Design
  - participation of end users in the design process
    - end users become members of the design team, but no tools are provided to let them create or modify software
- EUD
  - more active involvement of end users in the overall software design, development, and evolution processes

# Design environment for Cultural Heritage (CH) experts

- The design environment allows the CH expert to create a final application by selecting a specific application template and providing the proper content by directly manipulating the available components
- The design environment for History-Puzzle game:
  - Visual environment inspired by YahooPipes
  - It offers application templates, building blocks, multimedia resources, ..., that are selected by the user to complete the application

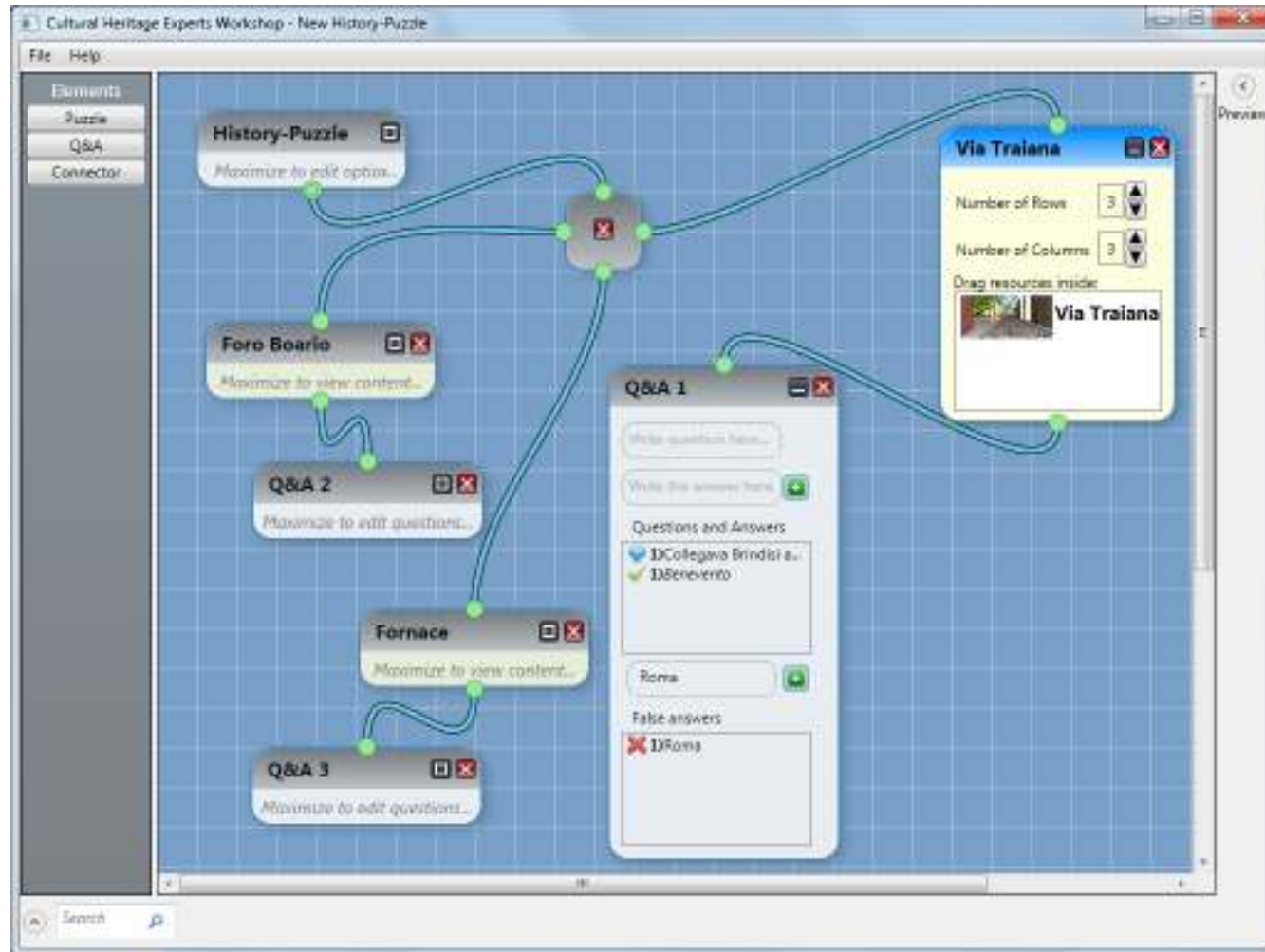
Lanzilotti R., Ardito C., Costabile M.F., De Angeli A., Desolda G. (2015). Pupils' Collaboration around a Large Display. *Journal on Visual Languages and Computing*, vol. 31 Part B, pp. 206-214

