Box. Open System for Connected People

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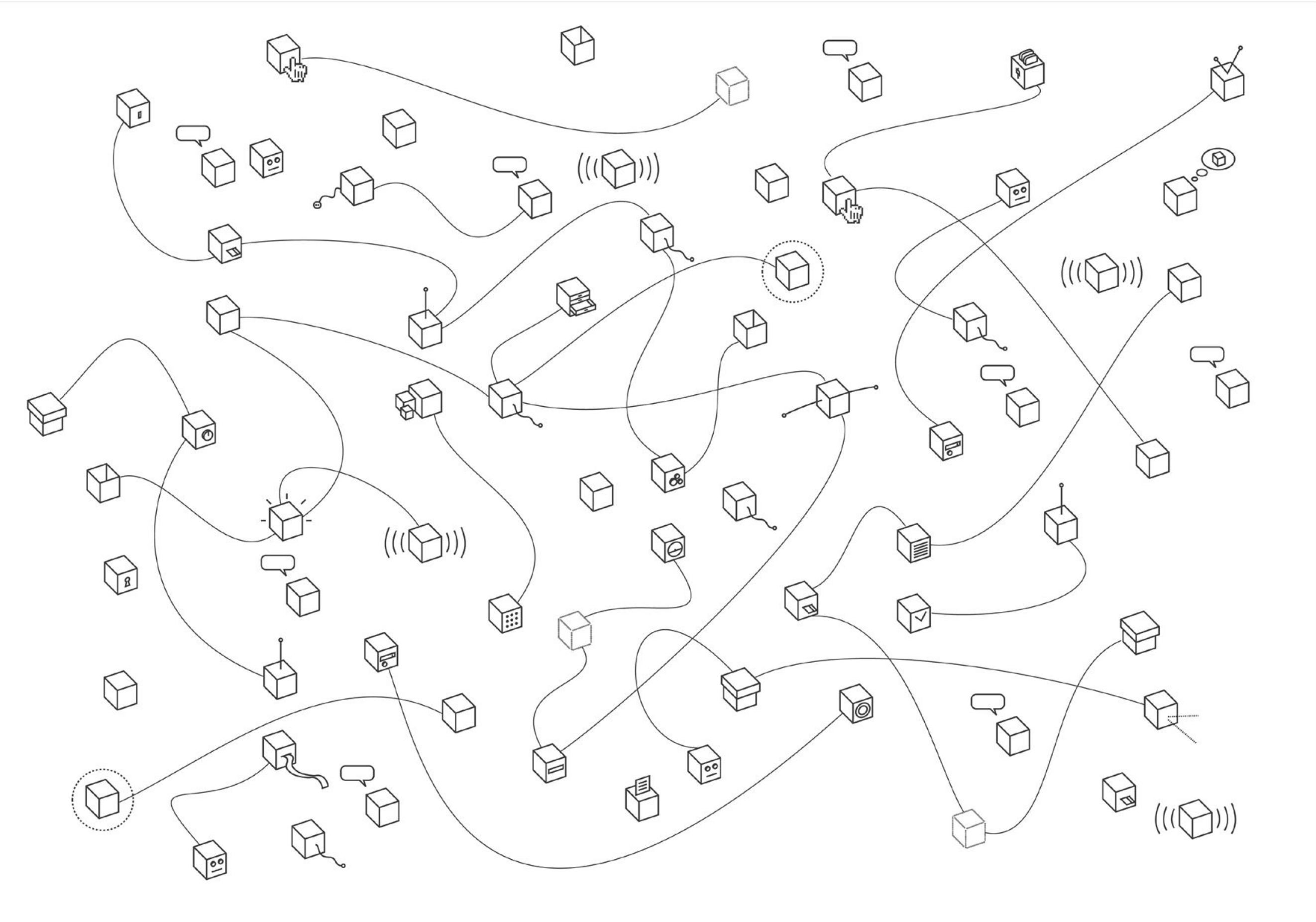
0 Abstract

The architectural spaces we inhabit will become an interface between humans and online digital information. The current research programme focuses on the exploration of computational systems that mix digital media and the physical environment. Tangible interfaces are becoming an increasingly popular design strategy as computational elements become smaller and more ubiquitous and integrate with everyday objects and spaces.

This project aims to offer an insight into physical computation that places information in shared social spaces, inside the context of a connected community. The main goal is to understand the basic elements that are part of information networks.

This will be supported discussing the box system: a visual language for information networks and a collection of wireless, physical objects that can be interconnected with this language.

Box. Open System for Connected People



The box system proposes an open platform for communication and information exchange, providing a virtual structure and a collection of simple physical objects.

1 Introduction

A modular system –box– is proposed to physically couple virtual and actual space and to network an unlimited number of entities, creating a participatory environment for communication and information exchange. The system adapts the notion and principles of software architectures, to the world of tangible artefacts.

The context of the proposed system will be a connected community: A group of people in local and/or remote situations that on regular basis share some kind of information and that communicate through information technologies.

The ultimate goal is to create an open platform to facilitate the exchange of knowledge and the interplay of ideas, to create inmersive information experiences, to transform users from atomised, passive consumers into active interpreters of information.

1.1 Motivation

With the new information society we, as designers, are approaching a new space which we still do not completely understand. The main motivation behind this research programme is to offer an insight into the new set of constructs, elements and concepts which relate to the design of information networks. It is necessary to define a new language, to understand its context and meaning. It is also necessary to experiment, free from commercial trends and real world constrains, in order to discover the implications of designing for this new space.

This program hopes to lead to the development of new tools and methods for the embedding of computation in everyday objects, to create information containing objects, researching on how new functionality and new use can emerge from collections of interacting artefacts.

1.1.1 Designing for Connected Communities

Connected communities have the potential to support a wide variety of activities related to information seeking, information provision, and information sharing, in addition to socializing and other types of everyday interaction. There are opportunities for designing networks to promote all these types of activities.

1.1.2 Personal Area Networks

We live, work and play surrounded by an increasing number of technological devices, all of them able to gather and/or deliver some type of data from and into the networks. From our bank account details to the last SMS received, we should be able to decide which of these data is important to us and how to integrate it into our everyday lives.

1.1.3 Politics of Information

This research programme will also consider the transformative potential of new information technologies: readdressing what counts as information, exploring open-ended design strategies and alternatives to dominant information technology design paradigms.

1.1.4 Distributed Constructionism

One of the basic premises of this thesis is that humans learn better by actively participating in the construction of collective, meaningful environments and artefacts. Thus, the focus will be on defining a modular system, open to be expanded and combined in different structures, allowing users to create their own platforms to, let's say, debate, play, ask for help, or simply to stay in touch.

1.1.5 From Content to Structures

A visual language will be defined to analyze the intrinsic characteristicis of structures and information flows. The focus will not be on the content, nor the technical infrastructure that supports this exchange of information, but on the types of platforms that might help to create knowledge and meaning out of a specific collection of data. Ultimately, this language should help us, as designers, to understand and play with information flows.

