Permeability Regimes between Man and Interactive Spaces

Programming the dialogue between the sensing, processing and actuating aspects of performative and interactive architectures

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Abstract. In this paper we will present the permeability regimes: concepts conceived to contribute with the understanding of the new roles and necessary skills for the architect and designer to design performative and interactive spaces. This contribution, as will be shown here, is based on theoretical and empirical bases that will address a specific context: the methods for introducing and making tangible the relation between information, human and space for architecture students. Therefore, we will describe the dynamics of an interactive installation developed by undergraduate students, relating it to the permeability regimes.

Keywords. Digitalization; interface; mapping; hibridization; permeability.

INTRODUCTION

Permeability regimes between man and interactive spaces are metaphors where the relationship between users or designers, and the use or design of an interactive space are seen as three different possible relationships between an observer and a mirror: mirroring (mirror generation), transparency (making the mirror transparent) and traversing (of the mirror).

With these regimes we aim at helping the understanding of the relationship between the physical and informational aspects of interactive spaces which, alongside human aspects, favor the rise of behaviors. These behaviors, depending on the mathematical model implemented via algorithm and the resulting spatial / environmental transformations, may aim at achieving an optimal state in terms of environmental comfort, energy sustain-ability, etc. However, discussing the implementation of algorithmic models to achieve specific goals is out of the scope of this paper. Here we will discuss how the permeability regimes, together with the Quimeras System (a reprogrammable set of software fragments), conform teaching strategies for the conception, design and programming of the sensing, processing and actuating aspects of performative and interactive architectures. The sensing aspect involves the input of environmental information through sensors. The processing aspect, in turn, involves the algorithmic implementation of mathematical models that process this information and guide the control under actuating. Finally, the actuating aspect defines the realization of transformations in space from the control of electromechanical elements. These strategies were used in a subject in
the undergraduate Architecture, Urbanism and Design Faculty of the Federal University of Uberlândia, Brazil. One of the outcomes of this course was an interactive installation, which will be described here.

**PERMEABILITY REGIMES**

**Mirroring**
The relationship between a user and the interactive space is articulated and made possible by what we commonly call interfaces. These interfaces relate to the user and with the environment through inputs and outputs of information that make informational and computational processes - initially intangible to the user - viewable and manipulatable. It is worth noting the ambivalent nature of these interfaces, as characterized by Siegfried Zielinski (1997) when he describes them as a field of tension (Schnittstelle: “the place of rupture” in German), which coordinates the connection and separation between, in this case, man and interactive spaces. The interface connects because in it the similarity between those who seek to connect with each other is built: the connection happens between what is known on both sides. The interface also obliterates the unknown differences between those who communicate. Drawing an interface, therefore, means generating a mirror. A mirror that, on one hand, makes familiar, tangible and usable, by the use of metaphors, the logical processes imposed to matter and energy in the electronic circuits. This mirror, on the other hand, limits the way we access and modify these processes.

**Transparency**
Making a digital interface transparent would mean operating a transparency on the mirror with the intention of leaving the mechanisms, which were behind and obstructed by the interface, exposed.

As we shall see, however, making the interface transparent will not reveal the material mechanisms (mechanical/electronic) behind the interfaces in the interactive space. This clearance will reveal another obstruction/connection: successive internal and pre-established interfaces that communicate with each other by inputs and outputs of information, as understood by Claude Shannon (1940) and Norbert Wiener (1962). These properties make this space interactive and its interfaces something very close to what is meant by “black box”, whose mechanisms and internal processes can only be inferred or deducted from its outside.

