Giulio Interlandi

Designing Interaction for Enactive Storytelling Experiences

Supervisor: Professor Margherita Pillan
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POLITECNICO
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SCUOLA DEL DESIGN

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Abstract

Companies are collecting and using personal data to propose personalized services. Content providers are pushing users to produce data in order to create personalized storytelling experiences. In such a context, the tech market is offering new low-cost solutions able to gather biodata. This research aims to investigate a new interaction paradigm that promises to seamlessly enable unconscious and enactive interactions for movie experiences.

Today's technologies, increasingly invisible and pervasive, are able to know us better than we can imagine. The enactive paradigm in such a context can be applied to produce data in real-time. The main question such research asks is whether this data can be useful in an interactive narrative context for the design of enactive storytelling experiences. The research explores how the enactive paradigm can be applied, using eye-tracking and emotion-analysis technologies as input for enabling enactivity. The thesis focuses on interactive streaming experiences as a promising field of investigation for this new paradigm of interaction. Thus, seeing interactive storytelling as a tool for the investigation. The present research supports the idea that interaction design, with its perspective and practices, can be a way to explore these issues, and contribute to the development of new products and services as well as to the exploration of new paradigms, and therefore can provide a contribution for the development of society.

The following study starts with an analysis of the state of the art of the use of data and personal data for the creation of tailored experiences and storytelling with particular attention to interactive narratives. Then the literature review brought to the identification of background knowledge on enactive cognitive approach and enactive cinema. Furthermore, this research explores the possibilities and contribution that today's unobtrusive technologies accessible to all can make to the enactive paradigm. The first part of the thesis clarifies the research aim providing also an analysis of different case studies related

to interactive and tailored experiences highlighting technological, practical theoretical aspects. The case study research guides the reader through an incremental focusing on the enactive paradigm.

The second part of the thesis consists of practical research. Through the creation and iteration of different prototypes in a research through design approach, the research aims to practically investigate the enactive paradigm, addressing more practical design issues. It explores the possibilities of eye-tracking and emotion recognition technologies into the design of enactive experiences through evidence-based explorations. Aiming at examining technologies to be involved in the creation of enactivity, the first prototype represented a starting point for the exploration and identification of potentialities of the use of eye-gaze as an input for controlling an interactive movie experience. Then, the second prototype implied emotion recognition as additional detected information that has been analyzed ex-post in order to verify the suitability of this technology for detecting emotional states so to further include it in the controlling of the interaction. The prototypes have been used as a matter of experimentation of a definition of possible new experimental areas of enactive interaction within the specific field of interaction design.

The iterations of interactive prototypes and the investigations produced initial guidelines aimed at creating design areas of experimentation identifying the starting point for possible future directions. Moreover, the knowledge produced in this work can be considered as a quantum leap in design awareness, including the enactive paradigm in a context of design process and research through design.

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Designing Interaction for Enactive Storytelling Experiences

Introduction

My personal background consists, in addition to a scientific high school diploma, in a three-year degree in "Technological Arts" at the Fine Arts Academy in Catania, achieved with an evaluation of 110 cum laude. This bachelor's degree in Art gave me the opportunity to open my mind to the artistic and creative world, thinking outside the box in order to have a critical thought slightly different from that of a classic Design student. While Design is about solving problems with effective and creative solutions, Art, on the other hand, is often disconnected from objective problem solving, leaving a greater and more personal possibility of exploration, which often concerns the internal dynamics of the individual. On the other hand, attending the Politecnico di Milano has given me an enormous richness from a design point of view. Providing me with the necessary tools to manage a great complexity with confidence and competence. Although Art and Design move in the same world, sharing society, language, creative thinking, and tools. Design and Art come into people's lives in different ways. As Ettore Sottsass said "the design is a way of discussing life. It's a way of discussing society, politics, eroticism, food, and even design. Finally, it is a way of building, a possible figurative utopia or to build a metaphor for life" (Radice, 1993). While Art is born as a need and mirror of humans and society, showing what society is and giving way to deep reflections. Design is able to enter people's lives in a veiled way, changing habits, rituals, and radically transforming society. For this reason, a Designer has great responsibilities but at the same time has the possibility to bring beauty, meaning, and functionality to everyone's home, transforming society in a deeper way than Art does. That's why studying Design has been for me a reason for individual, spiritual, design, and human growth. Moreover, studying at Politecnico di Milano gave me the opportunity to work in teams, providing the tools to manage very complex projects in a simple and collaborative way. Working in teams is a reason for dialogue and personal growth as well as an opportunity to manage very complex and articulated

projects. The thesis, however, is an individual work, thus giving me the opportunity to focus freely on what I love to do. This study focuses on the design of interactions for enactive storytelling experiences. This journey stems from a personal passion for design and prototyping using innovative technologies. It was precisely this passion that led me to choose this path among the many possible. Moreover, besides having a passion for prototyping and for new technologies, one of my vocations is visual performance or VJing. This great passion has given me the possibility to experiment with the concept of synesthesia, not only from the audiovisual point of view but also from the environmental one. The great Sergei Eisenstein, as reported in this thesis, used the audience to experiment with his concept of cinema as a psychological laboratory. In the same way, I always liked to analyze, interpret, follow, and speculate on the audience's response to my live visuals shows. What has always fascinated me about images is first of all its etymological meaning, from the Latin imāgo -gĭnis which is able to condense its meanings of the mental, dreamlike image with those of real, pictorial or cinematographic image. Moreover, the power that the image has to communicate with the deepest part of ourselves in an immediate, universal, and very personal way. One of my curiosities has always been about the reasons behind the difference in the interpretation of an image from person to person. Nevertheless, the image has its own language and grammar in continuous evolution, as we can see from the fact that from photography, we have moved on to cinema, and now to entirely digital experiences. The human senses crystallize around the core of the visible (Hellpach, 1923), which allows us to perceive and create an image that in turn makes us feel emotions. Obviously, emotions are not only felt by those who have the gift of sight, hearing and other senses also contribute to the experience of what Hellpach calls landscape. Another of my passions is dance, and I was lucky enough to be a dancer in my life. One of the motivations that led me to never stop dancing was that dancing, and therefore moving, gives you very strong emotions. This was for me the tangible proof that emotions, as we will see later, are embodied in humans. The enactive approach, in fact, considers body and mind as unique, emotions are embodied and inseparable from the body-mind system. I consider myself very lucky also because I had the support of the professors and of the Pheel Lab of Politecnico, who have made available their knowledge, experience, and instrumentation to achieve a more scientific and objective result. This research thesis, however, for limits of time, knowledge, and technology, does not aim to obtain valid scientific results in the neuroscientific and psychophysiological field but aims to explore new possibilities enabled by some increasingly precise technologies available to all. Nevertheless, the area in which I have decided to conduct

research is an area that still has various gaps both from the point of view of knowledge, technology, and instrumentation. In addition, this research explores topics that have enormous complexity, and therefore there would be a need for higher-level research involving experts from multiple fields (psychology, neurology, film language experts, and other figures). Also from the technological point of view, although the tools that have been used are valid and very advanced, future research could and even should include more precise technologies. It is important to consider that the point of view of the researcher is that of an interaction designer, and that therefore despite the limits of knowledge both from the theoretical and engineering point of view, the core of the research remains the exploration of new ways of interaction that the new technologies taken into consideration can enable. This research is supposed to be the masterpiece of my master's degree course, for this reason, I have chosen to deal with a topic that is dear to me and to manage it in a personal way, putting my skills and my passion for design and prototyping at stake. The whole path of this research was born from a workshop in which it was possible to use innovative technologies such as eye-tracking, in a technology-driven design perspective. In this workshop, the design direction that was undertaken was the creative one, that is to use this technology not to solve a problem, but to explore new possibilities. After the workshop I decided to pursue the project, working and doing research in order to explore a new paradigm of interaction, the Enactive one. In fact, during the workshop, we worked on technologies focusing on the fact that they allow us to know the individual better than himself/herself, and that today they can enable unconscious interaction. The thesis work focuses on the enactive paradigm, a broader cognitive paradigm that not only enables unconscious interaction but considers interaction as a larger system that includes variables inside and outside the individual that are ultimately the same psychophysiological elements with which people interface with reality. Having the workshop as a starting point, and slightly adjusting the focus of the research, I was able to identify an innovative field, which does not exploit technologies for user research, design for all, and trivial advertising purposes, but uses these technologies in an innovative way, radically changing their meaning and their use in a design context. This has allowed me to take a step forward within a new paradigm that could radically innovate not only the context in which this research fits, but could certainly have a great impact in many other design contexts. Once I established the exploratory objective of the thesis, I decided to adopt the Research through Design approach, both because from the research point of view it seems to be the most suitable one, and because from my personal point of view it matches my passion for prototyping and

exploration. This methodological approach has allowed me not only to manage the complexity of the thesis in a gradual, incremental and coherent way, but also to put my creative and design skills at stake from both a theoretical and practical point of view. The study proposed here is therefore divided into two main parts, the first part is a research clarification, the second part is a practical research that with the use of prototypes tests and explores the proposed solutions. In the first part a theoretical research was conducted on three main topics, the use of personal data and tailored user experiences, storytelling by focusing interactive narratives, and the dynamics of the mind in enactive cinema. In addition, the first three chapters show a series of case studies and literature that accompany the reader in the state of the art of the use of data, interactive narratives, and enactive cinema. The first chapter, in particular, focuses on the tailored user experiences enabled by the use of personal data, analyzing various products and services that create value through data. The second chapter instead describes some aspects of interactive storytelling, focusing on digital interactive narratives experiences, and on how they are experienced today. Paying particular attention to the current Netflix entertainment paradigm, and the use of the data behind it. The third chapter introduces the reader to enactive cinema through an analysis of the enactive approach from a cognitive point of view and from the analysis of the basic literature of this thesis, which is the Enactive cinema Simulatorium eisesteniense work of Pia Tikka (Tikka & Taideteollinen korkeakoulu, 2008). In addition, the enactive cinema installation Obsession is investigated, providing a theoretical basis for the second part of the thesis. The fourth chapter is at the beginning of the second part because it acts as a bridge between the two parts of the thesis. In this chapter is shown the research methodology applied to the whole thesis, which includes the Research through Design approach, the iterative structure of the prototype, and the user research methodology. Chapters 5 and 6 show the development of the prototype through an iterative process. By showing how the results of an iteration are a source of both answers and questions for the next iteration. The seventh chapter is the final chapter. In the conclusions, starting from the results obtained from the last iteration, some suggestions and guidelines are illustrated. It is also explained that further iteration and research would be needed, but due to the historical moment it is very difficult to carry out a new iteration at this time. However, the topic of a further iteration based on previous iterations has been discussed, integrating the guidelines and suggestions obtained so far. Moreover is explained in detail the algorithmic logic that this last iteration should have, as well as the various logics of choice considering the scenes used in the previous prototypes, so as to obtain a continuity in the iterative logic. This

chapter also provides a key to interpreting the values of biological signals that can be obtained from emotion-detection and eye-tracking devices, as well as the flow of scenes in the narrative sequence that the prototype should have. In addition, the topics of applicability of the new paradigm and ethical concerns are addressed, broadening the scope of applicability to solutions even very different from digital narratives and discussing the impacts and consequences that this kind of solutions could have on society. ***Fig. 1*** shows the flow of activities that have been carried out in this study. Starting with the research and analysis of the background knowledge in different areas (tailored user experience, storytelling, cognitive approaches) which led me to a formalization of the possibilities of applying the enactive cognitive approach. I then identified the methodology of Research through Design as suitable in this research, in which I introduced the enactive approach. Then I created prototypes that through iteration allowed me to formalize a contribution within the possibilities of interaction design, specifically on the application of the enactive approach within the RtD methodology.

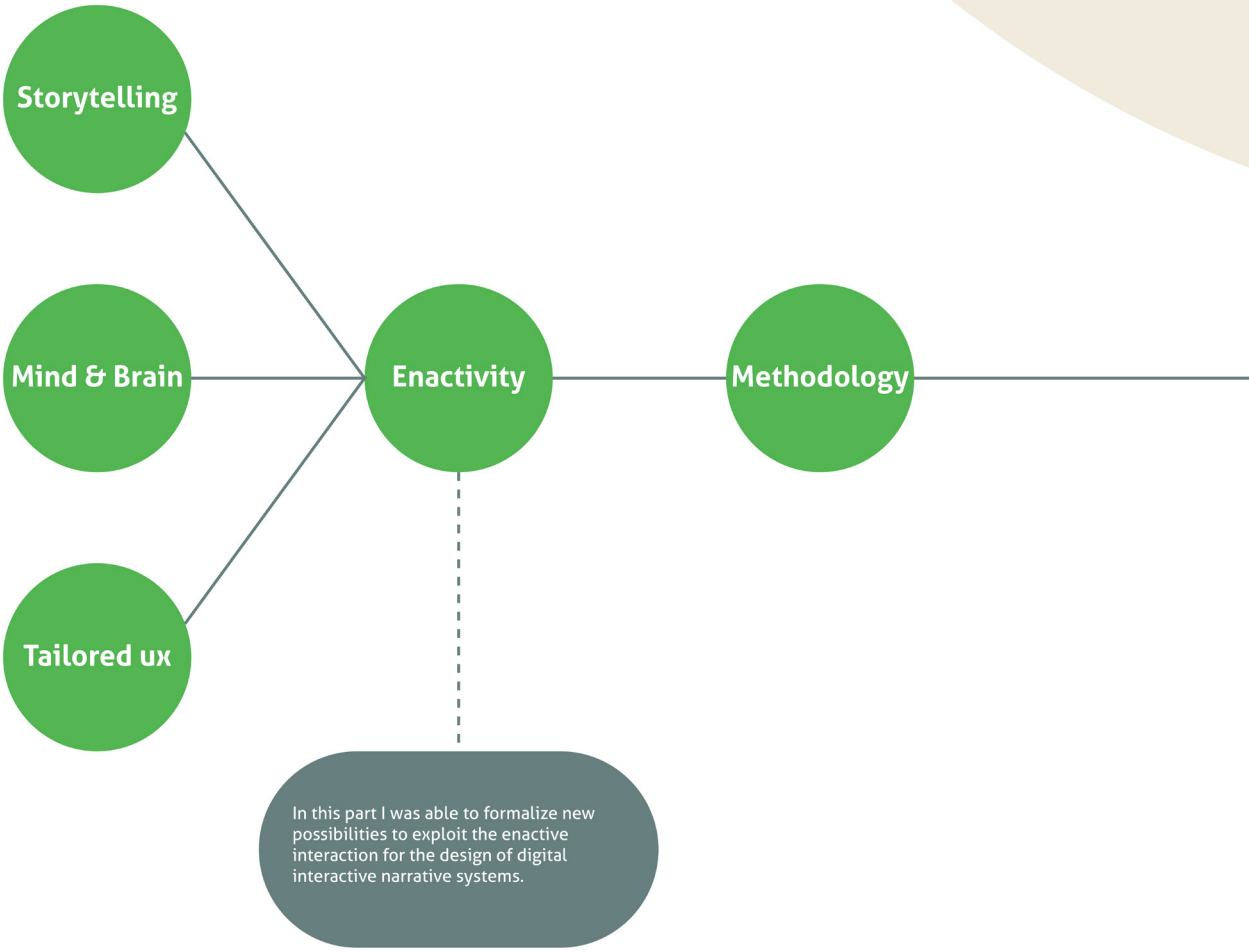


Fig.1 *Flow of the activities carried out during the research process*

In the last workshop within the master's degree course, together with the team of colleagues, I was able to conceive the concept of the project and then I worked on the technical and technological development. This allowed me to explore practically the eye-tracking tool provided by DeepGlance.

Within the pheel lab I learned how to conduct evidence-based research. I was also able to deepen my knowledge of the technologies used in the laboratory's research areas.

Collateral Activities

Workshop

Stage

1st Prototype

2nd Prototype

Conclusion

Here I was able to make some reasoning that allowed me to draw some limits and possibilities about the prototype and the interaction in modern-day storytelling. Technological development has allowed to obtain tools that are of a higher level than those used in Pia Tikka's research. I have therefore identified the possibility of integrating enactivity through eye-tracking and emotion detection technologies.

At this stage I redesigned and developed the prototype using Unity software. I identified the key points (4 scenes) worth of investigation. I also performed a user test and an evidence-based investigation thanks to the Pheel laboratory that provided me with the tools to perform emotion-detection. In this way I was able to analyze the emotional data.

1 - Tailored user experiences and personal data

Intro

This thesis is the result of a master's degree in Digital and Interaction Design, therefore for obvious reasons, the writer's perspective is an Interaction designer perspective. Hence the thesis is a research that through both a theoretical and practical approaches based on an iterative Research through Design structure that born from a Research through Design approach, led to the creation and iteration of prototypes in order to explore and understand possibilities given by the technology and possible outcomes gathered from the users (see chapter 4). In this chapter we will introduce the reader to the User Experience, highlighting the basic concepts of User Experience and understanding what kind of different professionals are involved in this field. Then we will focus on tailored user experiences, analyzing how they work and reflecting on important aspects they involve. Finally, some case studies are presented to provide practical examples of how tailored experiences work today.