1.1.6 Tangible Interfaces for Computation

Input and output technologies constitute perhaps the most important dimension of change in terms of defining the nature of future technological systems. The reason lies in the fact that one of the most significant issues confronting the computers users is the problem of bridging the gap between the physical and virtual worlds. Thus, an interesting challenge faced by interaction designers is to create physical objects and spaces that seamlessly present virtual data in the real world.

1.2 Research Questions

·What are the basic elements of information networks? How do we visualize these networks?

·How do physical interfaces affect the way we learn, play and communicate through these networks?

·Can we create a modular system to support all kind of information sharing and socializing activities inside a connected community?

1.3 Defining the Terms

'Connected Community'
Group of people who share some kind of interest or motivation; learn, work or play inside a particular information environment and communicate often through information networks.

'Information Containing Objects'
Physical devices with the ability to receive or send data to the network or to other devices.

'Dynamic Information Network'
Combination of virtual and physical objects that allows constant flow of data between these entities.

1.4 Thesis Structure

The second chapter will describe the concepts, theories and philosophies that grounds this research.

The third chapter will introduce the visual language of the Box model. It will define its main elements and explain the meaning of its different constructs, properties and rules.

The fourth chapter will present the experimental approach taken for the design of information containing objects, and how this approach has been implemented.

The fifth chapter will illustrate some of the possible networks that can be configured with the box system, combining the physical objects with the visual language.

The last chapter will analyse and present conclusions, explaining how the theories presented apply to the design decisions taken and why the solution proposed has potential for further exploration.

2 Background

The first section will analyse the implications of designing for connected communities. It will discuss information exchange as a social act inside a particular context, and will introduce the distributed and emergent models of social networks.

The second section will focus on structures. It will analyse how the new task for interaction designers is to create structures, rather than content, and will explain the notion of distributed system.

The third section will introduce the recent developement of tangible interfaces, describing how this shift has occurred. It will also discuss the constrains of an usability approach against alternative design theories which include other social, psychological and aesthetic issues.

"Computer networks are social institutions that should not be studied in isolation but as integrated in our everyday lives."
[Wellman, 1999]

2.1 Designing for Connected Communities

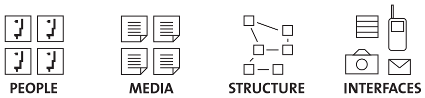
This section will discuss the context of this project, a connected community. It will present the importance of understanding its internal structure, a field known as *social network analysis*, and will make emphasis on the interpersonal aspects of information exhange. It will also define a collection of people, documents and networks as an *information neighborhood*.

One of the main assumptions behind this research is based on the idea of *distributed constructionism*, that asserts that an effective way of learning consists on the shared construction of documents, artefacts or environments.

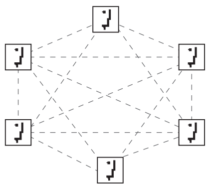
Following this premise, this project proposes an open-platform that will be constructed and self regulated by the same participats that will use it to exchange media and communicate, allowing the creation *of emergent social networks*, as defined at the end of the section.

2.1.1 Social Networks

Every organization is also a social network. The business of the organization is conducted by people whose communications most often take place as conversations and exchange of media. Skilfully structured and represented, those exchanges can become sources of social and intellectual capital. Knowledgeable use of tools to work, play and communicate with online information , can enhance and enable online social networks.



Computer networks allow people to dynamically interact with a collection of media, an internal structure, and a diversity of interfaces. This programme pretends to offer an insight into the elements that are part of this internal structure, in order to be aware of the values and design opportunities of information networks.



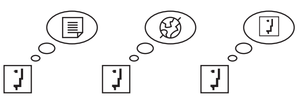
Social network analysis explores the way in which these associations and exchanges of resources between individuals creates connectivity among all members of a social system. The number and types of resources exchanged, the direction in which they flow describe the social structure of the system, and define the sustaining characteristics of the social group or community [Wasserman & Faust, xxxx]. The pattern of lines and connections describe the way in which resources flow from one member of the community to another, and among all members of the community.

It is these exchanges that show what types of resources are important for a community and which sustain it, and therefore which are important to recreate and provide support for in the networked environment.

2.1.2 Information Exchange is a Social Act

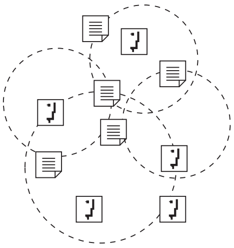
"The exchange of and availability of information are perhaps the most important aspects of community networks, but information is only one of many social resources that are exchanged through these networks."
[Burnet, 2000]

Specifically information-oriented activities within connected communities are relatively minor compared to emotional and peer-group support and other types of social interactions.



Thus, information exchange becomes a social act when it takes places inside a connected community: Information exchange is a mere transfer of facts; it only plays a minor role not only to computer mediated communication-supported communities, but also in human communication more generally.

We must valorise, above all, the interpersonal aspects of online interaction as opposed to the informational content that may be exchanged through communicative interactions.



2.1.3 Construction of Meaning

Connected communities function as forums for different types of information seeking: participants come both to find specific answers to specific information needs, and to situate themselves within a congenial *information neighborhood* where they can, on an ongoing basis, keep a lookout for any information related to their general interests and concerns. In addition, participation in connected communities also allows for less formal types of human information behavior such as browsing and information encountering.

One's *information neighborhood* is not only made up of media sources, but also —and perhaps most importantly— by people. The exchange of information is, in any human situation, fundamentally a social interaction rather than a mere instance of goal-oriented information retrieval or interaction with an information system.

Thus, information exchange within such a social setting involves not only active information seeking but also communication —including socializing— and other types of interactions. Information —as the content of social interaction— provides the raw material from which such *construction of meanings* can take place.

2.1.4 Distributed Constructionism

Constructionism [Papert, 1993] is both a theory of learning and a strategy for education. Constructionism is based on two types of construction. First, it asserts that learning is an active process, in which people actively construct knowledge from their experiences in the world. People don't get ideas; they make them. To this, constructionism adds the idea that people construct new knowledge with particular effectiveness when they are engaged in constructing personally-meaningful products.

Distributed constructionism extends constructionist theory, focusing specifically on situations in which more than one person is involved in the design and construction activities. Distributed constructionism asserts that a particularly effective way for knowledge-building communities to form and grow is through collaborative activities that involve not just the exchange of information but the design and construction of meaningful environments and artefacts.

Recent research projects have attempted to use computer networks that can facilitate the development of knowledge-building communities [Resnick, 1998], in which groups of people collectively construct and extend knowledge. In many of these projects, students share ideas, theories, and experimental results with one another.

2.1.5 Emergent Social Networks

When participants in a community are allowed to take control of the mechanisms they use to communicate and share information, a new potentiality emerges. Participants can manipulate the internal structure in any way they wish, resulting in self-emergent organizations that best reflect the social network that lies behind them.

We can create open-ended systems open for new ways of interpretation. This way we can integrate users into the design-process, and, rather than passive consumers, they will become active interpreters of information.

“The new task is to create an efficient structure and tools for working with arbitrary information, information which is always changing and always grows."
[Manovich, 2000]

2.2 From Content to Structures

As the task of the designer is shifting more and more to the design of networks, we have to become aware of the different models these structures can be built on. A distributed model best adapts to the intrinsic properties of a connected community.