Making an interface transparent in order to operate in the interface right below would mean the possibility of recreating the outmost black box from the innermost black box. Thus, transparency and mirroring end up being complementary. In this succession of cleared mirrors, the combinatorial, mapping and digitalization operations are recurrent. The combinatorial operation recombines the elements that structure the mirrors/interfaces/black boxes. In addition, this combination favors the mapping between domains: light, movement, images, sounds, etc. are translated and orchestrated by pre-programmed logics. Such mappings only occur because the concept of information was modeled and implemented: something that would cross and organize bodies (sound-body, light-body, matter-body etc.) without being contaminated, i.e. remaining autonomous. Finally, in digitalization processes this information is quantized and discretized, therefore converting analogue domains in binary numbers. Ultimately, these numbers organize states of matter/energy of the computer following the constraints of what we could call “computational coherence”: the juxtaposition of what can be modelled in logical terms; what can be modelled in mathematical terms; what can be modelled under the Information Theory terms; what can be modelled in computable terms (as seen in Turing Machines). These constraints establish that in every moment of the interaction with a computer (operating or programming it) one has to deal with a set of finite number of elements/variables and states of the machine, discrete entities, all structured in a logical way.

**Traversing**
To get through the mirror, we must change the concept of information as understood in the previous
regimes: we must not see the communication between domains as information transmission (something autonomous in relation to the environment where it propagates) but as resonances between bodies under transduction processes, as understood by Gilles Deleuze (1976) and Gilbert Simondon (1991). If interpreted as such, this communication comes to be seen as the hybridization of bodies or domains. Traversing the mirror therefore means breaking the fiction of impenetrability of the mirror, the intransparency of the black box and the fiction of information autonomy, thus shifting the emphasis from the poles (human x interactive space, physical x informational aspects, information x body) to what is in between, i.e. the hybrid that inhabits the tension between these poles. If understood as such, traversing the mirror is no longer impossible and becomes the only really existing operation.

SENSING - PROCESSING – ACTUATING
In order to draw the relationship among the sensing, processing and actuating aspects of an interactive space, we must temporarily regress to the transparency regime and consider the fiction of autonomous information so that we can establish the informational dialogue between black boxes from the articulation between the following fundamental operations: digitalization, combinatorial and mapping. For programming the interaction between such informational aspects of interactive and performative architectures, we propose exercises involving these fundamental operations through experimentations with the Quimeras System.

**Quimeras System**
The Quimeras System is a collection of computing solutions composed of small pieces of software that are grouped and reprogrammed in a way they can be easily expanded, mapped and recombined among each other. They are divided into three main modules (sensing, processing, and actuating), which in turn are subdivided into sub-modules. The sensing module is subdivided into sub-modules that address robotic vision, structured light scanning, video capture and audio capture and analysis. The processing module is responsible for computing solutions for the treatment of information collected by the “sensing” module and for coordinating the actions of the actuating module. Its sub-modules are subdivided into: artificial intelligence, generative and genetic algorithms, video synthesis, video processing, audio synthesis, audio processing, virtual and augmented reality, 3D modeling, communication protocols (TCP/IP, OSC, UDP), etc. The actuating module is responsible for turning the digital level into physical and tangible actions, therefore promoting the dialogue between the processing module and actuators. Its sub-modules are: D/A converters, servomotors control, stepper motors, video projections, audio amplifiers, etc.

Thus, recombinations and mappings between the sensing and actuating modules may be linked to automated modeled operations in the processing module, and compose complex activities when interlinked to algorithms of artificial intelligence, robotic vision, generative systems, genetic algorithms, etc.

Various dataflow programming platforms are used in the composition of this system, e.g. MAX/MSP, PD, ISADORA. These platforms may expand and establish relationships with programming languages through “code lines” such as C, C++, C#, JAVA, Processing, JavaScript, Python, Ruby etc.

**BLENDING THE PERMEABILITY REGIMES AND THE QUIMERAS SYSTEM**
In the “Architecture and Interaction” classes (at the Faculty of Architecture, Design and Urbanism of the University of Uberlandia - Brazil), we opted for an empirical approach: recombination exercises between modules and sub-modules in order to establish the existence of the mirror, and then accomplish its transparency. However, as we have seen in this article, transparency is not sufficient for understanding the hybrid nature of the interface. In order to understand this nature, we propose a change of perspective in the idea of information (from Shannon), introducing the students to the concept of trans-
duction: the recombination between the modules was only possible because there were “resonances” between “bodies”. This resonance emphasized the non-neutrality of the medium, the transformations that it operates, highlighting even more the artificial aspect of the mirror. At this point, we intended to show to the students that there is something beyond modelling established by the “computational coherence”. The computational coherence is extended by what we called “consistency of the medium”, which emphasizes the participation of the body in the creation (and not only “transmission”) of information and the mutual contamination between bodies that are communicating.