1.1 The Experience Economy

User experience design is nowadays a key element for success, in fact, companies are progressively investing more and more resources in it. Products and services are changing every day in more personal and pervasive ways, aiding the user, guiding the experience towards his objectives and transforming ergonomically around his needs and habits. The reasons that drive people in choosing one service instead of another and the meaning that users attach to products also suffered a change in line with the cultural and technological development that we experience today. Products today are extremely distributed, one could even talk about superfluous production. This both optimal and comforting distribution also exists thanks to platforms like Amazon and its competitors, that have been able to employ the available network and technologies to create a service that works properly and inspires customer loyalty, offering users a buying experience that employs a new shopping paradigm in our days. A fitting definition of the economy

in which we merged through the last decades is that of Joseph Pline II and James H. Gilmore, from their paper Welcome to the Experience Economy. (Pine & Gilmore, 1998). To show us the change in the economies, Pline and Gilmore summarize the entire history of economic progress in the four-step evolution of a birthday cake."*As a vestige of the agrarian economy, mothers made birthday cakes from scratch, mixing farm commodities (flour, sugar, butter, and eggs) that together cost mere dimes. As the goods-based industrial economy advanced, moms paid a dollar or two to Betty Crocker for premixed ingredients. Later, when the service economy took hold, busy parents ordered cakes from the bakery or grocery store, which, at $10 or $15, cost ten times as much as the packaged ingredients. Now, in the time-starved 1990s, parents neither make the birthday cake nor even throw the party. Instead, they spend $100 or more to "outsource" the entire event to Chuck E. Cheese's, the Discovery Zone, the Mining Company, or some other business that stages a memorable event for the kids – and often throws in the cake for free. Welcome to the emerging experience economy.*" (Pine & Gilmore, 1998).

1.2 User Experience

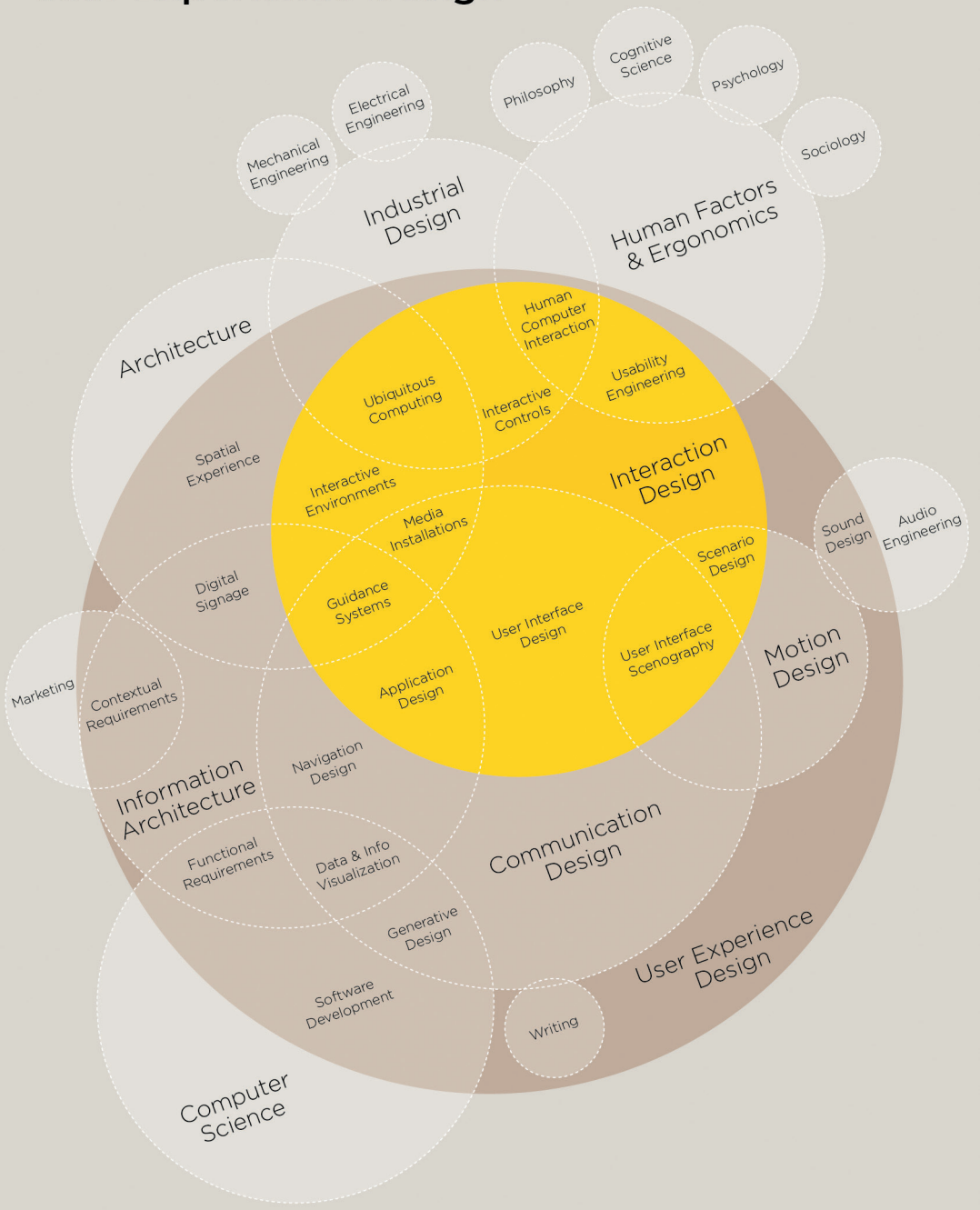
Experience economy completely reflects modern society about the culture we live in, in which the meaning the users give to a good/service/experience is what makes the difference. In addition, the progress of economic value that Pline and Gilmore show us attributes a larger value towards competitive position and pricing of goods and services to experience economy. A product/service has now no more competitive value without a storytelling and an accurately designed experience. In order to enhance competitiveness, companies are giving ever more importance to the user experience approach, user experience designers are in fact a much needed professional figure. UX design has its roots in user-centered design, of which the fundamental principle is to serve the user. Users are humans, every human life can be described as a string of moments, each moment follows one another in a continuous experience (Kahneman & Riis, 2005). So, in order to assess what is UX design and what a UX designer does, it is important to understand what is an experience. Epistemologically speaking, we can have three main different meanings of experience:

- The conscient phenomenological experience (hic et nunc.).
- The episodic memory of memorable situations (Pine & Gilmore, 1998)
- The abstraction of episodes into patterns & schemas (Sweegers, 2014).

We can say that an experience is a subjective representation, conscious and

intentional, of a lived event. The tricky part is, the decisions we make at each moment are based on memory (remembering self), rather than current experience (experiencing self). People organize in semantic networks their models or representations of experiences. Those models are made of a motivational dimension (why), a temporal one (when), a spatial one (where) our concepts (what) and other actors (who). According to the international standard on ergonomics of human-system interaction ISO 9241-210:2019, user experience is defined as "*User's perceptions and responses that result from the use and/or anticipated use of a system, product or service*". This definition includes all the users' emotions, beliefs, preferences, perceptions, comfort, accomplishments, physical and physiological responses and behaviors that occur before, during and after use. The same document says "*User experience is a consequence of brand image, presentation, functionality, system performance, interactive behaviour, and assistive capabilities of a system, product or service. It also results from the user's internal and physical state resulting from prior experiences, attitudes, skills, abilities and personality; and from the context of use.*" (ISO 9241-210:2019, 2019). The UX design is, therefore, the discipline that during the design process focuses on the user experience in order to provide meaningful and relevant experiences to users. It should be involved in the entire design process, managing aspects of usability, design, interaction, functionality, branding, and features. There are many definitions of UX design, but I choose to report just a couple of them to avoid confusion. For example, Steve Krug, the author of the famous book about usability Don't make me think (Krug, 2000) describes the UX design saying "*An umbrella term for any activity or profession that contributes to a better experience for the user.*". Donald Norman, the inventor of the term User Experience says "*No product is an island. A product is more than the product. It is a cohesive, integrated set of experiences. Think through all of the stages of a product or service – from initial intentions through final reflections, from first usage to help, service, and maintenance. Make them all work together seamlessly.*" (Interaction Design Foundation, 2002).

The Disciplines of
User Experience Design



www.envis-precisely.com

Fig. 2 *Infographic approach showing all players' relationships of the interactive field, the different areas and how they connect and overlap. Made by UX consultancy envis precisely (Envis Precisely, 2009), based on Dan Saffer's work "The Disciplines of User Experience". (Envis Precisely, 2013).*

It could result very useful to see Peter Boersma's T-Model (Boersma, 2004). It is used in many researches such as *Maturing a practice* (Hobbs et al., 2010), which introduces professionals and fields of User Experience and Information Architecture to the basic concepts of practice-led research.

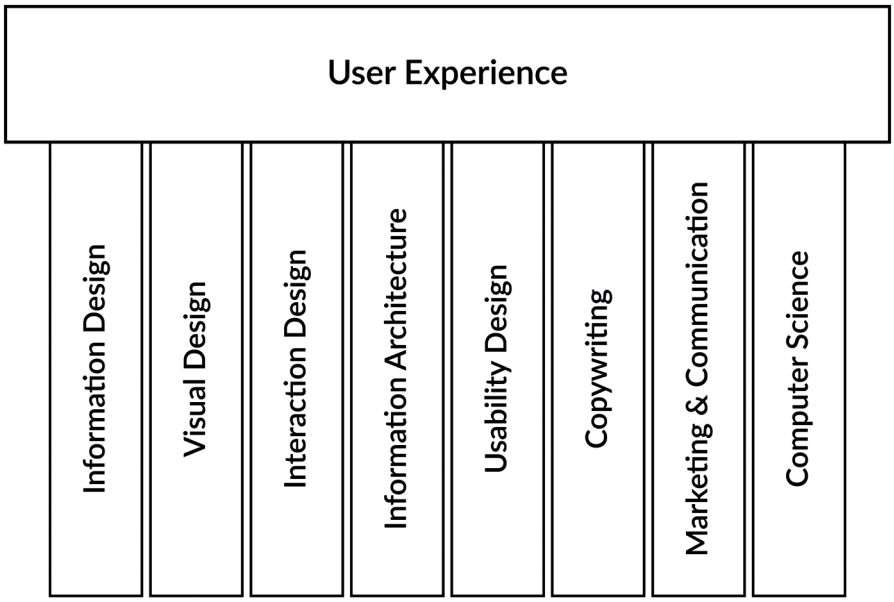


Fig. 3 *Peter Boersma's original T-Model. (Boersma, 2004; Hobbs et al., 2010).*

"*In my opinion, it is time we re-label the field of Big IA into User Experience. [...] The model showed a big "T", with the vertical line representing the field of IA with varying degrees of depth, while the horizontal line represented the width of related fields around us. We decided to call it the T-model*." (Boersma, 2004).
In Boersma's idea, UX is an umbrella term that joins many related fields as interaction design, usability, information design, visual design, accessibility, copywriting, business modeling, marketing, and computer science, creating the common ground. "*The horizontal overlap is the place where User Experience (UX) practitioners operate*." (Boersma, 2004). This model

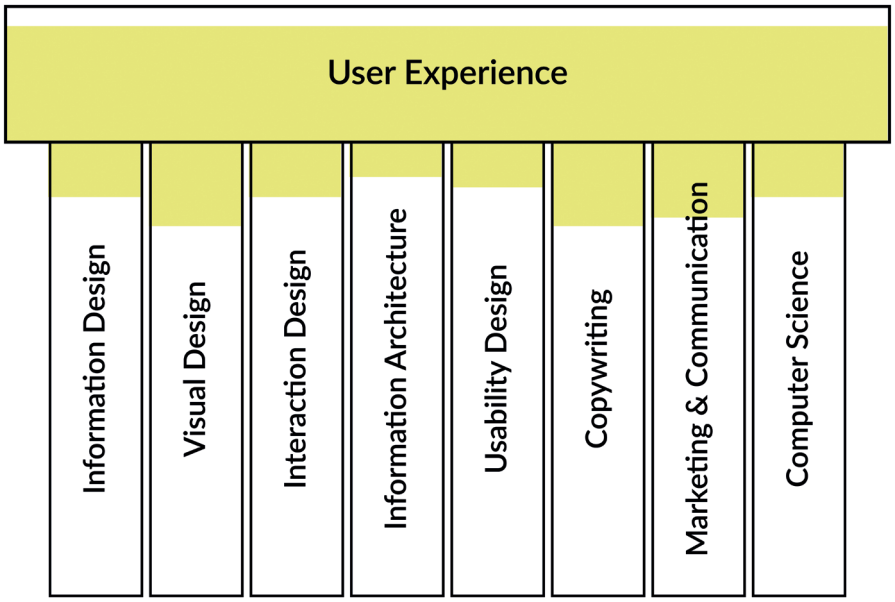


Fig. 3.1 *Peter Boersma's T-Model showing a Ux Generalist professional.*

has provided for years a tool for IA analysis, even today we can use it as a scheme to understand how UX professionals can be different from each other. Obviously this differentiation is only superficial, but it still helps us to have an idea about the User Experience Designer profession. **Ux Generalist** is a professional who has a balanced knowledge of all the disciplines. **Ux Specialist** is a professional who's a specialist in one of the disciplines thanks to his/her depth knowledge in one field, moreover this professional has some knowledge of the other disciplines. **Ux Hybrid** is a professional who is a hybrid of a generalist and specialist. This figure has deep knowledge in at least one field and broad general knowledge in all disciplines. They are usually the most experienced UX professionals.

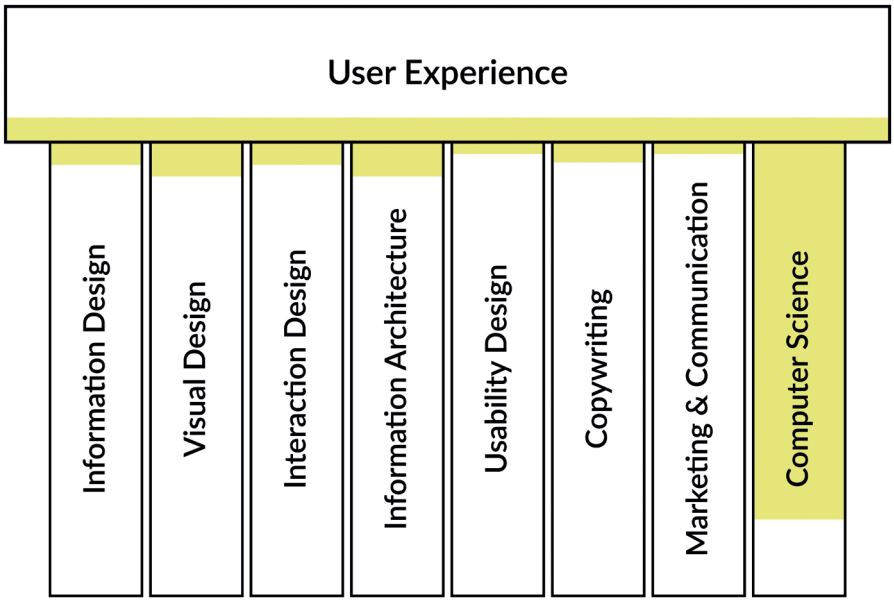


Fig. 3.2 *Peter Boersma's T-Model showing a Ux Specialist professional.*

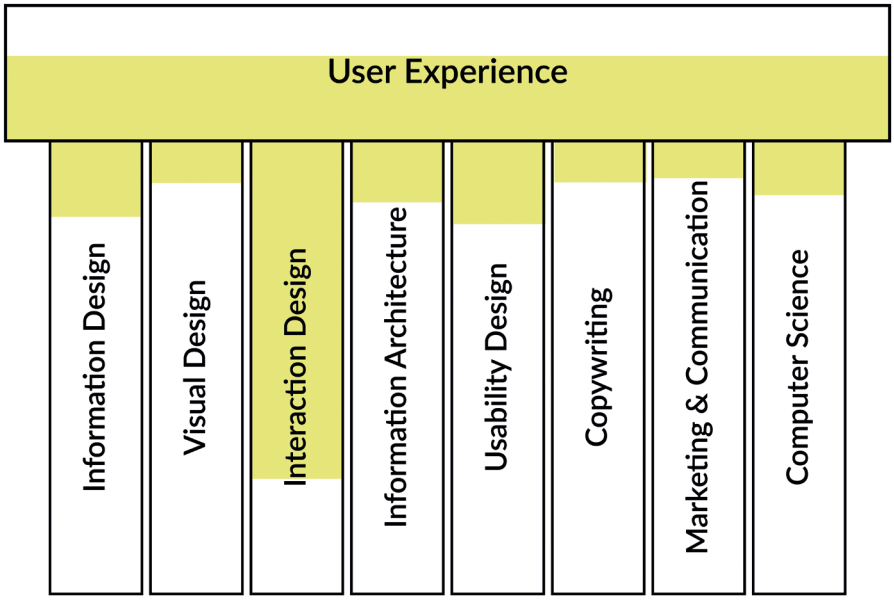


Fig. 3.3 *Peter Boersma's T-Model showing a Ux Hybrid professional.*

1.3 Tailored user experiences and personal data

One critical topic nowadays is the use of personal information by service providers in order to create a personalized and meaningful experience for each user. These services are tailored on user's needs and preferences, and the core of these services is the use they make of personal information. These kinds of services provide, thanks to the use of personal data, the so-called tailored user experience. Today digital technologies and environments pervasively and constantly record data about the user, furthermore today many services are only available if the user accepts to share their personal data. According to Varisco "*people are what their data says about them and we know each other according to which data we share, and even technology and devices interact with the people according to their data*." (Varisco, 2019). We live in a paradigm/dimension that Weiser called 'ubiquitous computing' or Ubicomp (Weiser, 1999), a dimension where technology is pervasive and sees a relationship between people, practices, and technology (Varisco, 2019). In this paradigm, the privacy topic is a critical one and is mainly related to who has access, can use, and share one's personal data. Many products use personal data to provide different services such as medical, security, fitness tracking, navigation/maps, safety. Many of these products don't entirely rely on personal data but use it as a value added to the service. An example is Fitbit (Fitbit, 2007), its core functions rely on the use of biodata, and it uses the GPS to understand patterns and create a personalized service with proactive insights. These wearable devices can communicate with other services such as weather prediction to suggest for example an indoor or outdoor activity. Google Maps (Google Maps, 2005) instead uses personal preferences to provide the experience of discovery during the maps navigation, for example when it suggests "the coffee shop on Third St" as a result of "Explore" and "For You" features. *Explore* takes into account the current user's location and time of the day. *For you*, on the other hand, relies on areas and places the user usually frequent to give a personal recommendation on restaurants or trending places. "*Google Maps not only provides a tailored service for the user itself, but it also creates a large amount of personal data that can be traded, negotiated and used by third parties*." (Varisco, 2019). Personal data can be viewed as a by-product of digital devices (Schneier, 2016). In fact, personal information not only creates value for the individual, but also for companies that use this data to provide meaningful services. To take advantage of the potentialities offered by technologies that rely on personal data, it is necessary to accept not having a closed privacy. (Varisco, 2019). "*Is, then, essential for designers, to understand how the technological solutions can imply the use of personal data to provide meaningful new services or improve the already*

existing ones." (Varisco, 2019).