This section will analyse what that means for the design of an open platform: It will introduce the notion of *distributed systems*, in which functionality is given by interaction of many simple, independent modules.

It will also argue that an open, distributed platform allows the configuration of more complex, *emergent networks*, and will present the notion of *digital craft*, which presents the creative process with the digital medium as an opportunity to play and discover with a structure and a number of objects.

2.2.1 Distributed Systems

Many small simple independent elements can interact with each other to perform useful outcomes. By examining distributed systems we will change the way we think about design problems. But there is a trade off between efficiency and robust adaptability. Simple machines can be efficient, but complex distributed systems are often not.

Looking at complete systems changes the problems for design often in a favorable ways. The emergent complexity of decentralized systems is achieved through the interaction dynamics of multiple simple components all acting in parallel, each with their own set of simple rules.

As pointed out on the previous chapter, decentralized —distributed— models can integrate better with the social dynamics and learning processes found in connected communities. Until recently there have been few alternatives which would allow people to experiment with decentralized systems. Resnick has been building a number of new tools for kids at the MIT Media Lab which allow novices, scientists and designers to explore decentralized thinking [Resnick, xxxx]. His hope is that these conceptual tools will help people move beyond the centralized mindset. He contends that best way to develop better intuitions about decentralized systems is to construct and *play with* such systems.

How can you design self-organizing phenomena? Although the patterns are emergent and not designed, the individual parts that make up the system and their local interactions are. This is a different type of design, where the designer controls the actions of the parts, not the whole. Designers have to adopt a relaxed sense of control.

The goal for designers in creating decentralized types of systems is to be able to create spaces for possible activities and experiences. The best way for designers to develop and understanding and new intuitions about decentralized phenomena is to try to construct their own models and simulations of open systems.

2.2.2 Interaction Dynamics

Simple interaction dynamics between the different components within an environment can lead to emergent structure or functionality. Thus, modules with simple behaviors can be combined in order to produce more complex functionality. Neither one of these modules is primarily *responsible* for the behavior of the system. It is their interaction dynamics that makes the system work as a whole. Interaction dynamics between the component's behaviors of a social system can lead to emergent structure of functionality.

What is important is that such emergent complexity is often more robust, flexible and fault tolerant that programmed, top down organized complexity. This is the case because none of the components is really in charge of producing complexity. None of the components is more critical than another one. Rather, it is the interaction dynamics that lead to emergent complexity.

A decentralized system can be viewed at many different levels. For example an object may be seen as a mechanical level in one instant but also at a psychological level. Which level is *best* depends on the context, on what you already understand and on what you hope to learn. In general no level is *best,* rather the important lesson is that it is useful to be able to think about complex systems in terms of levels. Certain levels are more useful and appropriate than others, in certain situations.

2.2.3 Discovery in Digital Craft

McCullough argues that working with new media objects offers opportunities for skills that are familiar from traditional craft practices. He talks about playing as a way of learning:

"If a medium is defined by its affordances and constrains, then learning consists of exploring these properties. Experimentation is especially useful for becoming familiar with constrains, and for developing new strategies to achieve unexpected results. [...] Computation offers a rich space to play with new media objects. Play shapes learning; learning shapes the mind, mental structures shape software and data structures afford work and play."
[McCullough, 1999]

He also describes how the design process has for this reason two main phases: first, designing a structure, and second, exploring the consequences of working within such a structure. This proves particularly valid when working with modular and emergent systems, as it was explained previously in this chapter. The main reason is that the possibilities of working with such systems can not be defined beforehand, and only through play and exploration we can understand the implications of designing within such a framework.

When placed together in aggregates even the simplest machines can participate in extremely complicated dynamics. The key point for designers to take away is that in order to determine the behavior of some systems, there is no other option but to run them and see how they behave. This is a natural step for designers because iterating between different concepts is a natural part of the design process.

" As computation becomes more ubiquitous and available in small, low power, networked and distributed form factors, computers are entering our shared social space. " [Jeremijenko, 2000].

2.3 Tangible Computation

This section looks at the tangible interface to such ubiquitous computation, covering the development of interface design strategies and applications of computation that exploit the tangible and physical aspects of these new devices.

This section discusses the constrains of an usability approach to designing information containing objects, and which other design strategies we might employ to incorporate social, psychological and aesthetic values into the design process of these new devices.

In addition to the *privatised mobility* we have come to expect from shrinking processors and increasing power efficiencies, some of the more interesting characteristics of this realm of design are the exploitation of peripheral attention (*monitoring*); tacit skills in manipulating physical objects (*intuitiveness*); multiple information retrieval, management and interpretive strategies from a lifetime of manipulating physical devices (*priority, persistence, particularity*) and the capacity for supporting many person interactions within the rich social contexts to which we are accustomed.

2.3.1 From the GUI to the Disappearing Computer

A program for how to make computing an integral, invisible part of people's lives, called ubiquitous computing, was developed by Weiser and colleagues at Xerox PARC in the late 1980s [Weisser, 1991]. One of their hypotheses was that to effectively become part of the environment, computers have to be sensitive to where they are located, who is using them and similar issues related to context. The first devices that came out of the experiments were the tabs, pads and boards. They correspond to different sizes of commonsense objects: objects that fit in the hand (*tabs*), objects that can be carried around, e.g., about the size of scratchpad or a book (*pads*); and objects that are stationary resources, such as wall-mounted boards (*boards*).

Other approaches to interface design, such as *Calm Technology* [Weisser, 1996], were developed. Central to the notion of calm technology is the idea of periphery and peripheral attention. A characteristic property of peripheral information sources is that we can move our attention to them when needed in a seamless, and to some extent even unconscious, fashion. With calm technology, this vision of ubiquitous computing involved considerations on all levels of design ranging from hardware to the aesthetics of computational things in use.

Ubiquitous computing as a term was, at least initially, associated with these projects at PARC, but it is increasingly used as a general term for the research field that these ideas generated. Other related terms are, for instance, pervasive computing, sentient computing, invisible computing, and disappearing computing. The ubiquitous computing experiment at Xerox PARC represents one of the first reconsiderations of what information containing objects are and how to go about designing them, but there have also been other approaches to design for *ubiquitous computing* in the broad sense of the word.

Besides giving computers access to rudimentary information about where they are located, who are using them, etc. the idea with context aware computing is to make it possible for computing systems to infer what the user is doing so that he or she does not have to attend to the machine at all times commanding it what to do next.

The notion of tangible user interfaces represents another critique of GUIs and the personal computer. Early examples include work on graspable interfaces and experiments with tangible user interfaces at Interval. Ishii and Ullmer at the MIT present a design program for tangible bits that states that **"we are seeking ways to turn each state of physical matter —not only solid matter, but also liquids and gases— within everyday architectural spaces into interfaces between people and digital information." [Ishii and Ullmer, 1997].** Thus, tangible interfaces aims to literally turn the physical world into an interface, and to make computational resources available in a way that enables us to use the skills we have developed for manipulating ordinary physical objects.