By broadening the relationship between the digital and the analogue we intended to show the possibility of understanding the indeterminable and the accidental not as noises to be avoided but as essential qualities. These qualities can virtualize and create new meanings and actualizations from what was logically planned and organized in computational coherence ways.

However, when confronted with the experiments that used the modules and sub-modules of the Quimeras System, the theoretical explanation was in contradiction to what was experienced. The students had been exposed to “computational coherence”: to the Boolean logic, to programming logic, in which the information has been experienced as “information from Shannon”, which can be converted into numbers and thus recombined. Theoretically speaking, the constraints of the computational coherence are quite restrictive. However, in practical terms, after surpassing initial technical difficulties during the learning process of programming, the students are “enchanted” by the “almost” infinite possibilities. In fact, in perceptive terms, the possibilities are endless. But in logical and mathematical terms, the universe of possibilities is finite. In order to solve this contradiction it’s important to distinguish between the possibilities of what can be computable (within the digital circuits) and what can be brought to the tangible world (in concretization processes, as seen in Simondon). The difference between “virtual” and “potential”, as seen in Deleuze (1976), helps in this distinction, relating the possibilities in the computer as being “potential” and the possibilities in the tangible world as being “virtual”.

Returning to the information/transduction issue, how could we talk about bodies, resonances, contamination, if the previous experience (despite the fact it has paradoxically broaden the options) was based on a sort of submission to the computational logic and consistency?

The starting point in this direction was the construction of the understanding that the computer is not an isolated entity. We introduced the idea of a computer as a technical-object in a concretization/individuation process (as seen in Simondon), whose inner workings are transductions and whose interface with the “external side” does not end in the physical limits of a keyboard, a monitor or any other conventional interface. Its interface includes and transforms bodies, forming quasi-objects, in the sense established by Bruno Latour (2005), that are continuously intertwining and recreating each other mutually. In this process, different bodies histories blend together and new histories emerge from that. The computer boundaries are blurred, as are the limits of the environment where the computer is located, the limits of local and non-local, individual and collective, past and present. By promoting this mixing, the interfaces change what is mixed.

From the foundation provided by this concept, a work was proposed in which the student could problematize these issues empirically.

In this work, the students should reflect on the temporal dimension of a technical-object/quasi-object in a network formed by human, technical-objects and the space. Based on this discussion, the students should use the modules covered in the previous exercises (where they could freely recombine the modules and sub-modules) and compose a new interactive installation. In this way, the temporal dimension should be drawn from the combination of modules already studied and a sub-module especially designed for this exercise. This special sub-module was a combination of components
(small programs) of robotic vision (which tracks the direction and amount of movement), an automated video recording system and a system that would read / play automatically recorded video files. Certain combinations of these components enable the construction of systems that automatically recorded and exhibited video clips, depending on the user input. After working with these systems the students should make questions about temporal matters relating to space, imagining possibilities for juxtaposition or interpenetration between past and present in space. From these demands, both theoretical and practical, the students should choose a location on the campus of the Federal University of Uberlândia to conceive and perform an interactive installation.

**INTERACTIVE INSTALLATION – “BETWEEN MIRRORS”**

The site chosen for the installation was a corridor located on the ground floor of the Course of Architecture, Urbanism and Design building of the UFU. In this corridor an interruption was built: two screens, separated by a distance of one meter, completely occupied the cross section of the corridor. These screens received projections on their outer surfaces (the sides facing the corridor and not the internal space generated by the two screens). Each of these screens had a vertical opening where people could walk through (Figure 1).