1.4 Knowledge in practice, case studies

These case studies are useful to understand how tailored experiences work today, we will analyze in particular the type of data that they rely on (biometric, researches and choices, liked content, and so on), the type of service that they offer (streaming, monitoring and so on), and how the data is used in relation to the service (content suggestion, new functionalities, and services). In order to depict and understand the value of the case studies, I chose to walk the lector in the state of art of two kinds of experiences, first tailored user experiences, and further on interactive storytelling artifacts. I also chose to use the model proposed by Varisco to show the process of knowledge creation in digital services. (Varisco, 2019).

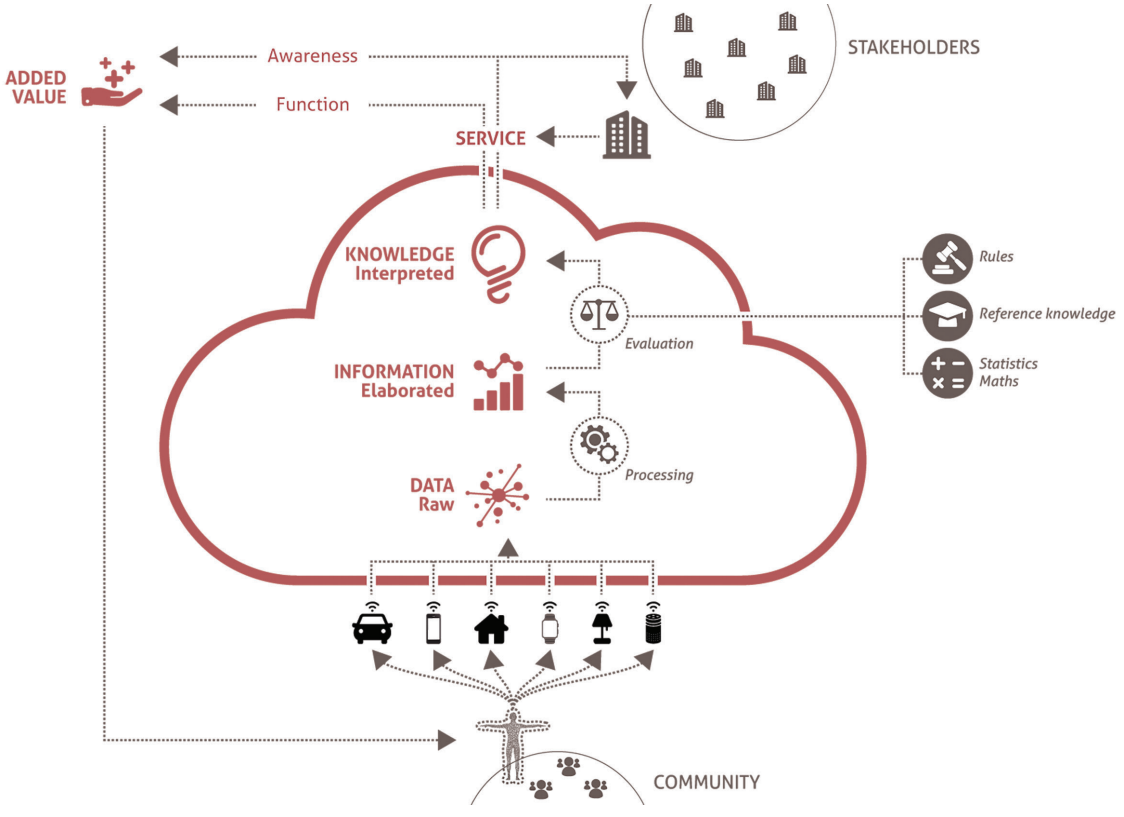


Fig. 4 *Representation of service value created by the use of personal information in services. (Varisco, 2019).*

1.4.1 Fitbit

Fitbit (Fitbit, 2007) is a service that provides personalized solutions for fitness and health. Born in 2007 it was conceived with the idea that today's sensor and wireless technology can bring amazing experiences to fitness and health, changing people's habits in a profitable way. They design products and experiences that enable people to achieve their health and fitness goals effortlessly. The system tracks activities, exercise, food, weight, and sleep during a whole day, helping users find their personal fit and motivation. Fitbit collects data thanks to its app and devices. They produce smartwatches, trackers, and smart scales. Each Fitbit device includes different hardware sensors that work through Fitbit Sensor APIs. These sensors are: **Accelerometer**, used to measure device acceleration and determine the orientation. This sensor measures acceleration along 3 orthogonal axes: X, Y, and Z. **Barometer**, used to measure atmospheric pressure and forecast short term changes in the weather. Because atmospheric pressure also varies with elevation, a barometer can also be used as a basic altimeter. **Gyroscope**, this sensor measures the device's angular velocity along 3 orthogonal axes: X, Y, and Z. **Heart Rate**, the HR sensor measures a person's Heart Rate in Beats per minute. **Orientation**, the Orientation sensor measures the orientation of a device relative to an orthogonal coordinate frame. Fitbit provides a Software

Fig. 5 *Full family of devices produced by Fitbit. (Fitbit, 2007).*

Development Kit (SDK). Users can find the SDK on the developers' Fitbit website, easily found online. Every user can customize their clock face, build and uninstall apps, personalize app settings and customize the UI. Each sensor's works according to algorithms, these algorithms can be found online, allowing developers to utilize these powerful APIs with minimal effort. They provide an online guide showing up all the algorithms and giving instructions and best practice, in a way it is easy to understand how the data produced by sensors are or can be used. Data gathered through the app and sensors are turned into information about body behavior, body movements, training and health goals and activities. The information evaluation is made taking into account health and fitness knowledge, user's goals, statistical and mathematical tools. The interpreted knowledge mainly consists of fitness performances, health state, activity tracking, sleep tracking, and so on. Fitbit service uses the generated knowledge in all the possible ways. First, it gives knowledge to the users in the form of awareness about personal performances and health monitoring. Secondly, it uses the knowledge to generate new functions as personalized training plans and suggested activities. Lastly, Fitbit has a lot of stakeholders in the healthcare ecosystem such as insurance, health plans, and academic researchers.

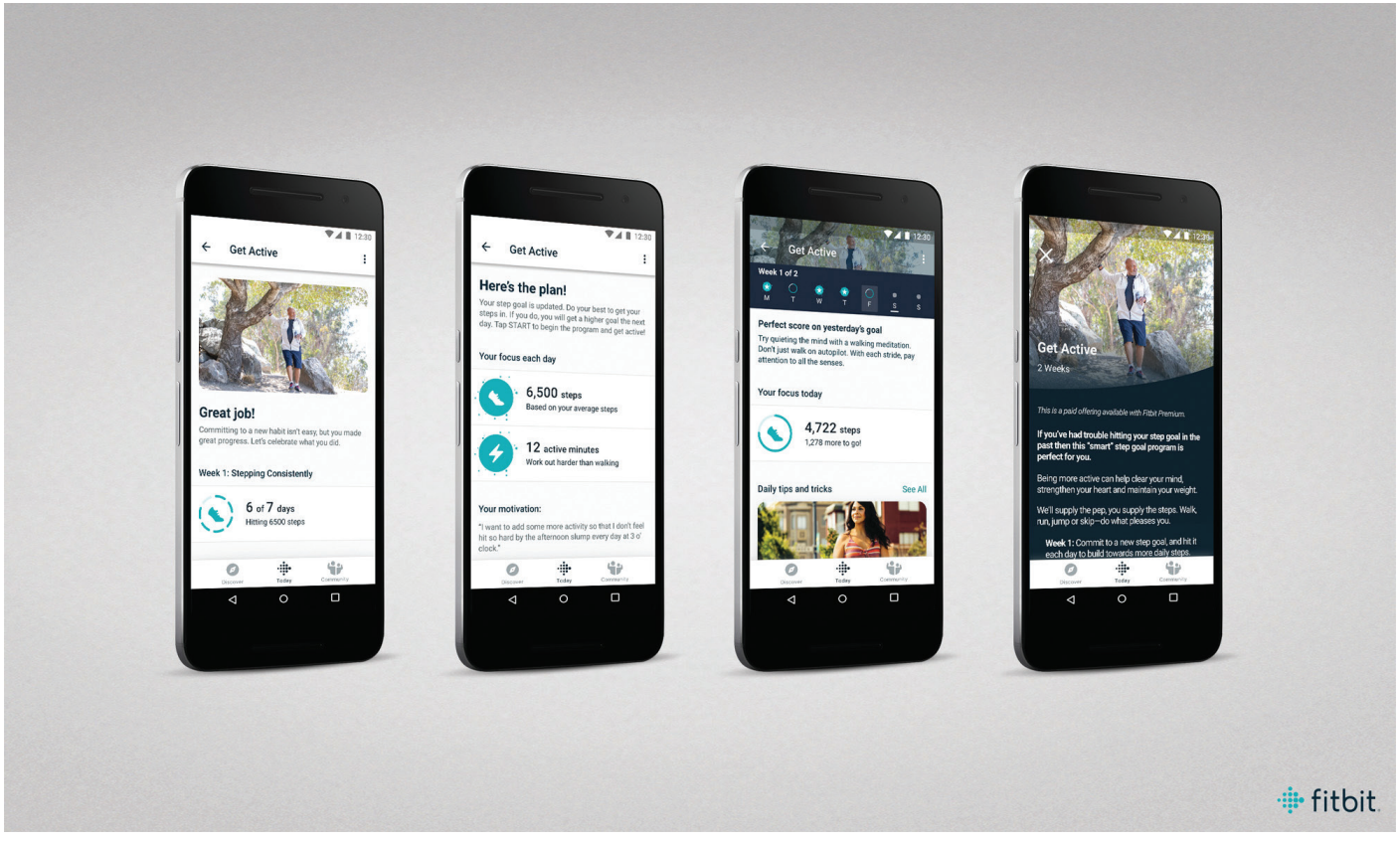


Fig. 5.1 *Some screens of the Fitbit Get Active premium program. (Fitbit, 2007).*

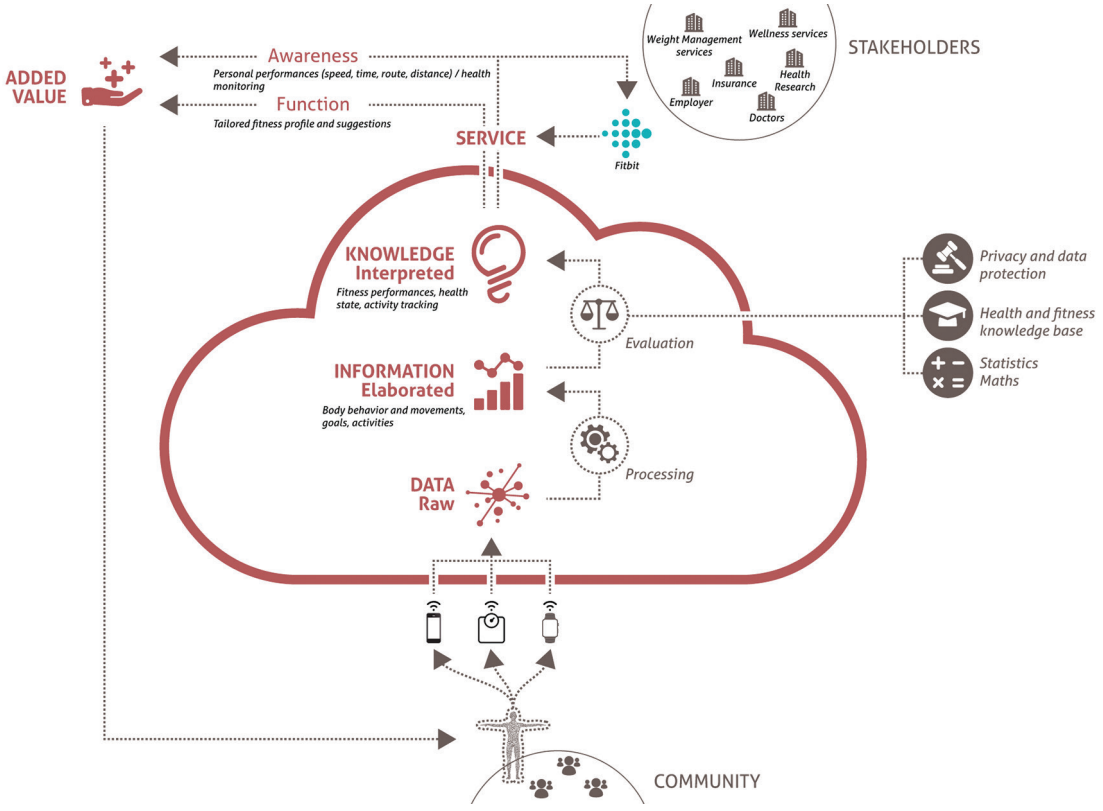


Fig. 4.1 *Model of the process of knowledge creation in digital services for Fitbit.*

1.4.2 Beast Sensor

Beast Sensor (Beast, 2014) is a wearable fitness tracker focused on performance scenarios like heavy training in gyms and dedicated activities, such as powerlifting. The athlete has the capability of interacting with the trainer through a dedicated app/web portal. The tracker can be worn on locations different than the wrist, such as the back or the arms, in order to enable different tracking scenarios. Beast Sensor collects data thanks to its device and app. The device carries the following sensors: Accelerometer (3x), Gyroscope (3x), and Compass (3x). Beast Sensor collects data relative to the user's movement and behavior during exercise sessions. Their algorithms are able to produce very precise data about power (watts), speed (Meters/Second), strength (N), explosiveness (G/s), reps, and many more. (Beast, 2014). Data gathered through the app and sensors are turned into information about body behavior, body movements, training and performance goals. The gathered information enables the system to create real-time awareness and functions for improved training sessions, performance learning and knowledge for the end-user and for the trainer. Furthermore, the ecosystem gives the possibility to the trainer to have kits of devices so to follow more users at the same time. Moreover, the system allows the user to join or use certain services such as Facebook, Twitter, Instagram, YouTube, and so on… Sharing with them their information.