The concept of *information appliances* [Norman, 2000] is closely related to the idea of replacing the computer with a number of highly interconnected specialised devices in the ubiquitous computing scenario above. Norman argues that what makes the personal computer so complex and difficult to use is that it aims to do too many things for too many different users. By replacing the universal computer with information containing objects optimised for a single task or activity, we can overcome many (if not most) of the usability problems associated with computers. To get more complex functionality, users should be able to combine the functionality of several objects, hence the need for communication between them.

This solution might not be as simple to implement as it might first seem, nevertheless, if we move beyond usability considerations, the concept of information appliances can be an interesting basis for reconsidering what information containing objects might be like.

The approaches described above are all examples of how the personal computer and present interaction design have been challenged, and how computers instead can be made part of everyday environments. Designing information containing objects is, however, not only a matter of making the interface reach out into the world, but also a matter of what we consider computer use to be about.

2.3.2 Computer Use Revisited

Considering the use of computers as approached in HCI, the notion of usability is central. Definitions of usability vary, but the following five attributes can be considered typical: Learnability, Efficiency, Memorability, Errors and Subjective satisfaction.

In the actual practice of interaction design, usability is not necessarily restricted to these attributes and so a list should not be seen as exhaustive. However, it gives a general idea of how computer use is approached, what criteria are used to determine the quality of a design and that the underlying premise is how to make people more productive.

It is obvious that the usability approach to design leaves out aspects of use that are acknowledged in other areas of design for everyday life. In fact, the basic premise of technology use as a way of increasing productivity, is in many respects incompatible with everyday life.

While the desktop computing paradigm has been challenged in a multitude of ways, we see little development in the understanding of what it means to have information containing objects present in our everyday lives. There are, however, examples of how to break away from this perspective on computer use. Dunne argues that:

“The result [of the Human Factors approach to design], as the computer industry merges with other industries, is that the optimization of the psychological fit between people and electronic technology, for which the industry strives, is

spreading beyond the work environment to areas such as the home which have so far acted as a counterpoint to the harsh functionality of the workplace."
[Dunne, 1999]

To open up for new perspectives on electronic products and reduce this tight *psychological fit*, Dunne has explored the notion of *parafunctionality*, a kind of *functional estrangement* by means of creating a *poetic distance"* towards the object. Another set of examples of new possibilities in the design space of information containing objects are the conceptual information appliances presented by Gaver and Martin.

"Suggestions for how digital technologies might be employed in everyday settings tend to represent a narrow range of cultural possibilities, reinforcing a simple dichotomy between work and play. Other values seem rarely to be addressed at all."
[Gaver and Martin, 2000]

The information appliances presented by them are instead designed to uncover new places for technology in everyday life by exploring different values, emotions and desires. Clearly, these proposals challenge traditional assumptions about computer use and support development of new possibilities for the design of information containing objects.

We can also consider the research programs that introduced novel approaches such as ubiquitous computing and tangible media, as they tend to use both artworks and experimental design objects as illustrations. For instance, one of the primary examples of calm technology — the *Dangling String* — is made by an artist, Jeremijenko [Jeremijenko, 2000]. Bishop's *Marble Answering Machine* is presented as a source of inspiration in tangible media [Bishop, 1998]. Further, experimental design by Dunne and Raby on *Fields and Thresholds* has served as inspiration for work on interfaces that act in the periphery [Dunne and Raby, 1999]. What is inspiring with these examples is not their practical functionality nor their technology, but how they differ from more traditional human computer interfaces.

When we turn to everyday life in general, we have to extend our notion of use to encompass aspects such as social and aesthetic qualities as well, and therefore, a strict focus on usability is not sufficient. Given the expected impact of computational technology on everyday life, it might even be the case that usability is problematic.

Box is an attempt to abstract information structures from specific contexts, in order to analyse the dynamics of information flows.

While the name of the system makes reference to the idea of *container*, it also implies notions of *modularity* and of *physical presence*.

3 The Model

This chapter will describe the box model: its visual language, properties and rules. By definition, box is a flexible, modular architecture that combines individual units or constructs, connected in specific configurations to represent dynamic information structures.

The model is conceived as a tool to visualise, analyse, and create information networks. It allows the representation of a diversity of structures, from real-time, synchronous, peer to peer communication devices to more complex community based platforms for discussion and knowledge exchange.

3.1 Visual Language

A visual language has been defined to better understand the intrinsic characteristics of information flows. It allows the visualization, analysis, and creation of platforms for communication and information exchange.

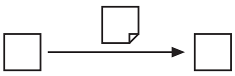
This generic language allows the representation of a diversity of structures: from real-time, synchronous, peer to peer communication devices to more complex, asynchronous, community based platforms for discussion and knowledge exchange.

The languge is conceived as a tool to create semantic diagrams of information networks, visualizing the flow of information and the process of transformation that suffers on every node of the network.

By representing and visualizing with a coherent language the abstract components of information networks, we can better analyse the basic mechanisms that govern a particular platform for communication or information exchange.

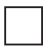
The visual language presents analogies, and builds up on existing diagrammatic languages used to describe flows, like electronic circuits and computer processes.

3.2 Elements



The model for this visual language is based on three basic types of elements or constructs: Objects represent entities wich hold or perform operations, Channels connect those elements in order to allow the flow of Data between them, creating a particular data structure.

3.2.1 Objects.The Constructs



An object is a modular element that contains, transmits, transforms, inputs or outputs data, and that can be interconnected to other objects in order to create dynamic information structures.

3.2.2 Data. The Content

Data is any piece of digital information that can be processed by the system. Data types vary from single string variables, to relational databases, to streaming movies or interactive content.

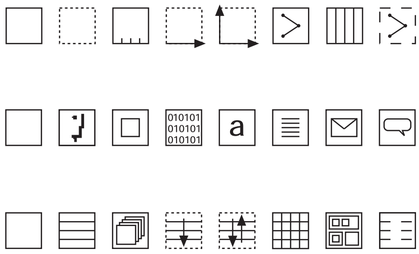
3.2.3 Channels. The Medium

A channel connects two objects and allows the flow of data between them. Channels might be uni or bi-directional, might be synchronous or asynchronous and have different properties that will affect how data flows through them.

3.3 Typology

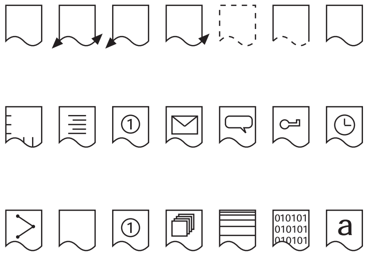
3.3.1 Containers. The Structure

Containers provide the structure to hold a number of data objects in a specific configuration. Containers might vary from simple lists or folders to relational databases.



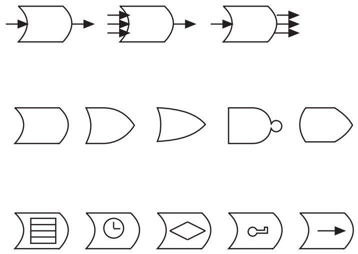
3.3.2 Transformers. The Algorithm

Transformers perform a specific operation with the data that flows through them. They can filter, perform mathematical operations, index searchers, etc. or execute any action with the incoming data.