Ardito C., Costabile M. F., Lanzilotti R., Desolda G. (2013). Integrating traditional learning and games on large displays: an experimental study. *Educational Technology & Society*, vol. 16(1), pp. 44-56.

Ardito C., Lanzilotti R. (2011). An EUD Approach to the Design of Educational Games. *International Journal of Distance Education Technologies*, vol. 9(4), pp. 25-40



# Design environment prototype





# Web mashups

*Online applications that use and combine data, presentation or functionality from two or more sources to create new services*



Consumer  
Mashups

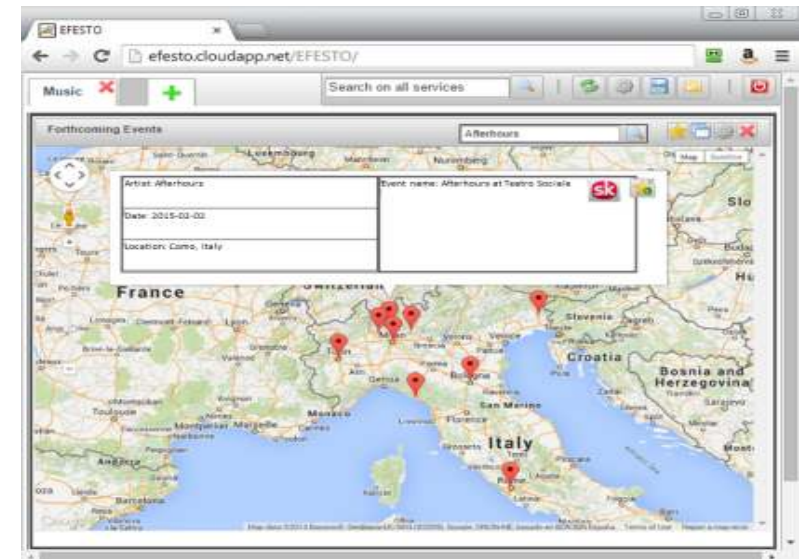
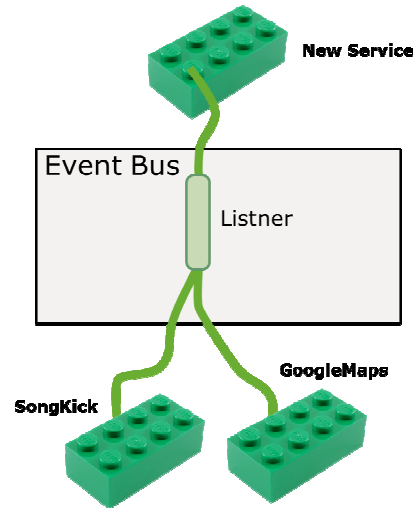
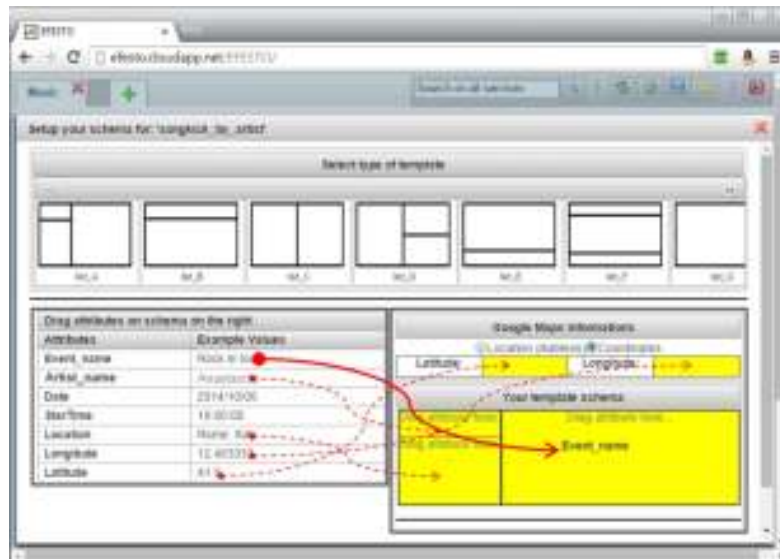