Fig. 6 *Beast Sensor products, on the left the product for athletes, on the right the product for trainers. (Beast, 2014).*

Fig. 6.1 *The web portal of the Beast Sensor system. (Beast, 2014).*

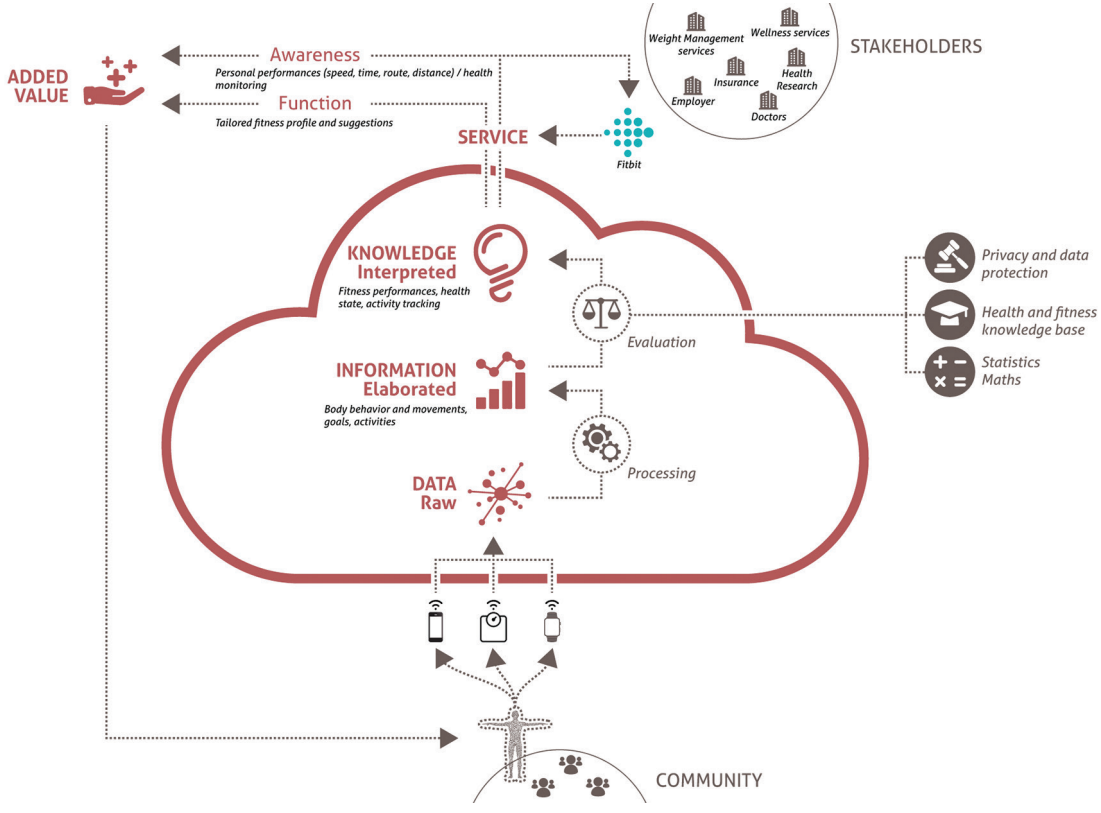


Fig. 4.2 *Model of the process of knowledge creation in digital services for Beast Sensor.*

1.4.3 Google Maps

Google Maps (Google Maps, 2005) is the most famous web mapping service worldwide, available as a website or app. Offering satellite imagery, aerial photography, street maps, 360° interactive Street View, real-time traffic, and route planning for traveling by foot, car, bicycle, and public transportation. In 2020, Google Maps was used by over 1 billion people every month. (Rijo, 2020). Maps collect data all the time thanks to its satellites and site/app, which can even rely on the device's sensors (GPS, accelerometer). Then the service cross-references the satellite data with the data of the device, to turn them into real-time information about traffic, user's position and movements, crowding of places, and so on. The gathered information enables the system to create real-time awareness about visited locations and timeline, and functions for improved mobility like indoor maps, business listings, local guides, suggested restaurants, and others.

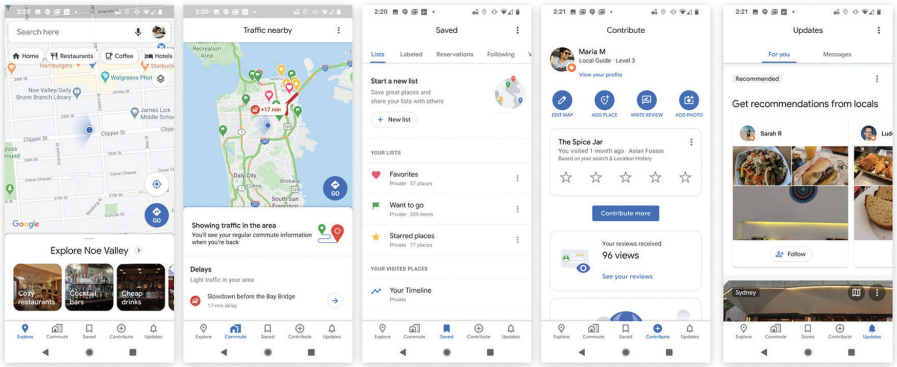


Fig. 7 *The mobile interface of Google Maps. (Google Maps, 2005).*

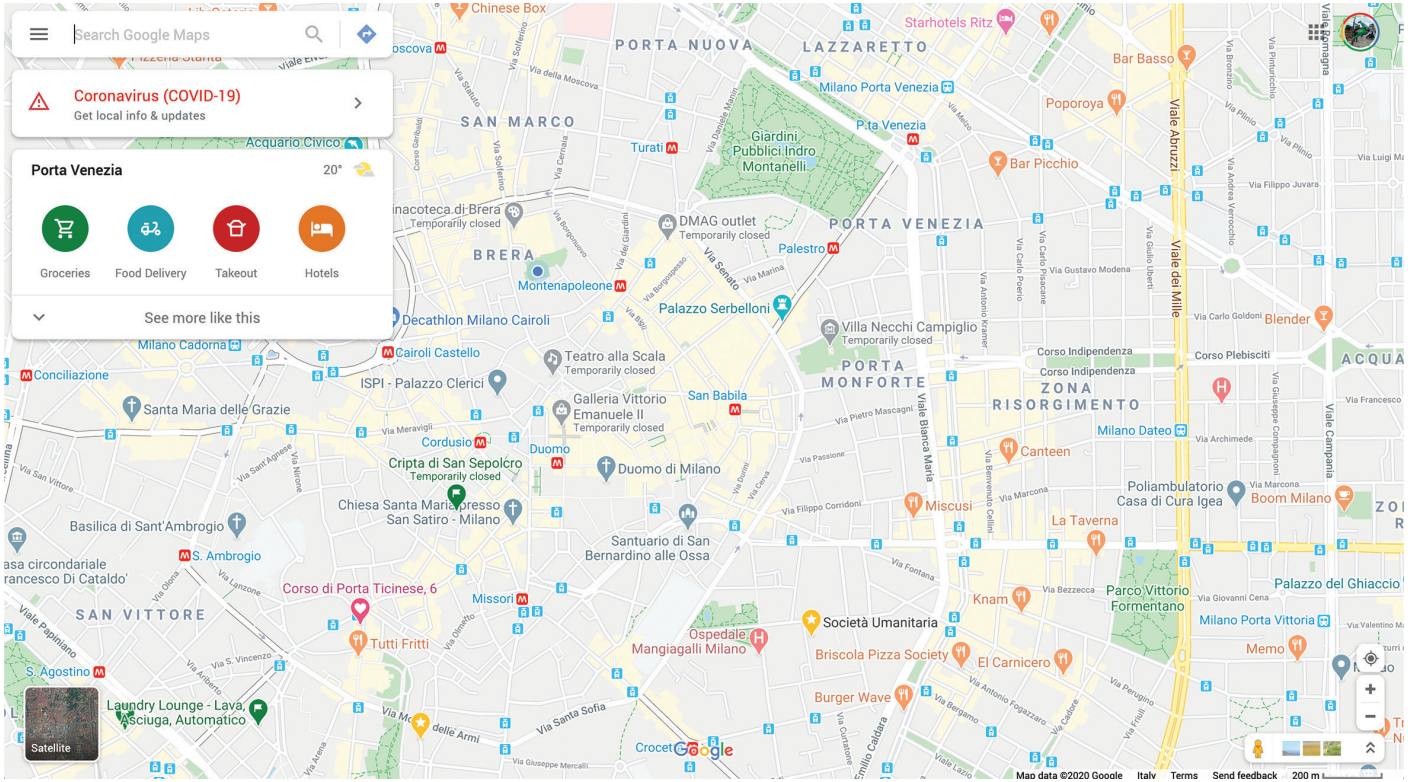


Fig. 7.1 *Google Maps desktop web interface. (Google Maps, 2005).*

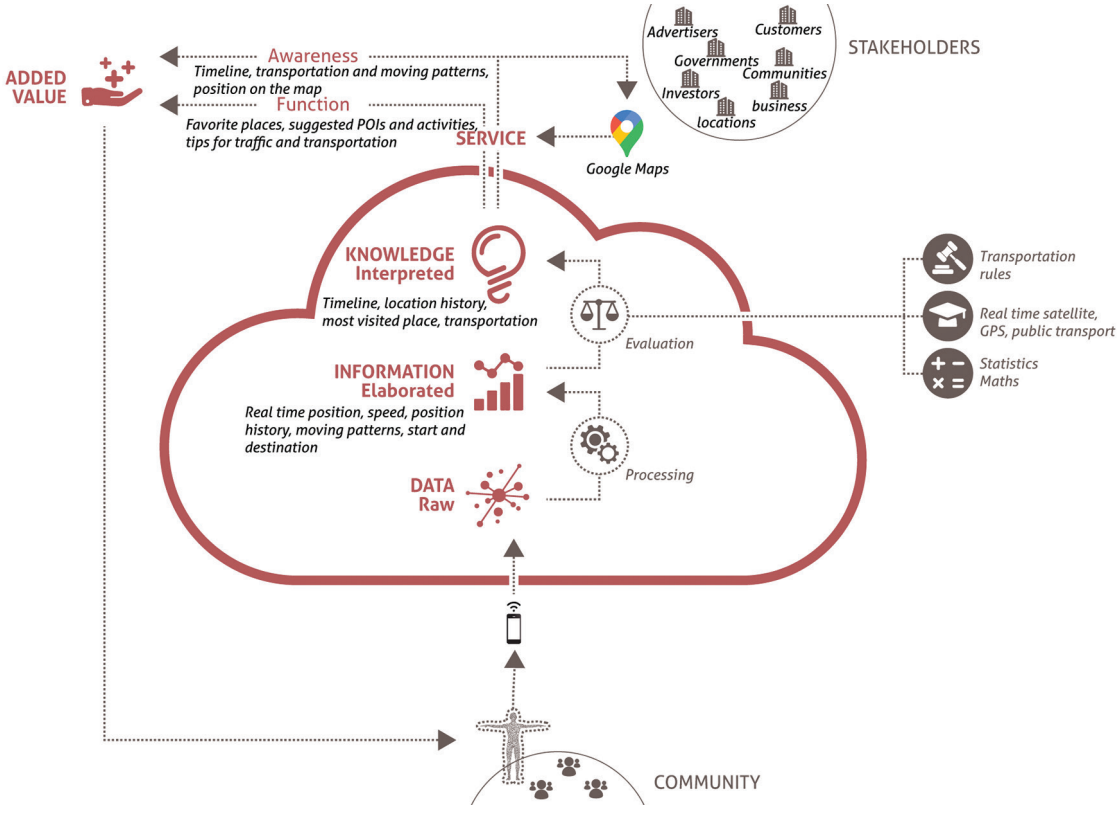


Fig. 4.3 *Model of the process of knowledge creation in digital services for Google Maps.*

1.4.4 Spotify

Spotify (Spotify, 2006) is a freemium audio streaming platform, the basic features are free but with advertisements or automatic music playlists, for additional features, such as offline listening, free playlist use, and commercial-free listening, is needed a subscription. Spotify collects data thanks to his app, they ask for sensor access in order to have data about the device, the sensors, GPS, microphone, and camera. They also collect data about plays, pauses, volume, profile info, following, and follower. They store and process user information in order to tailor the music experience in a personal way for each user. "*Spotify has frequently branded itself as a software-driven company that relies on machine learning and algorithmic data mining in order to generate music recommendations and create music experiences*." (Eriksson et al., 2019). Spotify knows very well users' habits, tastes, preferences, what paths they do, what places they frequent, if they are traveling, working, or at home. They use this knowledge as a core for their platform, suggesting and generating playlists and radios in relation to what the user is doing. They suggest "just for you" music and provide fresh daily mix based on users' tastes and preferences. They also generate tailored playlists allowing the user to discover new music they might like. Moreover, they provide mood, activity-based and trending playlists.

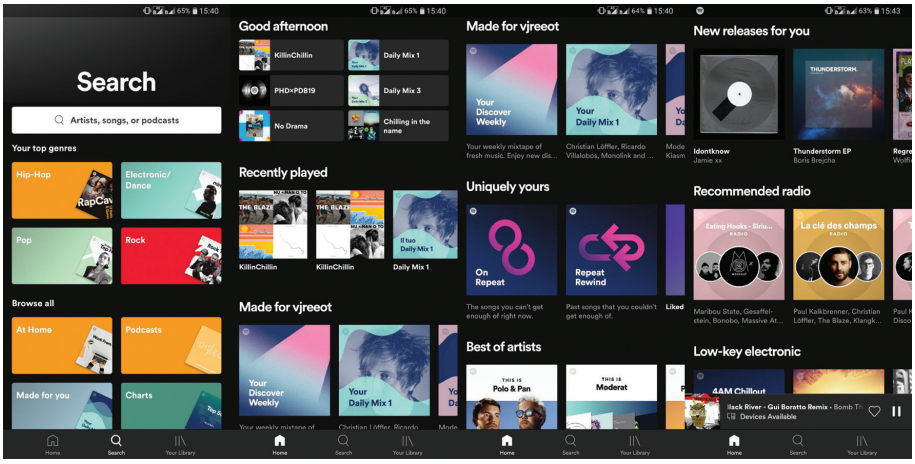


Fig. 8 *The mobile interface of Spotify. (Spotify, 2006).*

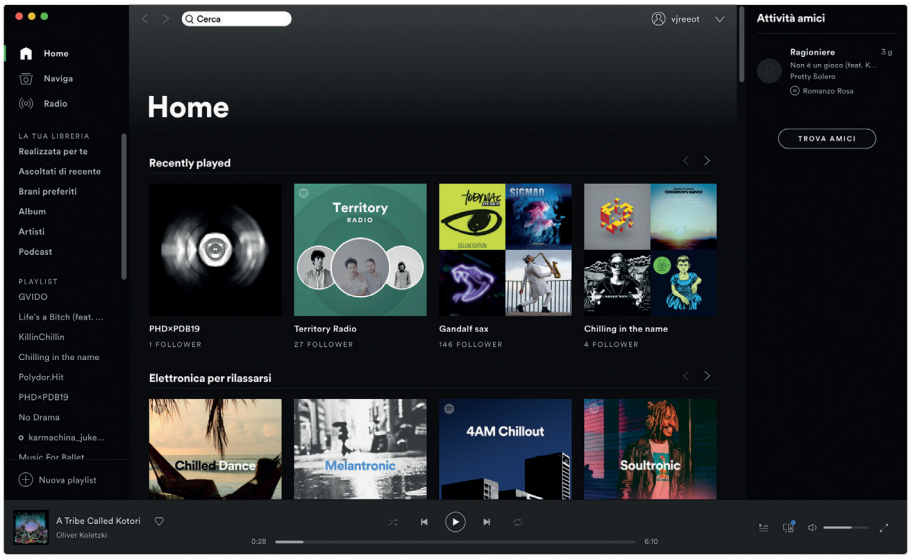


Fig. 8.1 *Spotify desktop interface. (Spotify, 2006).*

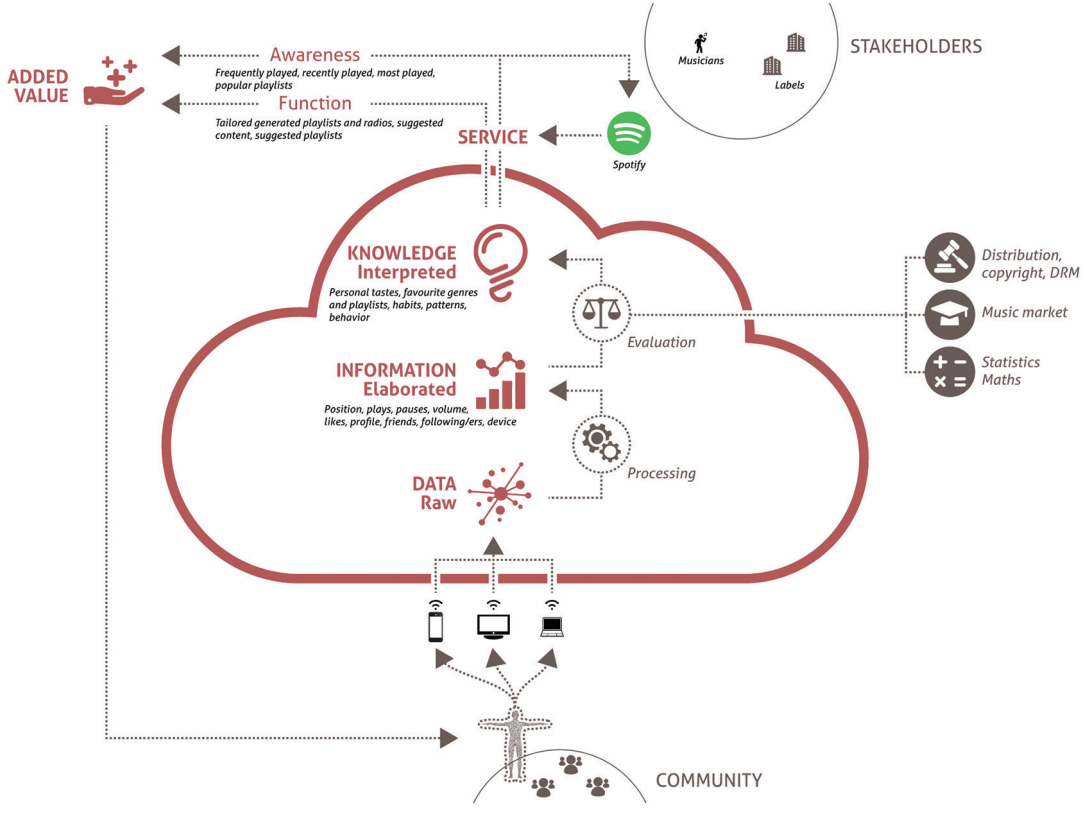


Fig. 4.4 *Model of the process of knowledge creation in digital services for Spotify.*

1.4.5 Sleep Cycle

Sleep Cycle (Sleep Cycle, 2008) is a freemium intelligent alarm clock app that analyzes users' sleep. The system generates sleep reports, tracks long-term sleep trends, and monitor the sleep quality, waking users during their lightest sleep phase in order to achieve a healthier sleep. The app collects data through the smartphone and eventually a smartwatch. The user has to place the smartphone in the right position according to the instructions or just wear the smartwatch. Then the system can gather data using accelerometer and microphones. The processed data creates information regarding behavior, sounds, and movements during sleep. These information are interpreted in order to know a lot of parameters about the sleep of the users, in a nightly or long period statistics. These statistics include stages of sleep, sleep quality, regularity, went to bed time, woke up time, time in bed, snore, and steps. This knowledge allows Sleep Cycle to have an important added value on both sides of awareness ad functions. The intelligent alarm clock is the main function tailored to the user's habits to achieve and control sleep wellness. The journal and the statistics are the major sources of awareness.