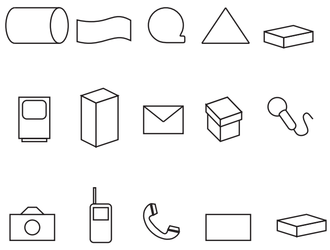
3.3.3 Transceivers. The Flow

Transceivers provide the mechanism to route data between one or many emitters to one or many receivers, allowing control of the flow of data following dynamic criteria.



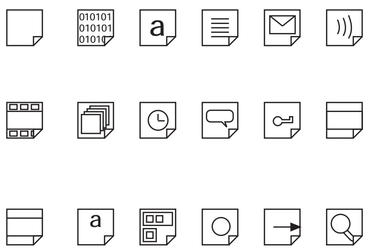
3.3.4 Interfaces. The Action

Interfaces both gather and broadcast data from and into the environment. While some of them are simple devices with limited functions and affordances, more complex interfaces can create visual and physical representations of data.



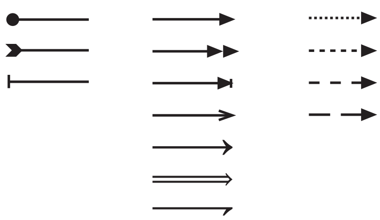
3.3.4 Types of Content

Box model can visualize flows of any type of digital media. From simple signals, strings or sounds, to more complex streaming video or interactive formats. The model defines objects for individual units of meaning, like link, result, or time.



3.3.4 Channels. The Medium

Channels connect different modules of the system to allow the flow of content between them. Channels can be synchronous or asynchronous, and have some properties that might limit or affect the content that flows through them.



3.5 Properties of the model

Sequentiality
Objects perform one operation at the time.

Distributed
Objects perform operations independently from other objects.

Communication
Every object or network has at least an input/output value.

Variability
Properties of the objects modify the behaviors they perform.

Adaptability
Properties of the objects can be changed by other objects.

Reproductibility
Objects or networks might have multiple output values, all identical.

Automation
An object or network perfoms an operation as soon as it receives input data.

Modularity
An object or network can hold any combination of other networks and objects.

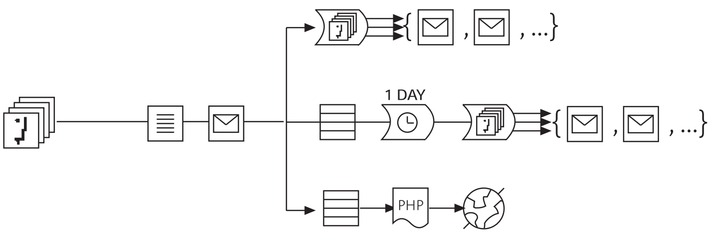
Dynamism
Any data or properties of the objects or networks can change at any time.

Recursion
The ouput value of an object or network might become its input value.

3.5 Visualizing Flows

Combining this elements in specific configurations, this visual language allows the representation of a diversity of structures.

In the following example, the underlying structure behind an email list is visualized. The original message is routed directly to the group of subscribers, stored in a list and sent after a period of time with other messages (digest mode) and sent to the internet to be stored in a web archive:



In a similar manner, the visual language can visualize platforms for information exchange, communication, debate, media sahring, socializing, or any other activity taking place through information networks. In the fifth chapter some of these networks will be illustrated next to the diagrammatic representation of its internal structure.

Examining the characteristics of information containing objects, and connecting them to the architecture developed with the box model, we can speculate and generate dynamic information structures.

4. Information Containing Objects

This chapter describes the experimental approach followed for the design of information containing objects. An initial review of the characteristics of physical information products, and the modular nature of the box system, suggested a collection of multipurpose modules that could be used in different networks.

As the focus of the research is on the internal structure, classical design issues on the design on physical objects were not considered. A basic cardboardbox provided the frame to hold the basic interface of each module. Boxes present only one simple function, emmiting or receiving data. The meaning of the object is dependant only upon the network is connected to.

Model and picture by Henry Newton Dunn, CRD 00

4.1 Properties of Information Containing Objects

When designing information containing objects, we need to consider the use of physical interfaces (tangible media) as a design strategy, and the implication of a physically based design approach for the development of information products. An important step will be on examining characteristics of the physical presence of information containing objects that can be used to design information products.

Peripheral Presence

The visibility of physical objects does not map completely to the attention given to them, unlike digital counterparts. They can be thought to have an independence from their users' attention scheme because they do not appear and disappear according to whether they are in use. They are therefore attention-directing devices. As such, physical devices can exploit peripheral information cues - sound and movement - to indicate state change, thereby unobtrusively redirecting attention when needed.

Particularity

Physical objects are a non-abstractable representation on actual space, providing a stronger presence on our schemas than those on the computer screen. Thus, physical devices might enhance the meaning of the information they contain, adding values and attributes not present on the digital space.

Locality

Physical objects have a particular position in space, and, unlike digital objects, only have one instance at any particular time. This provides a particular context to the information they contain, that can be exploited when designing information products.

Priority

The priority given to an object with which one shares the physical environment, has to do with 'planning' environmental interactions that are unpredictable. The objects involved are placed as obstacles to come across or to interact with in conscious or non-deliberate ways. Tracing this strategy of putting things in ones paths and arranging the physical environment as an information space informs the design of information environments.

Persistence

Physical objects - in contrast to digital objects – are persistent; they do not 'disappear' when they are not in use. An aspect of such persistence is peripheral accessibility; physical objects continue to be where you left them and are therefore readily accessible for just-in-time reference.

4.2 The Cardboard Box

To experiment with the box model and tangible media, a collection of modular, wireless, tangible objects is proposed.

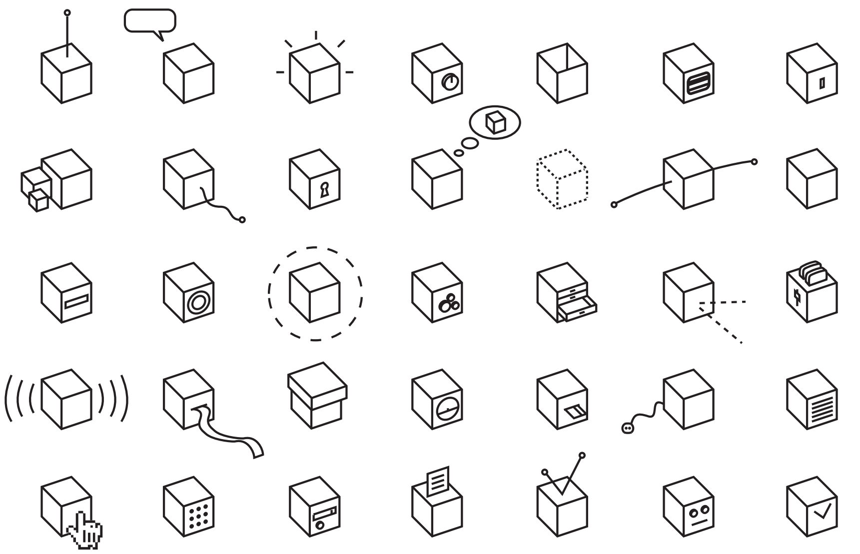
These objects have just one function and limited affordances. For instance, one of these objects presents an antenna that goes up and down, another one detects movement nearby, another one emits sounds, etc. Some of them are able to display information through an embedded screen or a small printer; others are able to gather data through sensors, switches or potentiometers.