Enterprise Mashups

- Big players' projects on mashups failed or almost unknown (e.g., Yahoo Pipes, Intel Mash Maker, IBM QEDWiki and Damia, JackBe Presto)
  - Mashup tool potentialities hidden by the difficulties to understand and use design notations

# EFESTO mashup platform

- A mashup platform characterized by
  - Abstraction from technical details
    - A platform speaking a language close to the users (functionality and terminology), possibly through **visual mechanisms**
  - Live programming
    - **Immediate visual feedback** → immediate mashup execution (no distinction between design-time and execution-time)



# Field studies

- Two field studies in different application domains
  - Cultural Heritage
  - Technology Enhanced Learning
- Goals
  - To verify the usefulness for end users of content made available by distributed data sources, as well as the overall validity of our composition approach
  - To identify improvements and extensions of the approach, in particular for the collaborative and distributed creation of interactive workspaces

# Field study in Cultural Heritage

- First phase

- Two professional guides composed their Interactive Workspaces (IWGs) related to the archaeological park of Egnathia

## Second phase

- The guides used and updated their IWGs using a large multi-touch display (46-inch) and a tablet device (7-inch) during the visit of Egnathia
- 28 visitors randomly divided into two groups of 14 persons



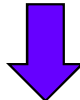


# The IW visualized on large multi-touch display and tablet



# Field study in Cultural Heritage

## - Important findings -

- Guides would annotate and share IWs
    - with their colleagues to collaborate during IW composition
    - with visitors to allow them to view and possibly add contents
  - Other issues
    - Visitors sometimes were not able to see the content visualized on the multi-touch display and the guides' tablet
      - the guides covered the screen with their body because they needed to be next to the multi-touch screen to interact with it
      - the tablet screen was too small and the sun light too bright
- 
- Multi-device collaboration mechanisms to enable remote control of the contents displayed on the large multi-touch screen or content delivery to visitors' mobile devices

# Field study in Technology Enhanced Learning (TEL)

- Carried out at a technical high school in Southern Italy
- A class of 16 students (19 years old) and one teacher
  - Day 1
    - the teacher composed an IW on “Communication Networks”
  - Day 2
    - the teacher gave a lesson supported by the IW on an interactive whiteboard
    - students (groups of 2-3) created an IW about a specific Communication Networks sub-topic, e.g. protocols, latency
    - students share IWs with the teacher
  - Day 3
    - a class on Communication Networks supported by the integrated IW
    - students and teacher fill in a questionnaire about perceived platform pros and cons
    - students and teacher participated in a design workshop



# Field study in TEL - Important findings -

- Teacher and students appreciated the opportunity to
  - Simultaneously interrogate multiple services
  - Quickly search for updated content
- The teacher needs a new visual template, such as a topic map, that can better support his class
- The participants would like the opportunity to collaboratively create an interactive workspace, both synchronously and asynchronously

# Emerged collaboration requirements

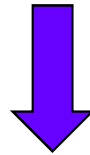
- Key features of interaction, composition and update of the IW
  - Live editing mechanisms to show and share personal contributions with other stakeholders that could enrich/improve a workspace
  - Use of annotations as
    - personal memos – by highlighting significant parts of a IW
    - expressions of thinking – by adding one's own ideas, critical remarks, questions
    - clarifying elements – by reshaping the information in the DIW into one's own verbal representations
  - Need of storing, in a frozen form, items from the dynamic content displayed in the workspace (a special kind of asynchronous collaboration)
- The composition platform should satisfy such requirements and allow a process of collaborative composition