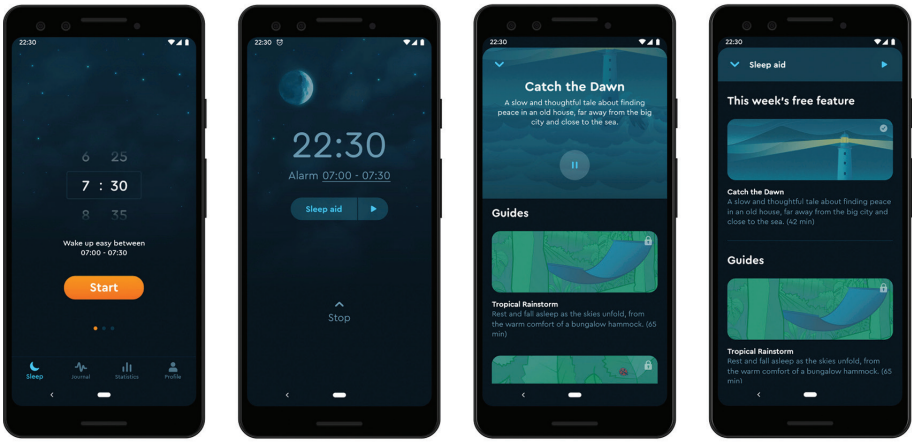


Fig. 9 *Some screens from the Sleep Cycle app. (Sleep Cycle, 2008).*

Fig. 9.1 *Some screens from the Sleep Cycle app. (Sleep Cycle, 2008).*

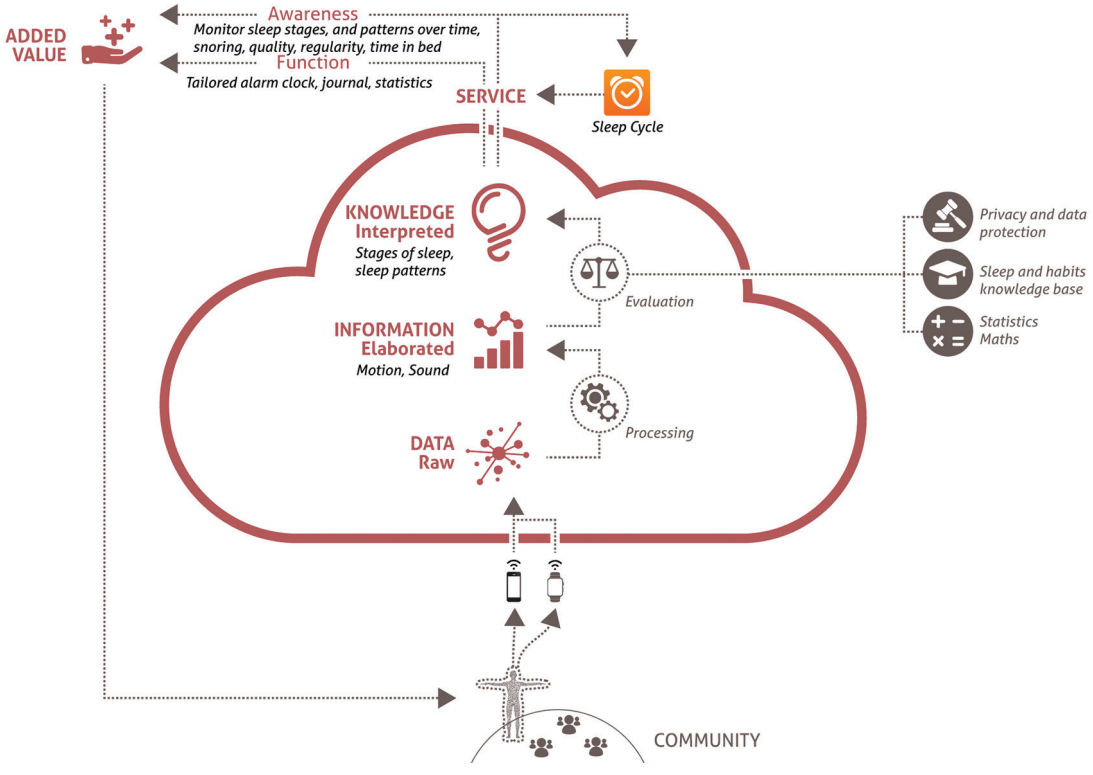


Fig. 4.5 *Model of the process of knowledge creation in digital services for Sleep Cycle.*

1.4.6 Happn

Happn (Happn, 2014) is a location-based online dating application. It works allowing users to like or dislike each other and chat if both liked each other (match). Happn works collecting GPS data in real-time and using personal data through social log-in or creating a new profile providing personal data. Happn gathers data in order to create personal information for each user in order to have very accurate profiling. They use public and private information profiles (first and name, ae, birth date, photos, gender, profile description, email address, phone number), and other information as working and education experience, messages and search history, location, locations where users crossed paths with other users, interests, device info. The most relevant aspect of this product is the way it uses knowledge to create a meaning that makes it different from its competitors. Classic dating apps, such as tinder, use the GPS data in order to know the distance between users, Happn uses the same technology to "find the people you've crossed paths with" (Happn motto). Their philosophy is to believe in the fate that brings two people to the same place at the same time, but they know that it is not easy to connect when you cross paths. For this reason, they created a tool that makes this process easier. (Happn, 2014).

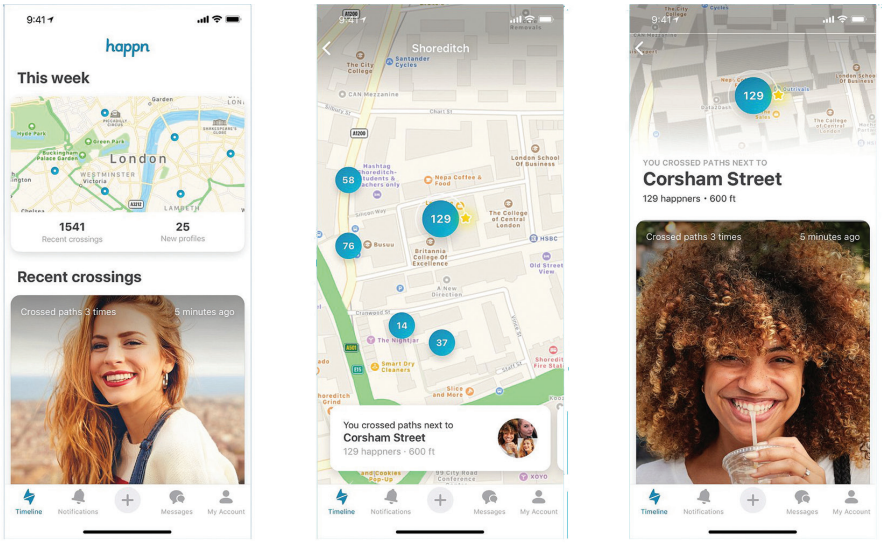


Fig. 10 *Some screens of the app, it is possible to see how the focus of the app is the user's position data. (Happn, 2014).*

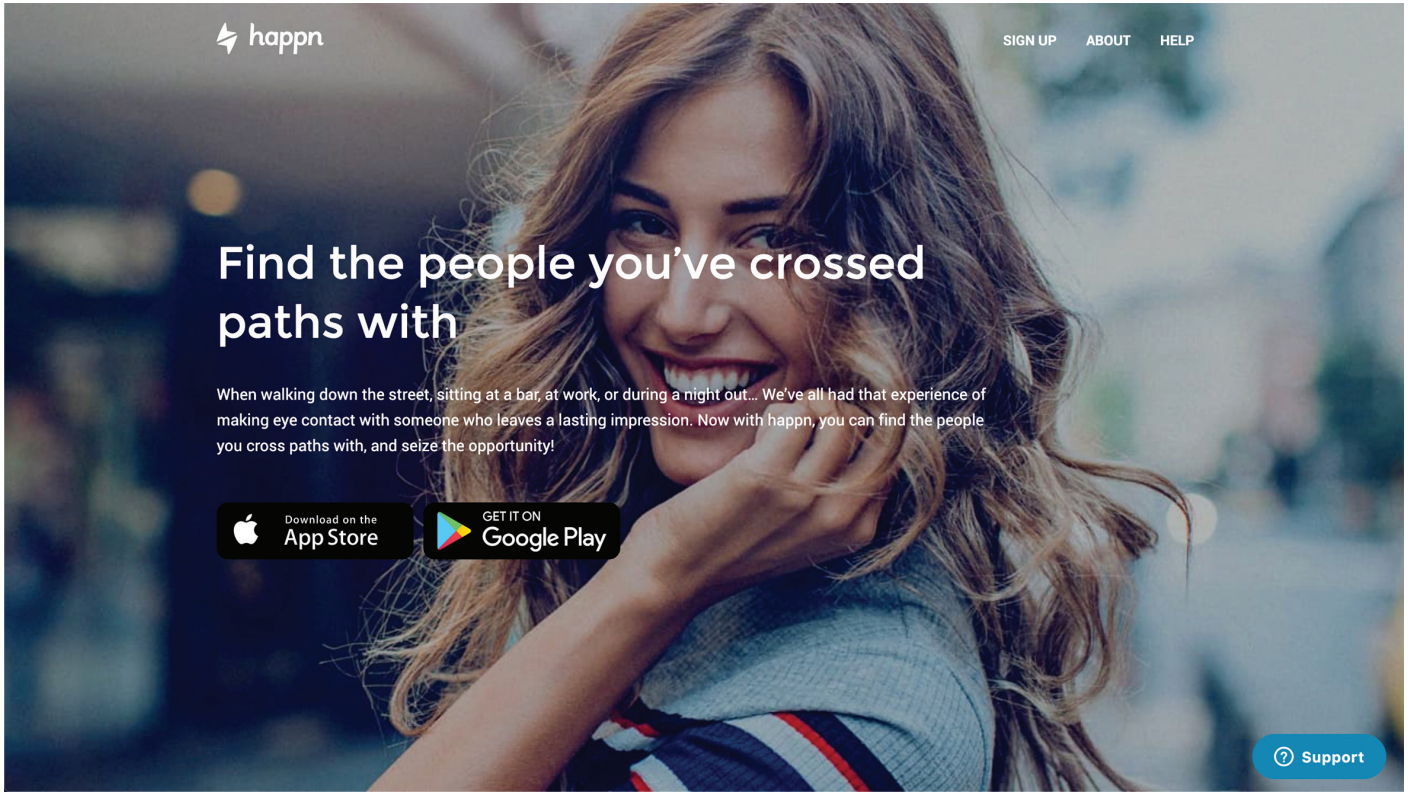


Fig. 10.1 *Happn website homepage, it is possible to understand immediately the meaning of the app, thanks to the effective communication. (Happn, 2014).*

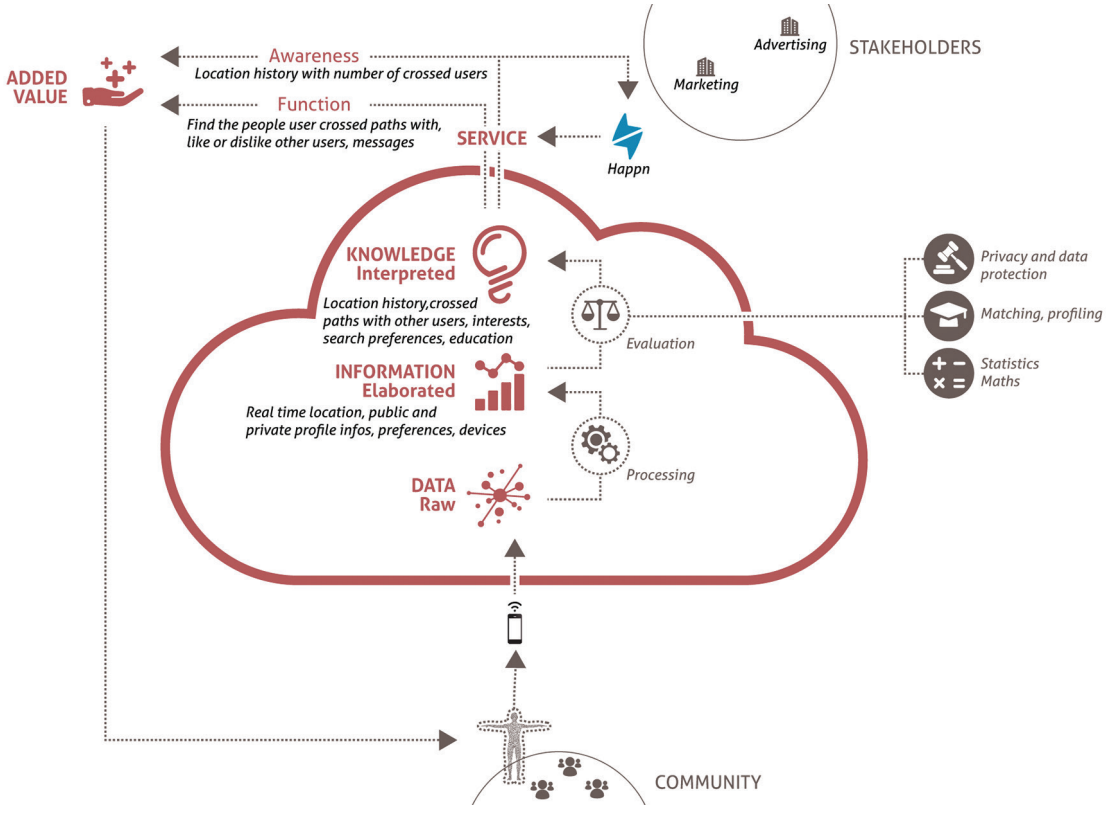


Fig. 4.6 *Model of the process of knowledge creation in digital services for Happn.*

In this chapter, we talked about User Experience, with a major focus on tailored user experiences, explored through some case study, in the next chapter, we will talk about storytelling and interaction, the most common and used forms of interactive storytelling are presented.

2 - Storytelling and Interaction, from gamebooks to new complex artifacts

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Intro

Storytelling in this thesis has a great and dual value. The initial part of the research succeeds in illustrating well how Eisenstein already used cinema, and therefore storytelling as a way to create a "psychological laboratory". In addition, the domain of interactive narratives offers an excellent field of application, especially for interactions. Storytelling is therefore intended as an investigation tool and as a possible area of application of the enactive interaction paradigm, it is not intended as an objective/goal. In this chapter, we talk about storytelling and interaction, the most common and used forms of interactive storytelling are presented. Starting from gamebooks we move to the digital side analyzing some case studies to understand how, thanks to technological advances, storytelling together with interaction, has come to bring us new interactive digital artifacts.

2.1 Interaction and Storytelling

When we talk about storytelling and interaction it is important to introduce the topic having a brief look at history and at the meaning of them, so as to understand their evolution until today. In the entertainment, storytelling is one of the main cultural activity of sharing stories "*it's one of the most natural ways to share information*" (Quesenbery & Brooks, 2010). Storytelling starts with the born of humans different languages and practices, it is a human need, "*stories have allowed people to shape and share their experiences by structuring the surrounding reality.*" (Ciancia, 2016). Every culture has its own stories that help the culture to preserve itself, to entertain, educate, and share moral values. Interaction instead, from the human perspective can be briefly summarized as the ability to have an effect on the surrounding world,

and the capacity to perceive the surrounding environment with its affordances and feedback, creating an input-output continuous loop, we are such as an algorithm, such as a machine. The world/environment can be both physical and/or digital, one example is Myron Krueger. He explored the idea of physical participation within the digital world, using the Responsive Environment paradigm. (Krueger et al., 1985). For obvious reasons, interaction and storytelling have always been developed in parallel, thanks to the advancement of technology and knowledge, interaction evolves, changes and explores new paradigms, in the same way, storytelling is shaped by the evolution of human interaction, technology, and knowledge. From ancient paintings found into caves, to nowadays complex digital artifacts there's a long history, this history is strictly related to the human capability of crafting tools, technologies and create languages, knowledge, interactions, and meanings.