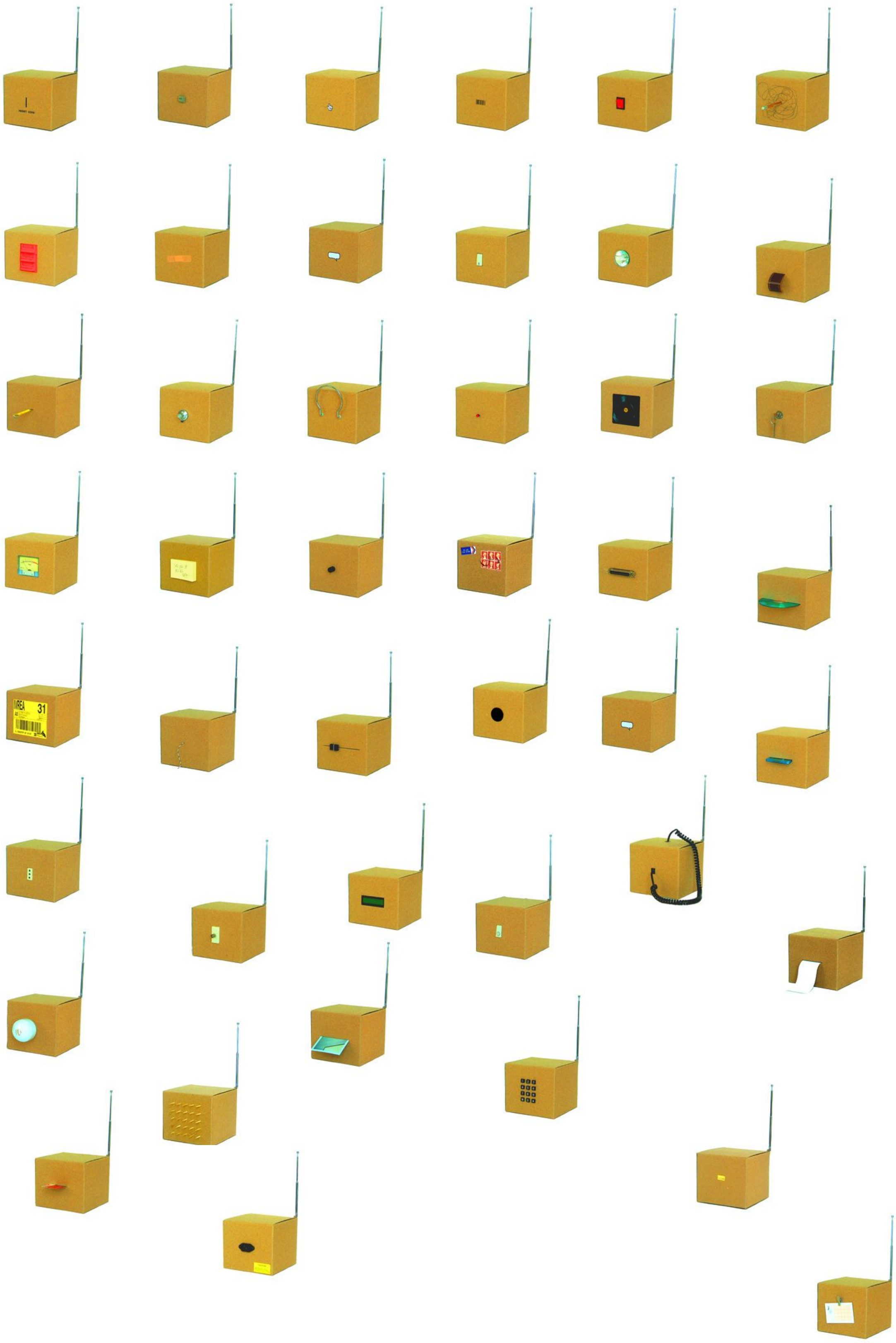
The modular nature of these objects allows the configuration of more complex artefacts interconnecting them with the virtual elements of the box model.

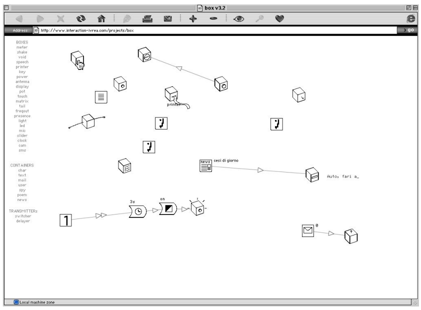
Boxes have been designed in order to serve two main purposes. First, they allow experimentation with the visual language defined before in order to create dynamic information structures; and second, they act as tokens inside a certain group or community, opening new channels for communication between participants.

The design of these objects does not consider issues about material, formal shape, or semiotics of physical objects, as the focus of the project is on the internal structure rather than on its external interfaces. As they are multipurpose, they present a plain design, because its meaning depends only on the content that flows through the structures they are attached to.

Their size responds to the need of being portable, e.g., an object that you can place in any location but that you don't carry around with you; and present a small antenna to indicate they are networked and have the ability to communicate wirelessly with other entities.







4.3 Implementation

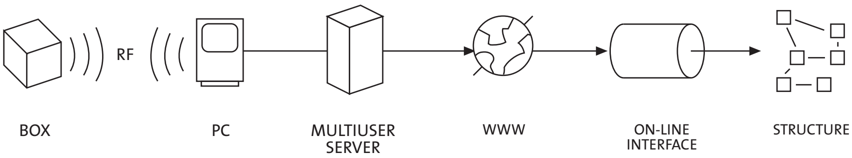
Boxes can be distributed around a building or public space, and share a connection with the internet communicating with a PC through RF technology. Every PC acts as a network node that can control up to 255 boxes.

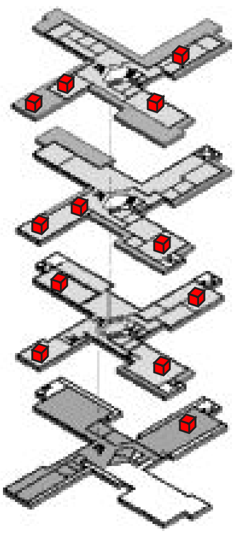
Boxes are implemented combining a micro-controller, an RF communication module and the specific interface of each object: a display, switch, sensor, motor or any other simple electronic device integrated within the object.

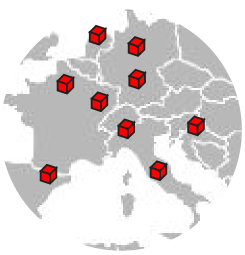
Boxes are assigned an unique ID number. Packages of serial data are sent and received from the central hub. A special protocol controls and synchronizes the communication. The wireless hub connected to the personal computer shares the incoming and outgoing serial data with the engine running on the multi-user server.

This server holds the inherent structure that can be accessed through a normal web browser. Thus, any participant can view and modify the internal structure of the system from any location: they can interconnect boxes that are far away from each other and make more complex structures with the virtual elements of the visual language.