A visual paradigm for allowing end users to  
customize their smart environments



# Motivation

- *Smart objects* can foster important changes in our lives as they are increasingly pervading the environments we live in
- Obstacles
  - Programming the behavior of smart objects is currently a prerogative reserved for professional developers
  - Smart objects expose very specific functionalities
    - it is not relevant to provide end users with very specific applications governing the behavior of single objects



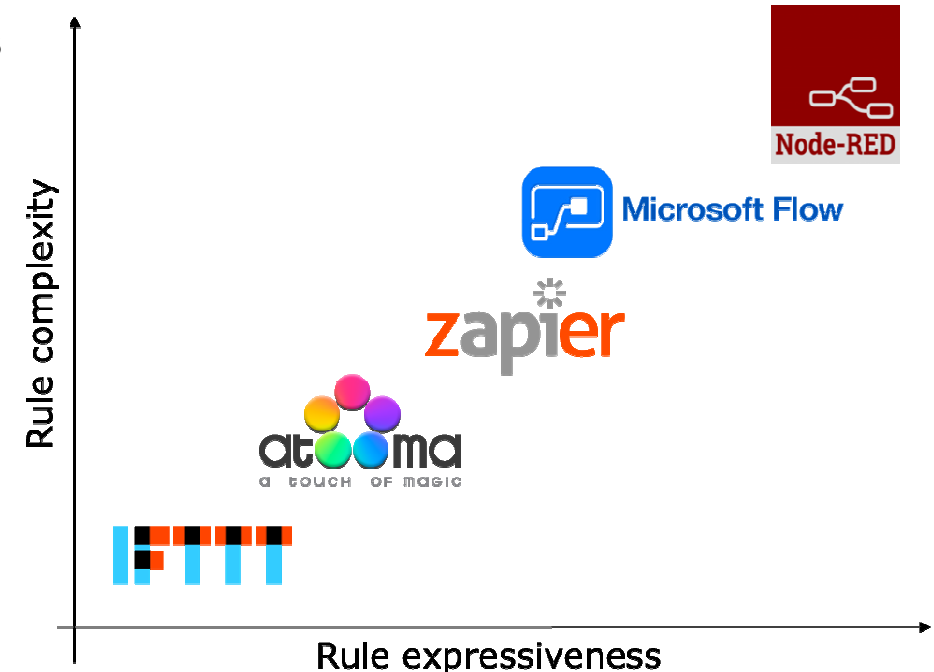
- Interaction paradigms to allow non-technical users to take advantage of *ecosystems of interoperable smart objects and services* by *flexibly* configuring their behavior

# Task Automation tools

- *Task Automation* (TA) tools allow to combine social services, data sources and sensors
- Limitations of most of the tools
  - the expressive power of the Event-Condition-Action (ECA) rules is limited to very simple synchronized behaviors
  - graph-based notations are suitable for programmers
- Scarce adoption of the available tools especially by non-technical users