2.2 Gamebooks

However, we can start our discourse with gamebooks or Choose Your Own Adventure (CYOA) books. CYOA is a series of gamebooks for children in which each story is written from a second-person point of view, the reader assumes the role of the protagonist by making choices that affect the main character's actions and the plot's outcome. They are one of the first commercial examples of interactive narrative. Gamebooks is the name of the more general category of printed books that allow the reader to interact with the story by making choices. These books usually don't follow a linear page or paragraph order, and the reader interaction is typically through the page or paragraph number. One of the first early works, the romantic novel *Consider the Consequences* (Webster & Hopkins, 1930) by Doris Webster and Mary Alden Hopkins was published in the United States in 1930. From 1970 to 1990 gamebooks were increasing in popularity until choice-based stories have moved away from print-based media to open a new path on the digital side. Anyway, there are many readers and fans and hundreds of books published, their production has not yet stopped and even today it is possible to buy them. However, this established form of interactive storytelling along with the advancement of technology opened the ground to new forms of artifacts in interactive narration and narratives as hypertext fiction, interactive fiction, adventure games, graphical adventures, and so on.

2.2.1 Consider the consequences

Consider the consequences (Webster & Hopkins, 1930) is one of the first early work in the field of pick-your-path books, it appears to be the first book designed to be interactive, an important achievement is that it was written

by two women. In this experience, the reader makes choices to create the destiny of the three protagonists. These stories are into separate narratives but they are connected and characters overlap in a fascinating read. It includes an introduction in which it's explained how the book is supposed to be read, like a typical cyoa book. The structure of the narrative is complex with several branches and sections that cross and overlap. For "Helen" story, we have 35 sections and 17 possible endings, for "Jed" we have 18 sections and 10 endings and for "Saunders" we have 30 sections and 16 endings. The possibility to play as different characters, two males and one female, allow the reader to experience insights about the social life of that period. Addressing

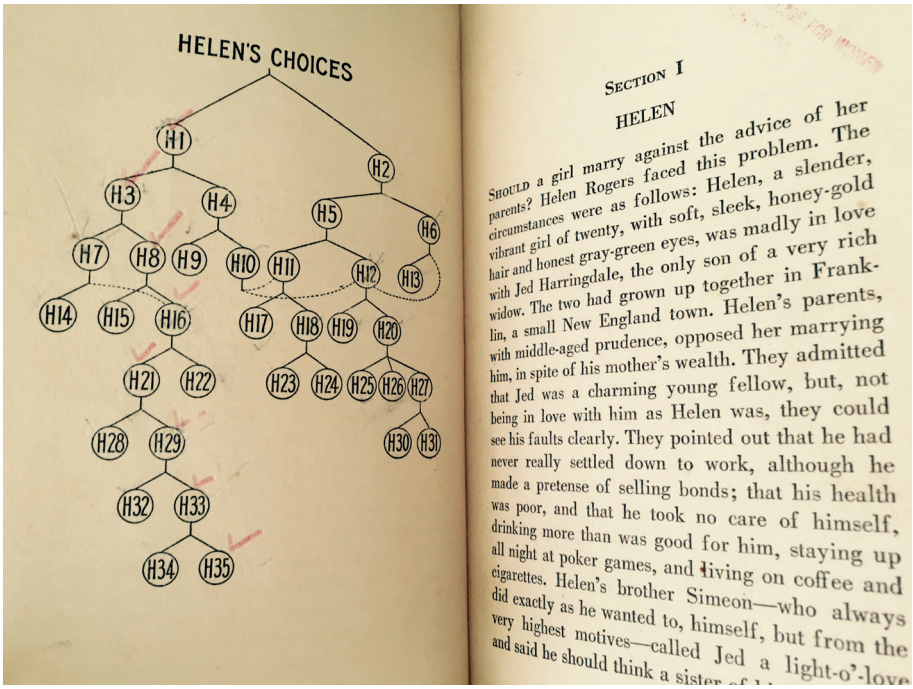
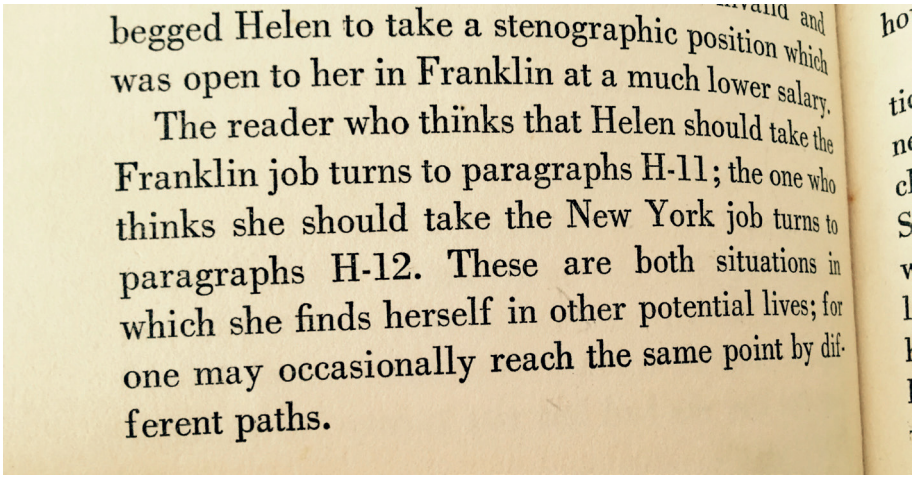


Fig. 11 *A picture from the book "Consider The consequences", it is possible to* see the branched structure of the narrative of a character's choices. (Webster & Hopkins, 1930) .

issues ranging from social class, marriage, divorce, woman emancipation, and single motherhood. It could result interesting from a sociological point of view also because the story depicts uncensored topics such as alcoholism, unusual family arrangements, political corruption, unmarried cohabitation, and even suicide. (Paredes, 2019).


begged Helen to take a stenographic position which was open to her in Franklin at a much lower salary.

The reader who thinks that Helen should take the Franklin job turns to paragraphs H-11; the one who thinks she should take the New York job turns to paragraphs H-12. These are both situations in which she finds herself in other potential lives; for one may occasionally reach the same point by different paths.

Fig. 11.1 *A picture from the book "Consider The Consequences", it is possible to see the way to choose of the reader during a decision (Webster & Hopkins, 1930).*

2.3 Digital narratives and games

From both digital and printed point of view, we can immediately define two big branches, interactive narratives, and interactive narration. Interactive narration is a work in which there is only one narrative and the user must actively interact in order to move forward in the story. An example could be some videogames in which the player is asked to complete a task or finish a level to make the narrative go on. Instead, the term interactive narrative means a narrative with a branched structure that allows the user to make choices. In some steps of the narrative, the user makes a choice that carries the story forward so that different choices can lead him to different events and endings. Gamebooks are a good example of interactive narratives but nowadays, technological development has allowed the creation of new forms of digital interactive narratives, ranging from adventure games to graphical adventures, from hypertext fiction to interactive streaming experience. Interactive narratives constitute a complex and articulated subject not only for the practice of authorship and entertainment but also for research and experimentation that is rooted in different epistemologies. Interactive narratives are objects of research in multiple fields from cultural studies, film and performance, psychology, and fine arts to narratology, computer science, digital media and game studies. (Ciancia, 2016; Mariani & Ciancia, 2019b). To date, a large number of professionals and scholars agree that the quality

narratives are those that allow the user to immerse and suspend disbelief. New contemporary digital media give users the possibility to act in different ways and forms. (Mariani & Ciancia, 2019a). This feature of digital media allows the various forms of interactive narratives to evolve synaesthetically to the new paradigms offered by technologies. The concepts of immersion and action, together with the participatory nature of digital media, are the basis of the ability to push users to go beyond single-story and single-media limits. Today it is possible to design new behaviors and hybrid experiences that favor inclusion and presence, in both physical and digital sides, in the narrative field. (Mariani & Ciancia, 2019a). The user interprets the narratives through a meaning-making logic that has its source in the experience. For this reason "*designing narratives goes beyond mere storytelling*" (Ciancia, 2016), it means conveying specific meanings, challenging ethical reasoning, issuing from wicked problems. (Mariani & Ciancia, 2019a). Since narratives are interactive thanks to the technology provided by new digital media, it is important during the design process from the authorship point of view, to know the possibilities and limitations of the media, and to think about the role and level of the agency. (Mariani & Ciancia, 2019b).

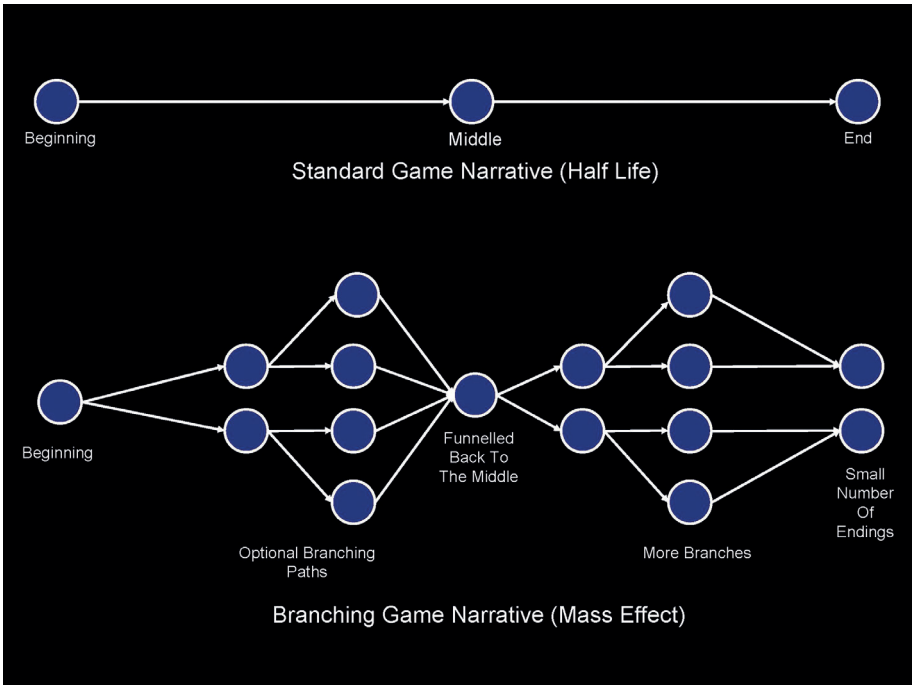


Fig. 12 *A linear and branched structure of two video games compared, from Emergent Systems as a Narrative Device (Jack, 2011).*

2.3.1 Heavy Rain

Video games are one of the most popular forms of interactive narratives. Not all videogames are interactive narratives, only those that allow through a branched structure of narratives, to have different consequences and ends are interactive narratives. The ones that follow a single story path are interactive narrations. Heavy Rain (Cage, 2010) is a game of David Cage by Quantic Dreams. It is a perfect example of an interactive narrative in the videogame field. According to the critics it could be classified as an action-adventure game, an interactive drama, a graphic adventure, a psychological cinematic thriller. It is a game in which the audience is faced with different themes for adult people. The plot of the game is explored through four distinct characters very different from each other, whose actions decided by the player, will define the paths to follow in the branched structure. The playable characters are connected to each other even if they don't know each other at the beginning of the game, all are connected thanks to the main antagonist, the Origami killer. Because it is a video game, not all decisions are made by choice, some require skills from the player to perform actions, for example saving someone. The branched structure allows the user to explore several possible endings, it's also possible to have different savings to better explore the structure. The end of the game is a series of epilogues, a general one and one for each playable character. The combination of these prologues can lead to 17 different endings.

Fig. 13 *A frame of the game Heavy Rain during a choice. (Cage, 2010).*

Fig. 13.1 *A frame of the game Heavy Rain during an interaction. (Cage, 2010).*

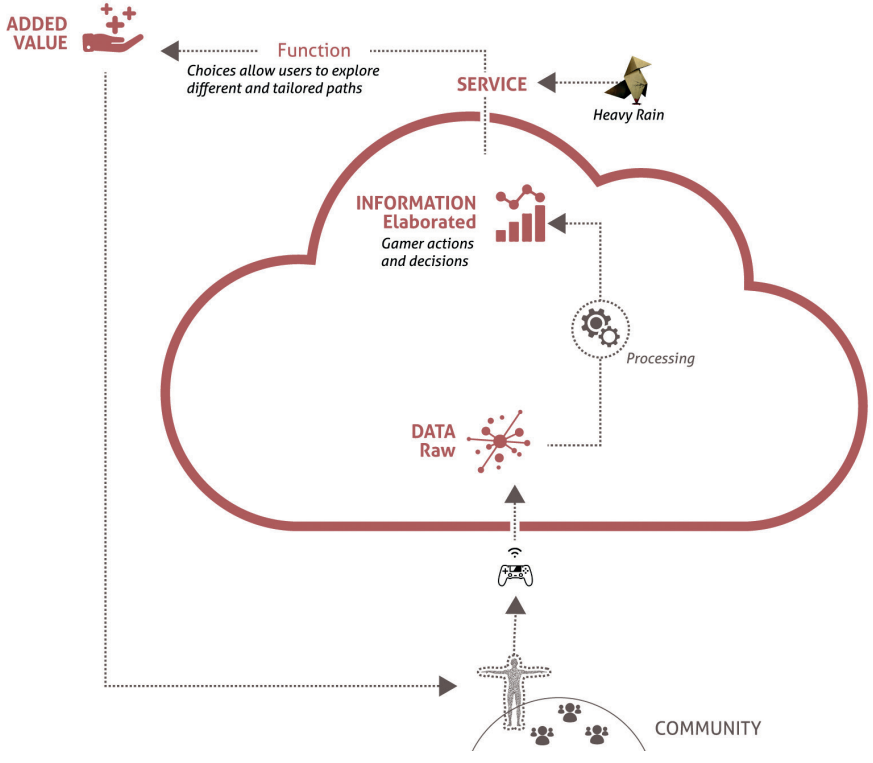


Fig. 4.7 *Model of the process of knowledge creation in digital services for Heavy Rain.*

2.4 Interactive streaming experiences

Another popular form of interactive narrative is one of the trends of today, the interactive movie experience on streaming platforms such as Netflix (Netflix, 1997). In these experiences, the interaction takes place choosing the path to follow between different options through the TV remote control. This new form of cinematic experience includes different movie genres such as i) Cinematographic: *Black Mirror's Bandersnatch* (Slade, 2018)), ii) Graphics Adventures: *Minecraft: Story Mode* (Minecraft: Story Mode (Series), 2018), iii) Documentary: *You vs Wild* (Buchta et al., 2019) and iv) Animated Films: *Puss in Book: Trapped in an Epic Tale* (Burdine & Castuciano, 2017). This experience has always the same interaction through a remote, users can choose between two or more options in a span of time. Otherwise, one of the options will be automatically chosen, usually the first one. This new approach of interactive streaming narratives has become very popular thanks to Netflix.