As the structure is stored online, nodes can be placed on remote locations, allowing platforms for communication and information exchange between boxes far away from each other.







This separation between tangible objects and virtual structure provides an environment with unlimited potential for expandability, based on the recombination of simple virtual constructs with a number of information containig objects.

This architecture has obviously its disadvantages, since the communication takes place through a centralized server, at the first level, and, at the next level, through a computer connected to each one of the hubs on each location. While this might seem at first place a contradiction with the distributed model of the system, it is important to remember that the model is based on the social and semantic values of these networks, not on the technical infrastructure that supports them.

What is important, is that participants can engage in the construction of platforms not worrying about the mechanisms behind them, and can concentrate on what kind of interaction they really wish to perform, between local and distant objects, data and people. Furthermore, they can adapt and modify this interaction using the virtual constructs provided on the online environment, observing the effects on the tangible objects in real time.

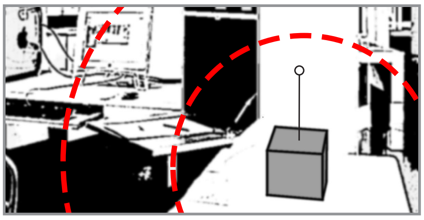
Box system allows configuration of networks between information containing objects on remote locations through its online visual language. It provides a construction kit, a participatory platform to encourage discovery and exploration inside a community.

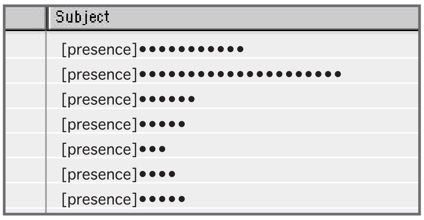
5 Networks

The following structures provide illustrations of possible applications of the box system inside the context of a connected community, Interaction-Ivrea. They do not try to be extensive, but rather to open up new design space and raise questions about the meaning of information networks.

As with any complex system, possible applications and outcomes will only be discovered through play and exploration with its elements and constructs.

It is the intention of this programme to allow free experimentation with boxes and the visual language through the online interface, to promote the creation of emergent social networks between participants.





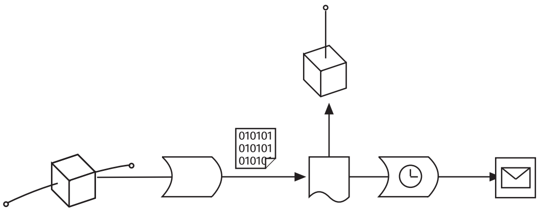
Concept for E-mail visualization:
Athena Anagnostopoulus, 'Petquake'. CRD 01

Awareness

Presence boxes that detect movement are placed around the building. Their activity levels are collected, and their average value is mapped to the height of antenna boxes: The higher the antenna, the more activity on the building.

This platform explores characteristics of physical objects like persistence and peripheral presence.

An alternative output of the data could be the subject line of an email message: remote users could subscribe and have a permanent reminder on their email software of the activity on a remote location.

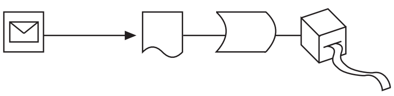


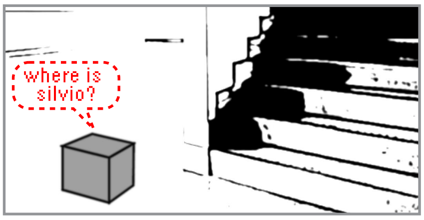
Announcement

Subject lines of messages sent to the email group of the community are printed on a small ticker-tape printer. As time goes by, this piece of paper becomes an archive of the community's activities, conforming a meaningful diary for its members.

Furthermore, this platform can be used as a platform to make announcements and comments that will be perceived in a different way that those existing only on the computer screen.

This platform explores notions of persistence, and the non-abstractable nature of physical objects.





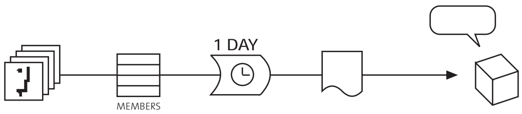
Builds up on 'HERO, the Helpless Robot', Michael Kieslinger, CRD 00

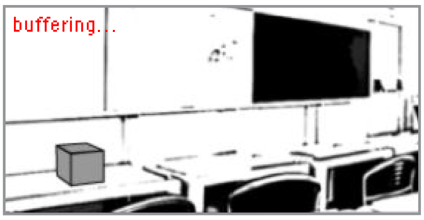
Play

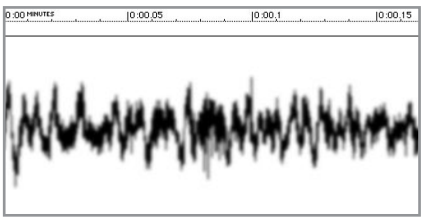
A voice box asks to be taken with a member of the community every certain period of time.

This simple structure pretends to illustrate how play can foster social interaction between members that otherwise might not have contact inside a community. It also explores notions of locality and particularity.

Furthermore, any participant looking at the online structure could know who has the box at any particular time, and send a specific message to this member that would be spoken through this box. Spontanous use is one of the main goals that an open system should seek.







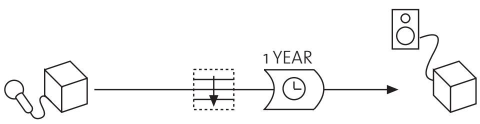
Builds up on 'Slow Mirror' CRD 01

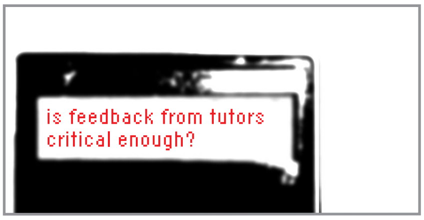
Archive

A recording box registers sound and stores it on an online buffer. The sound is played back exactly one year later hrough a speaker box.

This would enable, for instance, that a teacher could listen to himself explaining the same lesson one year before, or that students could eventually listen to a conversation with an alumni that has left the institute by then. Or someone might decide to leave a message for himself the day of his next birhtday.

This structure aims to illustrate that by combining tangible objects with virtual constructs, new uses and functions can emerge that were not thought of beforehand. What do this objects become? Where is the sound actually stored? Does it actually matters?



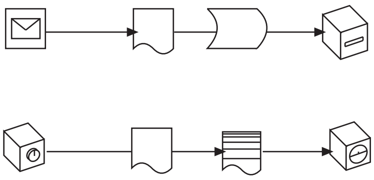


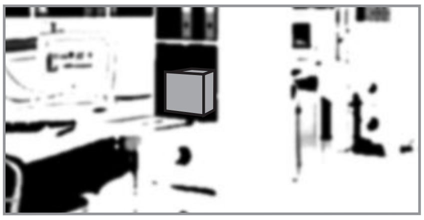
Debate

Members of the community can post a message on a screen BOX by sending an email message or typing directly into it on the online environment. Other participants can vote whether they agree or not by moving the slider on another BOX. Accumulative results over time are shown on a meter BOX, thus reflecting the average response from the community to the question posted.