When confronted with the first screen, people could see images projected on it. These projected
images during the movement of the user towards the installation were pre-recorded images of the same corridor (recorded ensuring the alignment between perspective of the corridor and the perspective of the projected image) showing unusual situations prepared by students: a procession with people carrying candles in the dark; an attack about to happen to a person sleeping in the hallway; a body being dragged down the corridor, a person walking and accidentally dropping a bag with a leg inside (Figure 2).

These sequences were randomly recombined by software (programmed in MAX/MSP). The user, when moving towards the screen, could watch this mix of video clips. The approach of the person, thus, generated a different narrative.

Sometimes, the user passed without paying attention to the projection. On other times, however, his attention turned to the screen. One of the possible reactions was to continue approaching and watching the images without stopping, until reaching and crossing the screen. Another possibility was to stop and to try watching what was projected. In this case the narrative was interrupted and he ended up watching himself in the projected image (the projected image was captured by the same camera in the same position used to shoot the pre-recorded images; in this way, the images of the corridor, even captured at different time points, past and present, would fit perfectly).

That image, however, would cause a certain cognitive strangeness: the image that the user saw had
a small delay, whose duration could vary within a range of seven to twenty seconds (Figure 3).

This time lapse generated different reactions: people would begin to move and make gestures, waiting for the projected image to repeat their behaviour; or just stop and wait for someone else to pass by. Some people, when realizing that the narrative was interrupted by the moment they stopped, they continued to walk towards the mirror. By continuing the approach, those unusual narratives started being projected once again. When getting too much closer, the user could not observe what was projected and would eventually decide to move backwards to a better position. During the backwards movement, different images were automatically projected: images recorded exactly one hour before this point in time. Therefore, each retreat triggered a different sequence of images that would never be seen again (Figure 4).

This image dynamics built a chain between the temporal dimension of the corridor and the people (scenes of a fictional past, scenes of almost-present/almost-past) mingled with the present time, creating new narratives at every interaction. In this sense, the interaction worked as a game where you could play with time.

Unexpected uses also happened: people not only passed through the screens, but also stopped and stood in the space between the screens, watching the projections from within (when no one was passing in the corridor, the system was programmed to randomly project any recorded image).
TRAVERSING PROTOTYPES

In relation to the creative process, it’s important to emphasize the prototyping approach applied to the development of the interactive installation. The interaction of the programmers with earlier versions of interactive installation and its users inspired new ideas of how differently it could have been modelled. A great amount of possibilities resulted by this interaction and enabled continuous reprogramming and actualizations of the interface. By the confrontation between what was “imagined” and translated into a logic and finite model, between what was programmed and what was the interaction finally obtained, the students could grasp the complementary relation between the “computational coherence” and “consistency of the medium”.

In technical terms, the students (under my supervision and programming support), recombined several sub-modules (computer vision; studies of real-time video processing; projection). During this recombination, new pieces of software were created and incorporated into the Quimeras System.

CONCLUSIONS

While we understand that the generation of interactive and performative architectures involve an extensive multidisciplinary work in an effort to meet specific and complex demands, we have proposed in this paper a feasible path to be tested and expanded in the problematizations developed.

So far, we could verify an enrichment of the creative process of these spaces when we empowered
students/designers with programming resources and with the theoretical approach presented here. The resulting critical view and the empirical side of this work by the making of mockups, prototypes, and spatial interactive interventions, enable the design of the sensing, actuating and processing aspects of an interactive space through their programming, immersion, use, and subsequent redesign and reprogramming. This continuous feedback process should make the concepts discussed in the traversing regime tangible for students. Moreover it should point to the new roles and necessary skills for the architect and designer to face the new demands for performative and interactive solutions.

With these strategies, however, we do not intend to create rules and frozen models of the interaction between man and digital systems. We intend to develop a meta-platform of creation and experimentation, something like collections of games we can play, modify and whose rules we can collectively adjust by recombining and expanding them, identifying and negotiating the rise of hybridizations, complexities, indeterminations and tendencies. In short, promoting the traversing of mirrors.

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