2.4.1 Netflix

Netflix (Netflix, 1997) is a streaming media services provider and production company. Since 2012 they started to produce and distribute their own original content of both movies and tv series, creating the "Netflix Original" paradigm. Netflix is also a big data company, they have over 100 million subscribers whose data is cloud stored to allow Netflix to use it for providing added value. They collect every data about the user interaction with their platform as ratings, searches, date and time the movie/show was watched, on which device it is watched, if the nature of the shows watched vary depending on the device, pauses, skips, re-watches, which portion of programs is watched and so on. They store and process these data in order to create information concerning user's profiles, preferences, behavior, personal tastes, and anticipations. The company spends most of its resources on algorithms and deep learning research, they have an entire department dedicated to developing them. In 2009 they even gave away a 1$Million prize to who came up with the best algorithm for predicting customers' likes based on previous ratings. These algorithms help them save a lot of money in value for customer retention. (Hallinan & Striphas, 2014). The knowledge they produce is the major source of their added value. They have one of the best data-driven approaches that allow them to tailor the streaming experience on the user's personal preferences and taste. Over 80% of what people watch, comes from Netflix recommendations (Gomez-Uribe & Hunt, 2016), from different content to personalized order of videos, selection and placement of rows, different images and so on. But the most important aspect of the company is "Netflix Originals". Originals comprehend both Netflix produced, co-produced, or commissioned shows and

Netflix content with exclusive streaming rights, sometimes they also acquire and produce continuations of previously canceled shows. The relevant aspect is that they create entire tv-shows, series, and movies starting from big data and machine learning that allows them to have an incredible amount of data, used to predict tastes and trends and to provide tailored movies. Is it just by chance that a company like Netflix, which invests a huge part of its resources in big-data, is also investing in interactive streaming contents? Lots of very important magazines such as *The Verge* (Porter, 2019) and *Vice* (Gault, 2019), have shown that Netflix actually saves data about every choice the user makes

Fig. 14 *The Netflix start page, there is a profile for each user to have different and customized content according to personal preferences. (Netflix, 1997).*

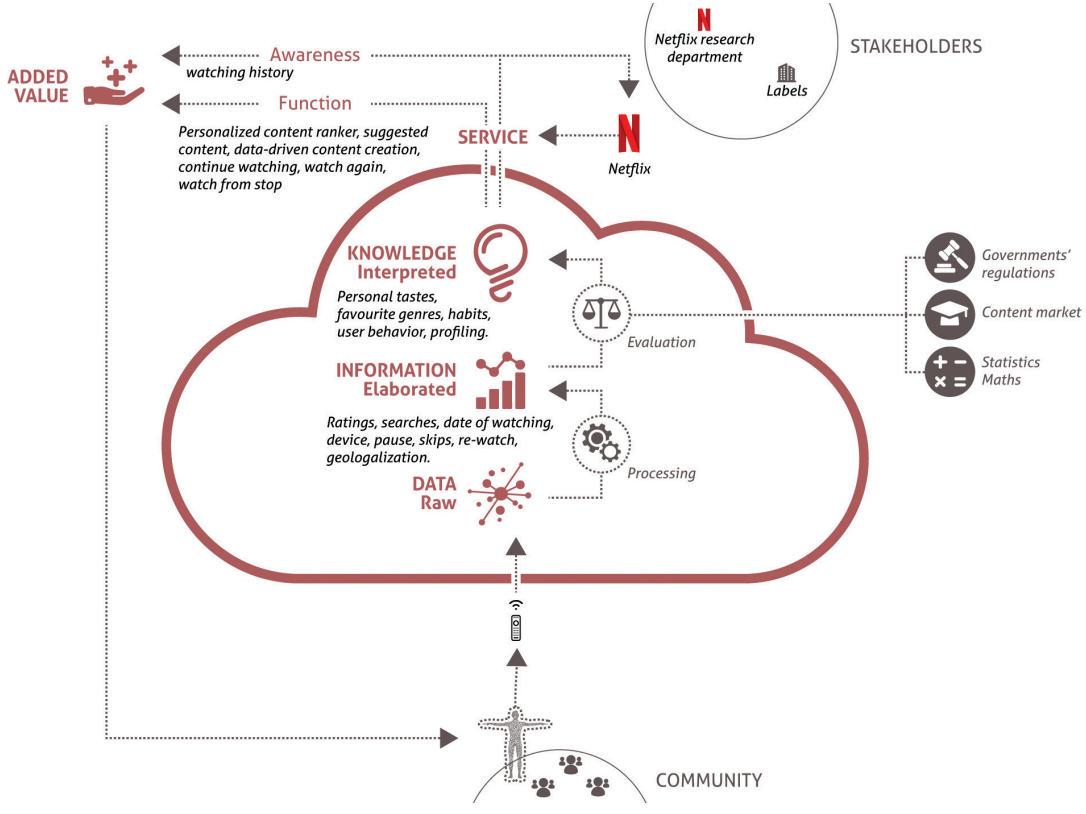


Fig. 4.8 *Model of the process of knowledge creation in digital services for Netflix.*

during an interactive experience, even *Wired* claims that this information is easily accessible to hackers. (Newman, 2019). Netflix, as we saw, knows very well the value of user choices, more than many others, they certainly have focused on the customization of the entire system, including their core, the content. To better understand the dynamics of interactive streaming experiences, we will analyze two different case studies, one is Bandersnatch (Slade, 2018), an interactive film from the famous TV series BlackMirror (Brooker, 2011). The other is Minecraft: Story Mode (Minecraft: Story Mode (Series), 2018), a graphic adventure based on the story-world of the well-known videogame Minecraft (Mojang, 2011). These two case studies have very different stories. Bandersnatch is a Netflix-Originals content, while Minecraft: Story Mode (Telltale Games, 2015), is a video game that was initially produced by Telltale, and later acquired by Netflix, which today holds the copyright for it. We can define this Netflix's approach, a matryoshka approach. Netflix as a recommender system has within it some tailored storytelling experiences as functions. These interactive experiences are a source of deep knowledge, which makes Netflix a matryoshka of tailored experiences.

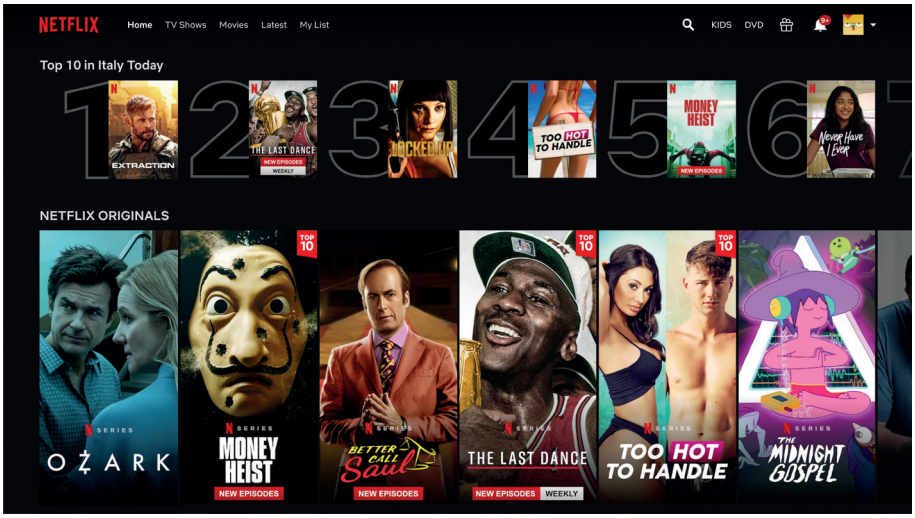


Fig. 14.1 *A screenshot of Netflix website showing the top 10 daily contents in Italy, as well as some netflix originals content. (Netflix, 1997).*

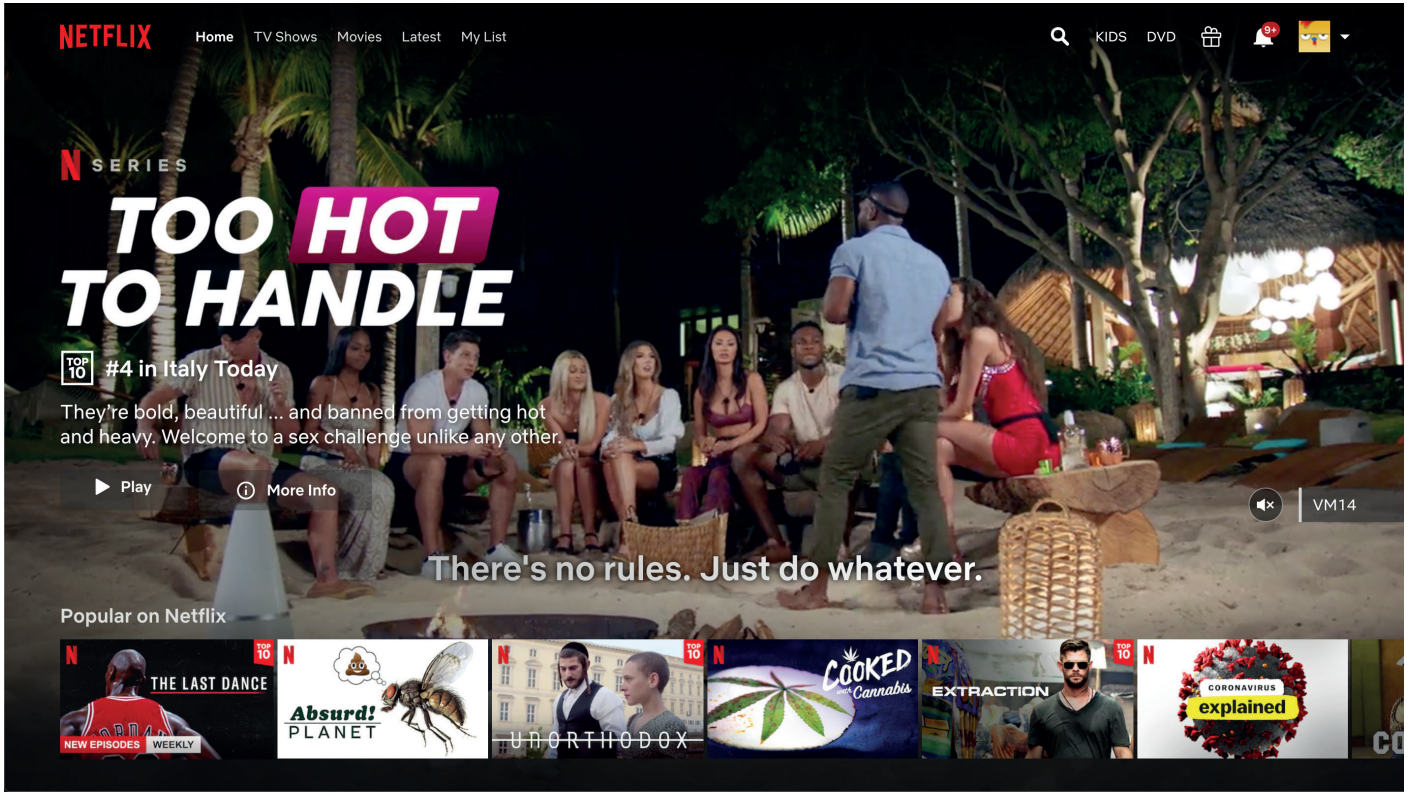


Fig. 14.2 *Two different Netflix homepages, it is possible to notice that the main content, and the other contents are different according to the profile. (Netflix, 1997).*

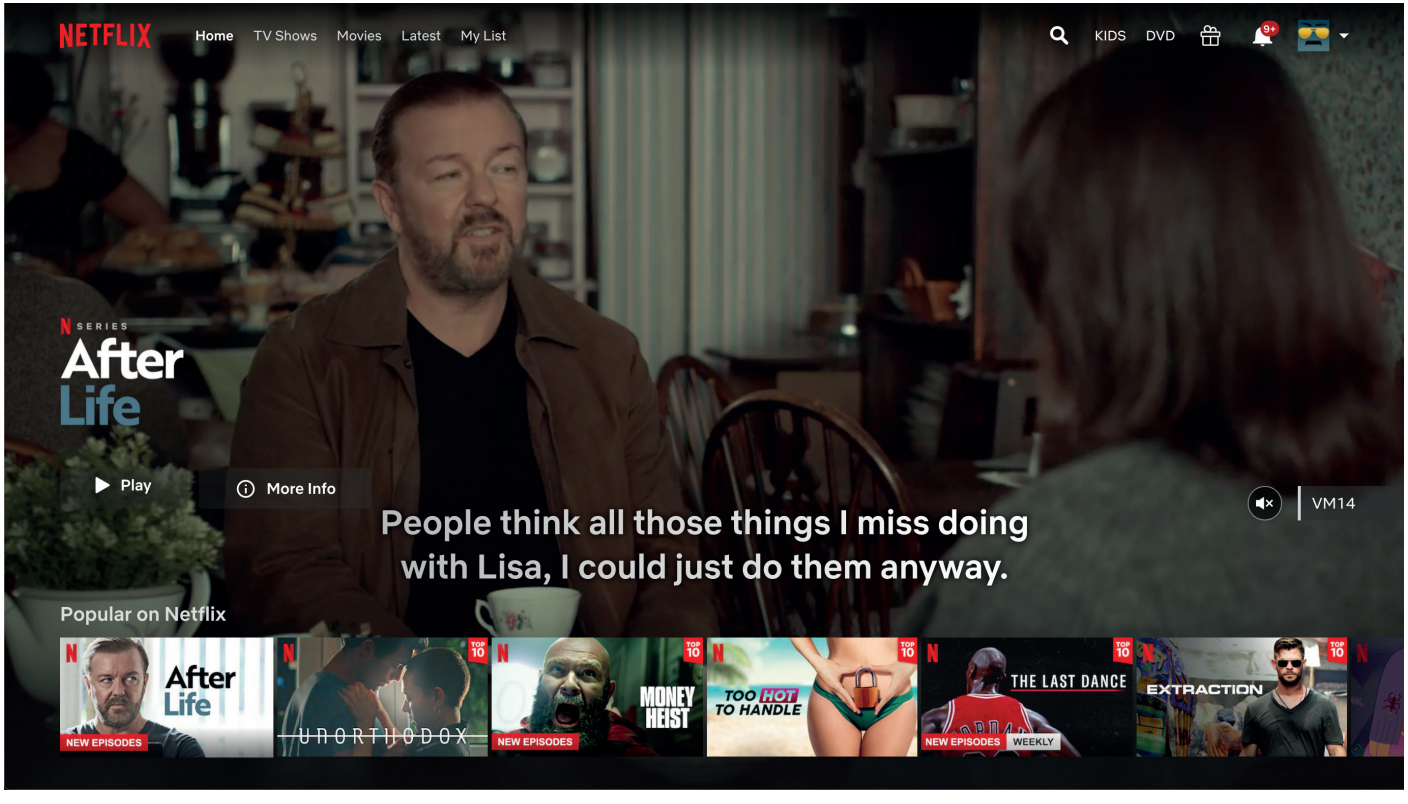


Fig. 14.3 *Two different Netflix homepages, it is possible to notice that the main content, and the other contents are different according to the profile. (Netflix, 1997).*

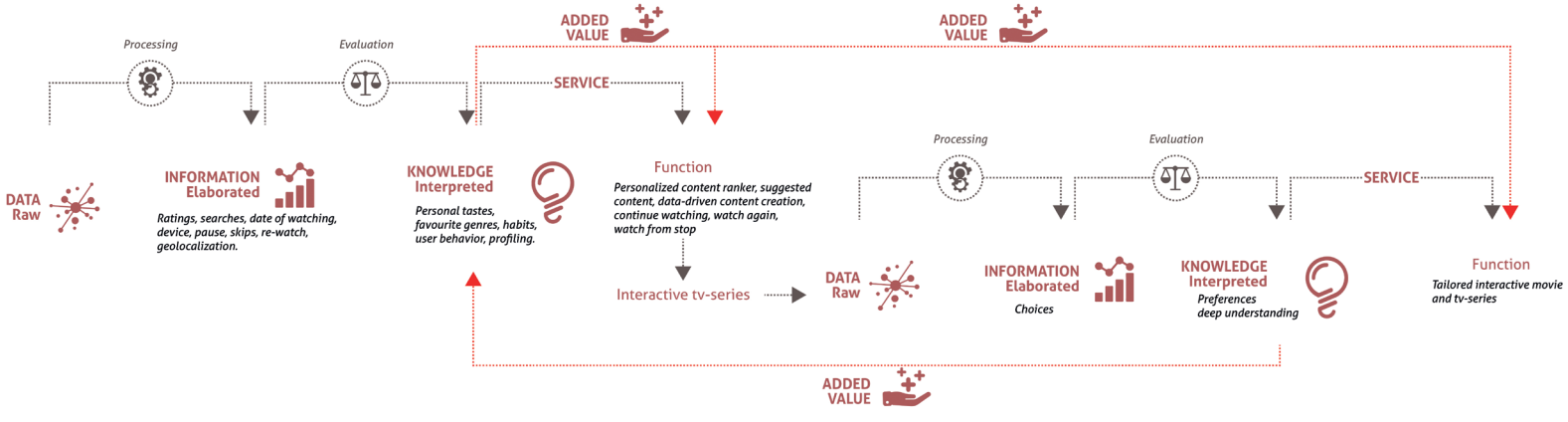


Fig. 4.8.1 *Revisited model of the process of knowledge creation in digital services, to show the matryoshka approach in Netflix.*

2.4.2 Minecraft: Story Mode

Minecraft: Story Mode is actually an interactive streaming experience by Netflix. The original videogame was an episodic point-and-click graphic adventure released by Telltale® Games, whose story-world is based on the original Minecraft developed by Mojang (Mojang, 2011). This game is a family-friendly interactive comedy-drama, intended to be one extent and possible interpretation of the original game. In the beginning, the player can choose the genre of Jesse, the protagonist. From then on, the player will be asked to collect items, talk to non-player characters and solve puzzles to keep the story going. The player's decisions will affect the whole story, including the following episodes creating a tailored story-path. One of the most interesting aspects of this product is its transformation from an episodic point-and-click videogame to an interactive TV series. Apart from the financial and managerial reasons, the transformation undertaken by Netflix regarding interactive content has certainly favored the transition of this product from one media platform to another. Showing that customization and interactivity are becoming more and more ubiquitous and are gaining ground in different fields, in this case, TV series. The point-and-click nature of the game was an advantage for Netflix because the interaction with a remote is more or less the same.