*Usable paradigms* offering a trade-off between rule power and tool usability



# The 5W model \*

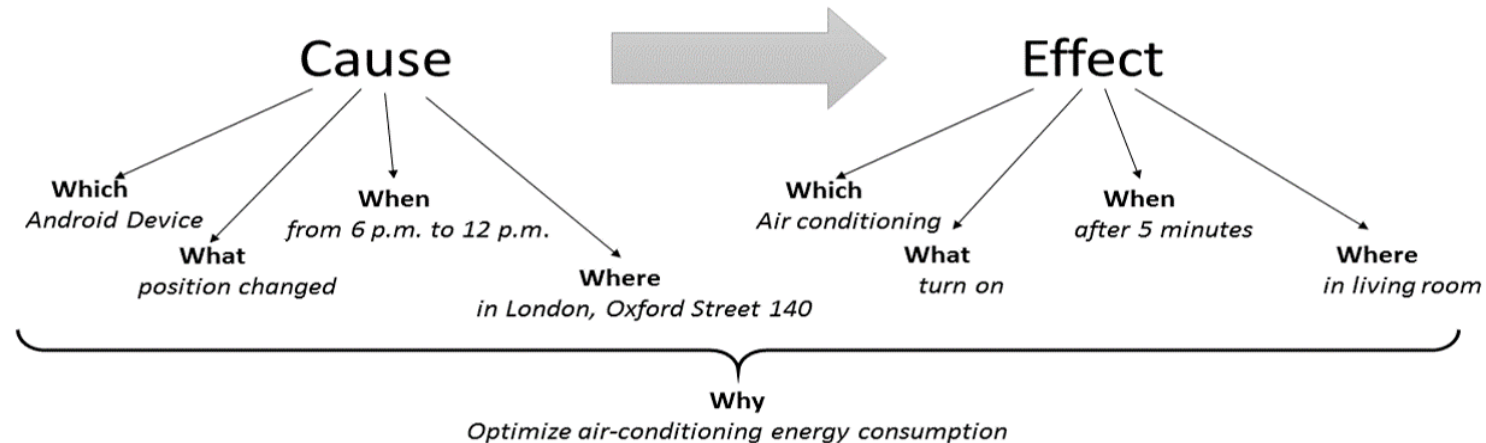
- We adopted the 5W model in an elicitation study aimed at identifying, with the help of users, a notation for the specification of task automation rules
- It suggests describing a fact by answering the following questions:
  - *Who* did it?
  - *What* happened?
  - *When* did it take place?
  - *Where* did it take place?
  - *Why* did it happen?



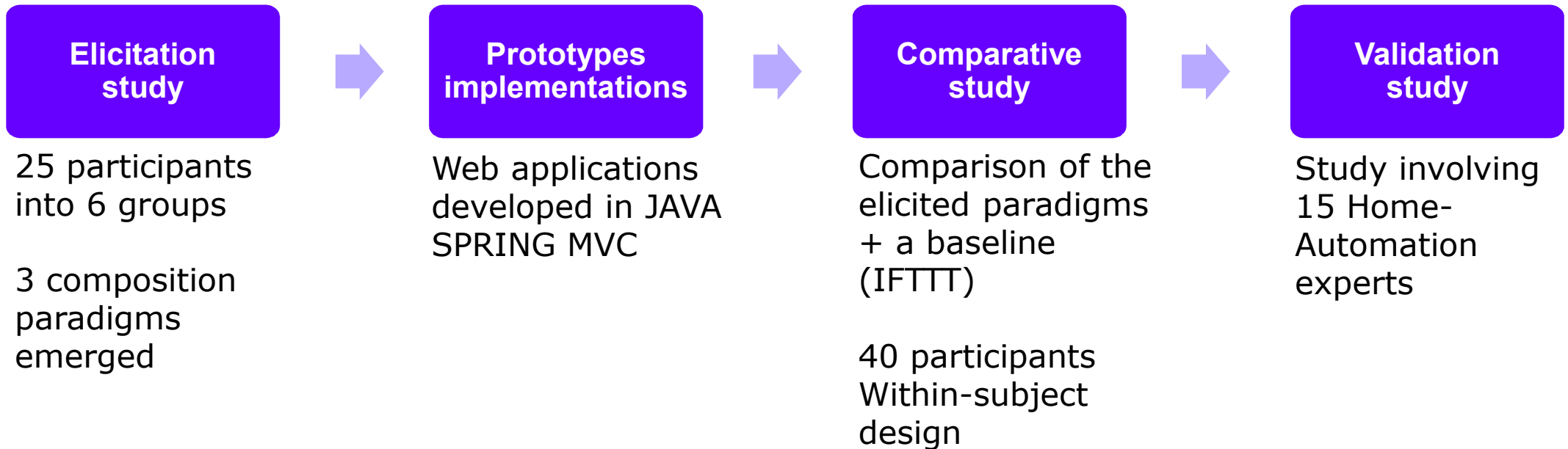
\* Adopted in several domains (journalism, customer analysis...) to analyze the complete story about a fact