This structure aims to illustrate how by combining a small number of BOXes more complex platforms can be created to encourage debate and participation.

Open issues are whether the system is transparent enough for users to understand the meaning of each of the BOXes without looking at the online environment, and how a code for interpretation has to be agreed beforehand in order to make these tangible objects meaningful.



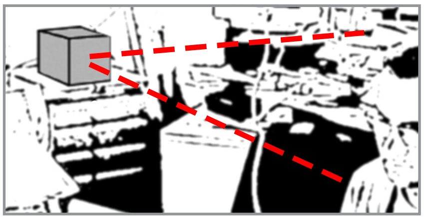


Moderate

A key box is given the affordance to lock certain parts of the online structure, thus allowing a particular member to control and moderate the system.

This box aims to illustrate the need for some kind of centralized strategy in order to control who owns a particular platform, who can modify it and how this process should be governed.

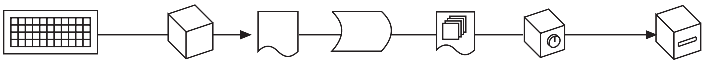
Would participants try to keep the keys for themselves? Would then other participants try to take away the BOX with the keyhole? Would they try to hide the box to avoid control of the open system?

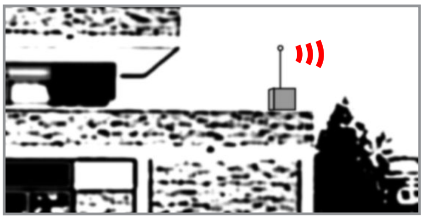


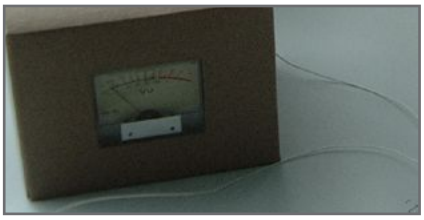
Privacy

A void BOX connected to the keyboard registers and sends online everything typed into the computer. Other participants can scan the archived texts turning the knob of a security BOX.

This structure aims to raise issues about privacy and security. Would members feel comfortable knowing that everything they type might eventually become public? Would they feel better unplugging the void BOX, even knowing that software might still be capturing their keystrokes?





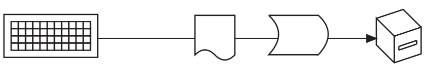


Remote

A meter BOX is directly connected to the keyboard of a partner on a remote location in order to be aware of his/her presence on the computer. The ASCII codes of the keystrokes are translated into a numerical value that will be reflected by the meter.

This structure aims to illustrate how to set up the system in order to communicate with distant participants. A code can be agreed between both users in order to add meaning to the apparently random movement of the needle; i.e., when I hit the Enter key, with a low ASCII value, it means I'm away for a while; If I hit letter Z, with a high value, it will mean I'm off for the day.

This way participants can develop their own code of interpretation, creating a channel that only they will be able to understand. We can see examples of such use of communication technology on special combination of characters sent to beepers and mobiles by teenagers that only they are able to decode.



With the proliferation of ubiquitous technological devices, the integratioin of a semantic web and the extensive use of computer networks to play, work and communicate, we, as designers, need to consider the issues, values and opportunities offered by these new technologies.

5 Analysis

This paper introduced some concepts and theories about connected communities, distributed structures and tangible media, and presented the box system: its visual language, collection of physical objects and how this system has been implemented. It also illustrated some simple possibilities of the system in the context of a connected community. While the development of the system is still at an early stage, initial implementation has proved feasible and expandable.

The system, although being a response to one of the initial research questions, does not present any conclusions about the effect of tangible media on information networks. Rather, it suggests that a modular, open approach can be an interesting starting point to design dynamic networks: new objects and environments mixing the virtual and the real.

The paper justified the design of a collection of simple, multipurpose devices, by looking at different approaches to tangible computation and applying the notions and principles of software architecture to the world of physical artifacts.

It underlined the message of *design your own network*, explaining why an open, distributed model is appropriate for the design of social networks. It proposed a generic abstraction, both visual and physical, to represent and configure information networks.

5.1 Evaluating the system

The system is self-explanatory enough for participants to understand its model after a short learning curve, and, at the same time, offers almost unlimited potential for expandability, as new physical objects and virtual constructs can be added on top of the existing platform. Combinations of constructs performing specific algorithms can be shared and re-used.

The system scores well in appeal and motivation. Results can be experienced on real time: as modifications on the on-line structure are made, immediate, relational cause-effect is visible on physical objects. This interaction provides an ideal environment for play and exploration with an interactive network made of physical objects and virtual structures.

The boxes, while plain and simple, provoke interest as they are open for interpretation. They provide a neutral frame to hold a node, a function, a location in space. The physicality they add to the networks brings up a number of issues that ask to be explored. As boxes are multipurpose they can be reused on different platforms over time.

Due to the modular nature of the system, simple structures, like the examples described on the last chapter, can evolve in complexity and start to function as networks between distant participants, integrated with content from e-mail lists, on-line sites, or databases. While there are issues that have not yet been considered, like usability, feedback, security, property, etc, the proposed model opens up a new design space that suggests further exploration.

5.2 Directions for future research

Initial implementation prototyped a small number of objects configuring simple networks and behaviors. The next milestone of this programme is to create a robust, error-proof platform to allow online access and a high number of boxes on remote locations. The typology of constructs of the visual language, an efficient graphical user interface, protocols and an online database to hold the structure and its content, are elements that must be implemented.

At the physical level, different configurations must be considered in order both to reduce costs and to allow distribution of initial kits of electronics to create custom devices integrated with the network. Exploration with different technologies and with different networks will be encouraged.

While ambitious, the programme expects to offer, rather than a significant conclusion, a new space to promote experimentation with information networks, being the learning process of design, test and implementation the main benefit to take away from this constructive activity.

5.3 Conclusions

Wireless networks is one of major trends on the technology industry, there are enormous amount of research being undertaken on open standards, protocols and technologies, both on personal area, satellite and mobile telephony networks. There is access to these networks almost everywhere, and sooner or later they will become cheap and fast and integrated with most technological devices.

With the proliferation of these devices, the integration of the semantic web, and the extensive use of information networks to play, work and communicate, we, as designers, need to consider the issues, values and opportunities offered by these technologies.

For the purpose of this paper is enough to assume that this connectivity will exist. The initial implementation proposed for the box system only aims to prototype a construction environment, and not a sustainable platform for every situation and type of community. The technology used to implement it is only a tool to represent a model, and does not pretend to be a solution to a problem.

What is important is that rather than providing a closed platform, with a set of devices and specific content and relations —service—, it proposes a construction kit to create personal networks, based on generic devices and a translucent online interface.

Although it is, at least today, almost an utopian idea to think that we will be able to interconnect every electronic device creating our own networks, it is useful to imagine and experiment interconnecting all kinds of media and machines, to better understand the design of information structures: a medium with a level of interaction that can offer surprising and unexpected results.

By abstracting the basic elements of information structures, and speculating with them free from commercial constrains, this project expects to encourage the creation of self regulated networks, between objects and online information, and primarily between people.

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Box. Open System for Connected People