# Rule\_5W model

- Highlight the elements that are essential for creating complete meaningful rules for smart object composition
  - “Who” is replaced by “*Which*” for specifying the services involved in a rule
  - “*What*” indicates the triggered events, as well as the actions to be activated
  - “*When*” and “*Where*” refer to the specification of, respectively, temporal and spatial conditions for triggering events and performing actions
  - “*Why*” is used for reporting a short description to explain the rule behavior to a human reader, e.g., other users with whom the rule is possibly shared



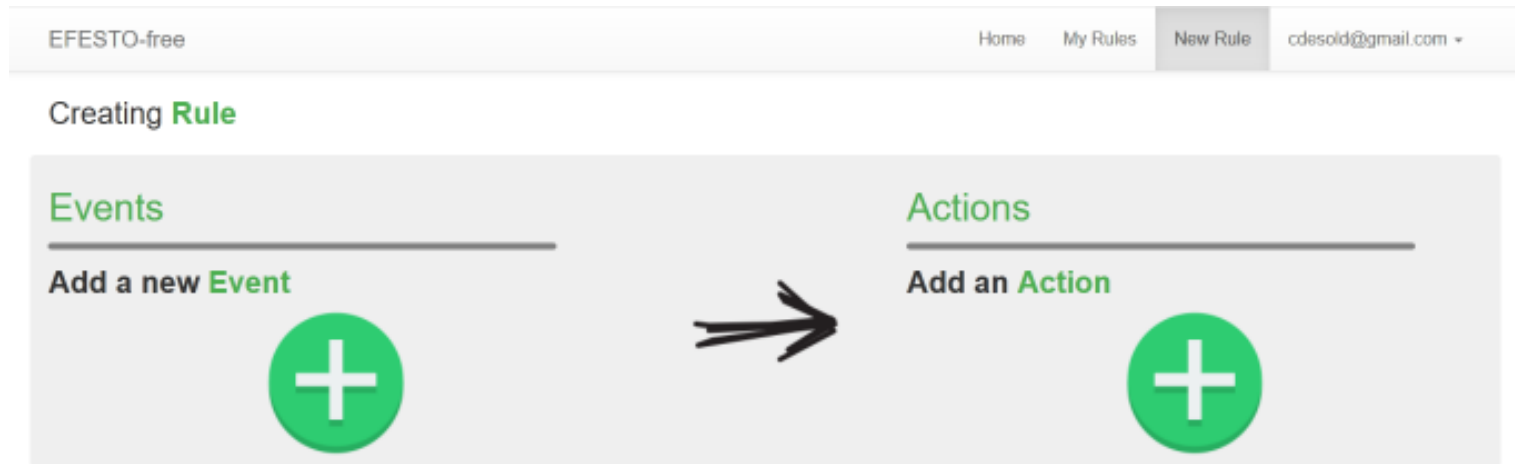
# A Human-Centered design process



Detailed description of EFESTO 5W prototype, studies, results and design implications in:

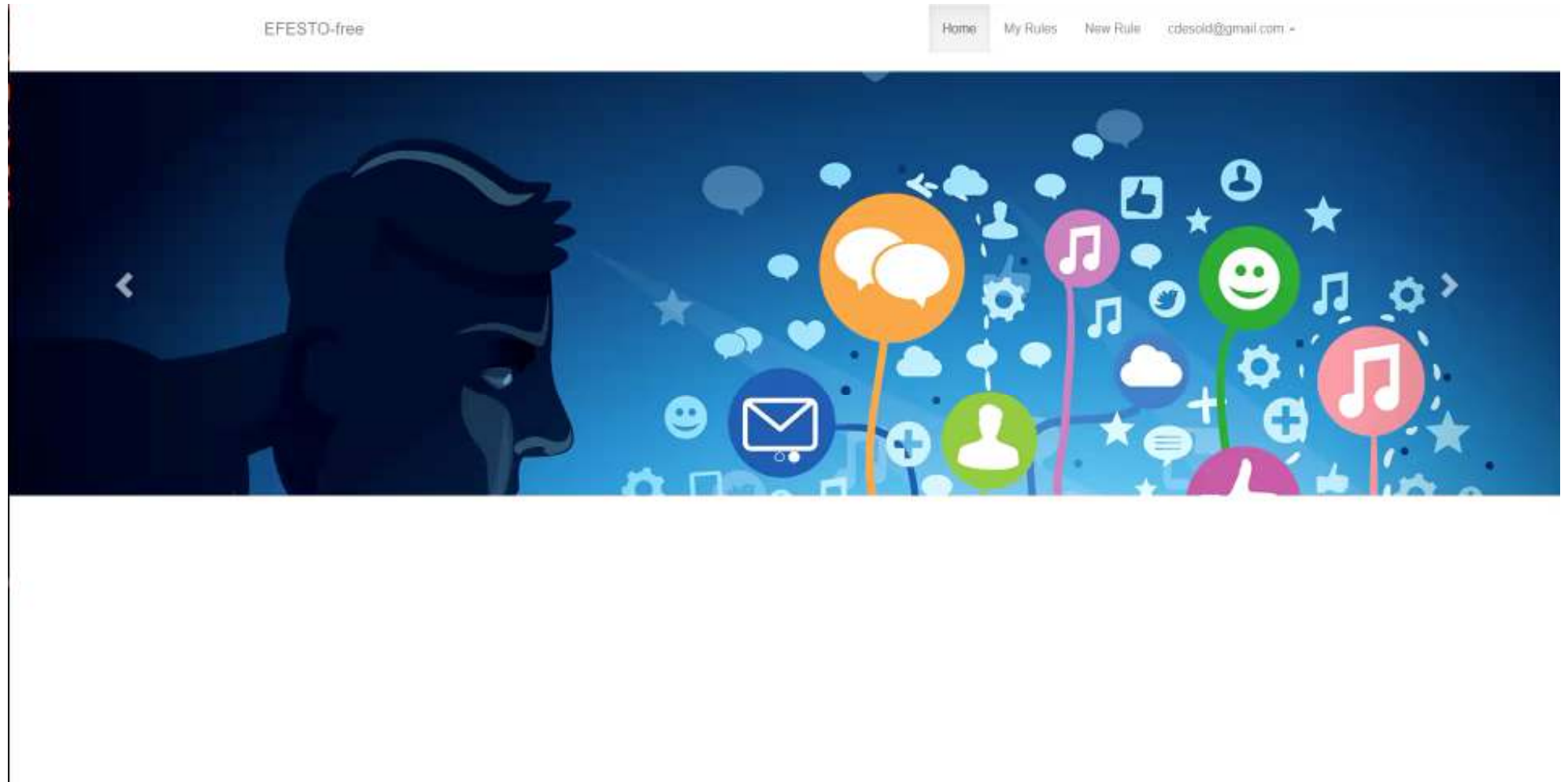
Desolda G., Ardito C. and Matera M. (2017). Empowering end users to customize their smart environments: model, composition paradigms and domain-specific tools. *ACM Transactions on Computer-Human Interaction (TOCHI)* 24(2).

# EFESTO-5W UI





# EFESTO-5W Demo




# EFESTO-5W UI


EFESTO-free Home My Rules **New Rule** cdesold@gmail.com

Creating **Rule**


**Events**


 JustAwake  
from 07 a.m. to 09 a.m. edit - delete

OR


 AlarmRinging  
from 07 a.m. to 09 a.m. edit - delete

Add a new **Event**


 And

 Or


**Actions**

 TurnOnCoffeMachine edit - delete

and

 OpenRollUpShutter edit - delete

Add an **Action**



**Why** (Description of the recipe, as a reminder)

Save

# A study with home-automation experts

- Goal: validate EFESTO-5W with domain experts
- 15 home-automation experts
- Two main phases
  - Utilization study to evaluate user performances and satisfaction with EFESTO-5W
  - Focus group sessions
- Main results
  - EFESTO-5W useful in scenarios such as security, home assistance, education for children, energy optimization
  - New requirements: meta rules, warning mechanisms, debug, recommendation, different complexity levels, access management policies



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# Thanks!

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