Fig. 15 *The character selection in the original experience released by Telltale Games. (Telltale Games, 2015).*

Fig. 15.1 *The character selection in the interactive experience released by Netflix. (Minecraft: Story Mode (Series), 2018).*

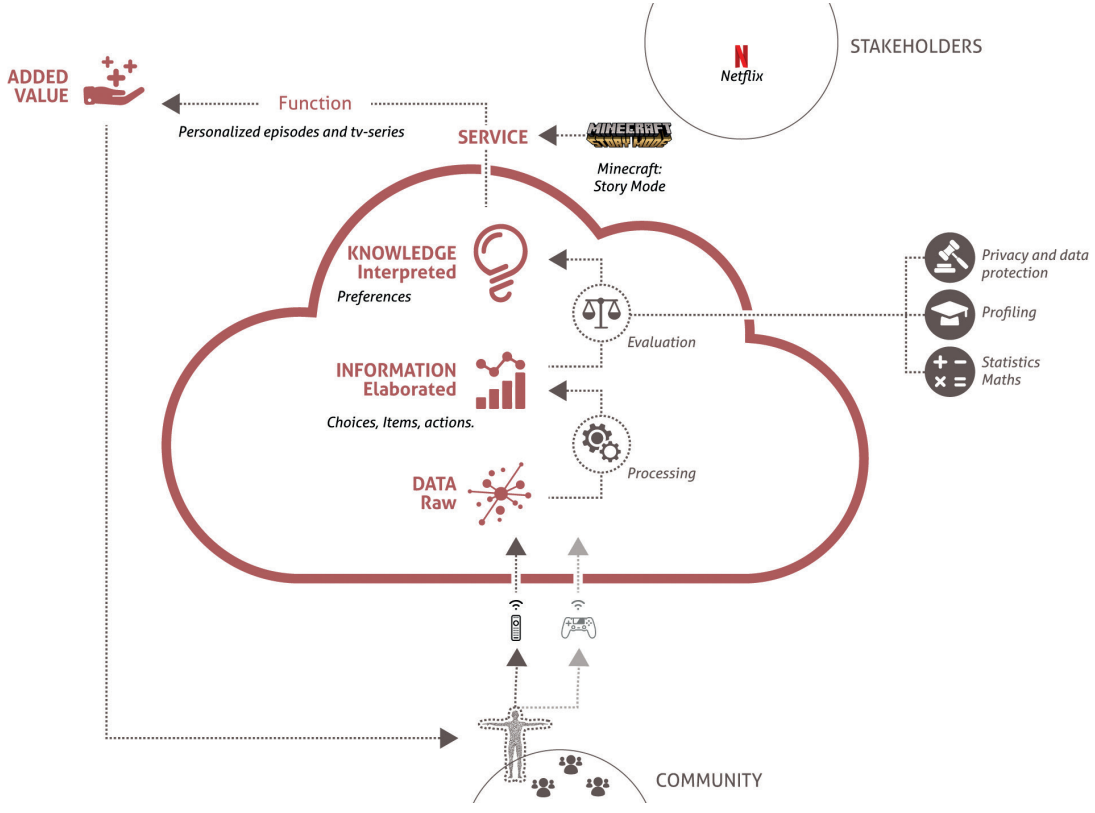


Fig. 4.9 *Model of the process of knowledge creation in digital services for Minecraft: Story Mode.*

2.4.3 Black Mirror: Bandersnatch

Black Mirror: Bandersnatch (Slade, 2018) is the first interactive adult-oriented film released by Netflix in 2018. In this film, viewers make decisions for the main character. Bandersnatch is a Netflix Originals content, wanted and created "ad hoc" in the style of the famous black mirror TV series (Brooker, 2011), of which it's the only interactive episode to date. The script for Bandersnatch has been written using various tools including *Twine* (Klimas, 2009), a very useful open-source tool that was created for the purpose of writing interactive fiction. Obviously the design of this kind of interactive movie for adults required a lot of effort as the script is highly non-linear. For this reason, a tailor-made program for Netflix called *Branch Manager* was created. Writing interactive stories that have more branches is not easy, and above all needs special tools and knowledge about interaction, as well as a deep awareness of interactive narratives and storytelling. The story is about a young programmer who dreams of creating a video game based on a CYOA book called Bandersnatch. The storyline runs through hard themes such as the heavy father-son relationship steeped in the loss of the protagonist's mother. There are five main endings in Bandersnatch, but each end may have its own variations depending on the path followed by the user.

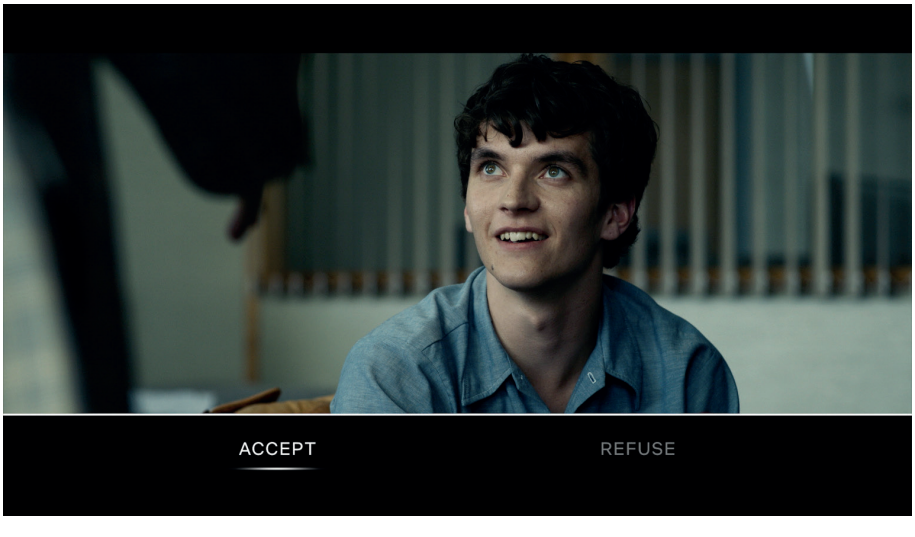


Fig. 16 *A scene from the interactive movie Black Mirror: Bandersnatch. In this scene the viewer is asked to make a choice. (Slade, 2018).*

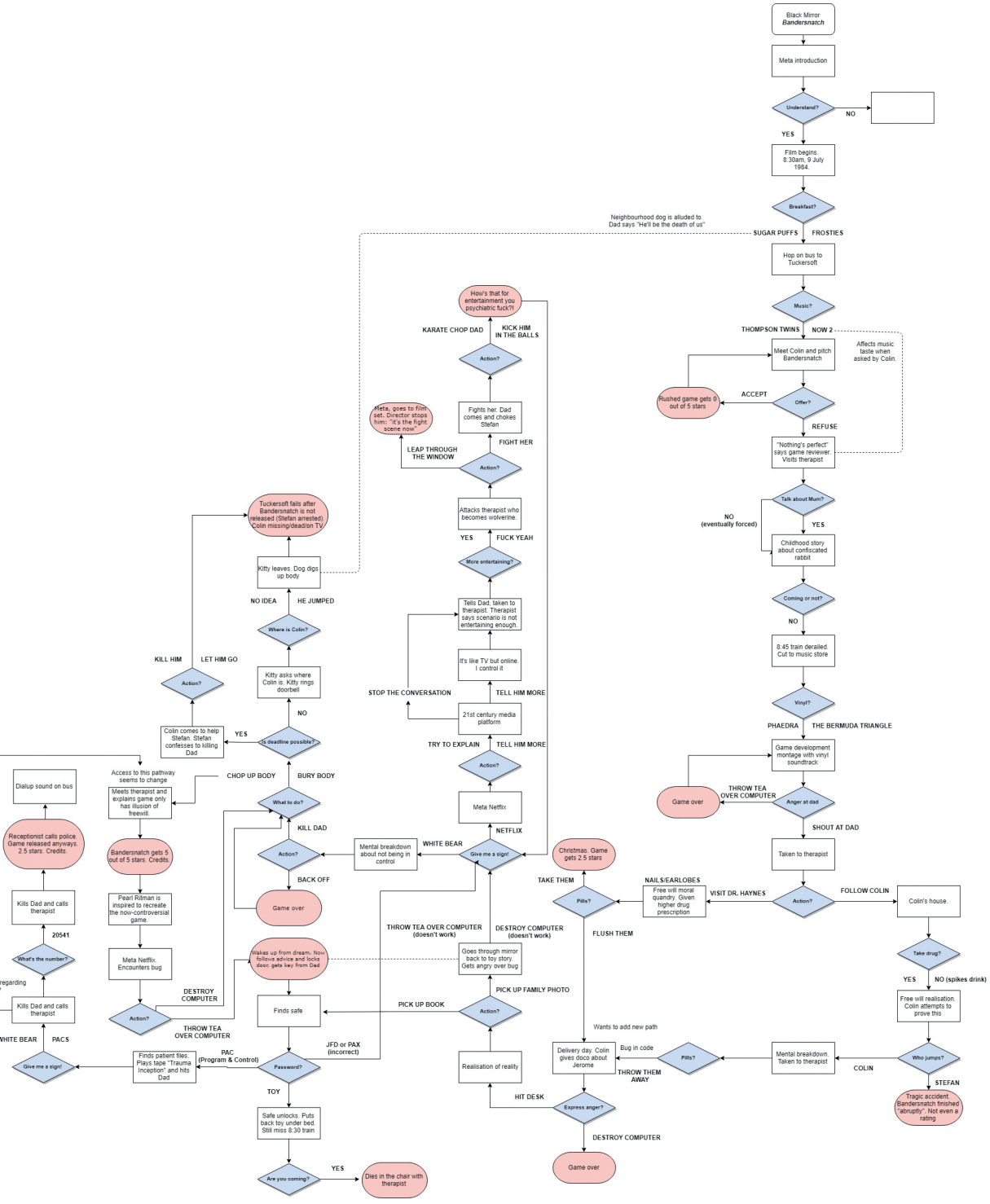


Fig. 16.1 *The branched structure of the interactive film Black Mirror: Bandersnatch. This image was created by u/alpine- on Reddit. (u/alpine, 2018).*

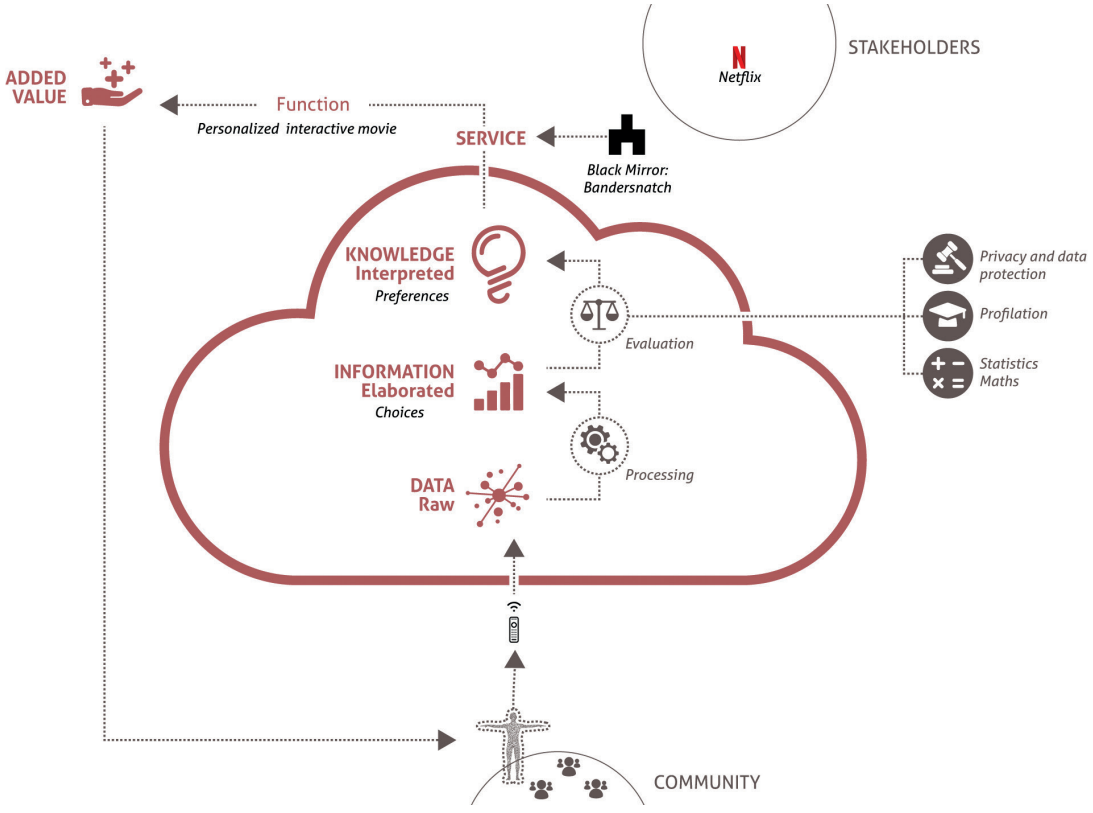


Fig. 4.10 *Model of the process of knowledge creation in digital services for Black Mirror: Bandersnatch.*

In this chapter, we talked about interactive storytelling to understand the state of the art of artifacts and platforms on which interactive narratives operate today. These case studies help us to understand the ground within which this research study is being conducted. In the next chapter, we will analyze the concept of enactivity, explored from a cinematographic and interactive point of view by Pia Tikka.

3 - Mind, brain and enactive cinema

Intro

In the last chapter we talked about interactive storytelling, now that we have seen and analyzed the different possibilities offered today by interactive narratives, in this chapter we will talk about the major cognitive approaches, focusing on enactivism and on the enactive-cognitive approach. Then we will analyze the research of Pia Tikka "Enactive Cinema, simulatorium eisesteinense" (Tikka & Taideteollinen korkeakoulu, 2008) which is the actual ground of this whole research thesis. In the end, we analyze Obsession (Tikka et al., 2006), a case study of enactive cinema installation which is the practical result of Pia Tikka's research.

3.1 From cognitivism to Enactivism

In the cognitive sciences, it is possible to distinguish different approaches, among the major ones we find cognitivism, connectionism, and embodied-dynamicism. Historically speaking they are consequential, cognitivism began in the 50s', connectionism in the 80s' and embodied-dynamicism in the 90s'. However, for some years now researchers have agreed that the cognitive sciences are incomplete because they focus on cognition while neglecting emotions, influences, and motivation. (Thompson, 2010).

3.1.1 Cognitivism

The "Cognitive Revolution" (Thompson, 2010) of the 50s' has as a central concept the computer model of the mind. As the computer is a symbol-manipulating machine, so is the brain. Cognitivism focuses on the concept of problem-solving, which from their point of view, has a symbolic structure and algorithmic nature. So making a comparison with the computer we can say that the first characteristic of this model is that the software is the core of the mental processes, while the hardware is neither involved nor considered. Cognitivism and behaviorism have in common the exclusion of the concept of consciousness. Behaviorism has excluded the analysis of the internal states of

the organism, formulating explanations in terms of input and output. Mental processes are therefore entirely unconscious, guided by sensory stimuli and behavioral responses. According to cognitivists, mental processes are inaccessible to personal awareness and are considered "subpersonal routines", creating an "explanatory-gap" in the scientific theories of the human mind. (Thompson, 2010). The architecture of computation, therefore, ignores various key concepts of human experience, the experience is embodied, perceived, and physically lived in the form of actions, as well as embedded in a sociocultural environment. We can therefore say that this model reflects well the properties of the sociocultural system in which the individual is embedded, but does not reflect his or her individual cognitive properties. (Ibid.).

3.1.2 Connectionism

The connectionism metaphor is mind as a neural network. This model of cognitive processes has the structure of an artificial neural network that consists of various layers made up of neuron-like, connected by links that have different weights according to the learning rules and system's activities history. Key concepts of this model are the numerical input/output representation and conversion rather than symbolic. The units, layers, and connections as architecture, the learning rules, and the subsymbolic representations from the network's activity as explanations. This movement has contributed to pushing forward the relationship between environment and cognitive processes, in fact from the connectionism point of view, sequential reasoning and linguistic cognition come from the interaction of the neural network with the symbols existing in the external environment, such as language, and visual elements. Apart from this contribution, connectionism still does not include subjectivity, either embodiment and there is still no addition on the explanatory-gap opened by the cognitivism. (Thompson, 2010).

3.1.3 Embodied dynamicism

While cognitivism and connectionism have not questioned the relationship between the surrounding world and cognitive processes, creating abstract and disembodied models, the embodied dynamism adds the idea that cognitive processes arise from the sensorimotor interaction of body, mind, and environment. In a continuous nonlinear and circular causality that is the surrounding world, the self-organizing dynamic system receives perturbations more than instructions as input. This model depicts the mind as an embodied dynamic self-organizing system in the world, this system changes state over time according to internal and external forces that shape trajectories, trajectories direct the system towards a state in the collection of all possible

states (state space, or phase space). (Thompson, 2010). Moreover, the embodied dynamicism proposes a different perspective for the cognitive unconscious: "*the cognitive unconscious consists of those processes of embodied and embedded cognition and emotion that cannot be made experientially accessible to the person*." (Thompson, 2010). These unconscious processes are part of the body that is continuously flowing through the material, social and cultural environments in which it is immersed.

3.1.4 The enactive approach

Varela, Thompson, and Rosch, in 1991 introduced the concept of enaction in cognitive science with their book *The Embodied Mind: Cognitive Science and Human Experience* (Varela et al., 1991). Varela depicted enaction as the laying down of a path during a walk, enaction means the natural performance of doing an action. According to this model, living beings are autonomous organisms that enactively generate and maintain themselves. Their nervous system is conceived as an autonomous dynamic system that creates meaning rather than computing information. Sensorimotor patterns of action and perception give rise to cognitive processes and structures. (Thompson, 2010). Moreover, the external world is not predefined and is created by the enaction between the being and the environment, for this reason, experience has a central role in understanding mind with his processes, and it needs to be considered central from a phenomenological point of view. The enactive approach takes a big step forward in the explanatory-gap that previous models have left open. From the phenomenological philosophy inaugurated by Husserl, there has been a growth that has led to a branch of phenomenologists aiming to naturalize phenomenology. Naturalization means that to be investigated, phenomenology needs to be related to biology and mind science. This concept of naturalization is well known and weighted by the enactivists. A great common point between the enactive approach and this branch of phenomenology is that both share the idea that the mind has to create its reality. The mind reveals and presents the world through awareness, and things are shown to our awareness through the intentional activity of the mind. Therefore from an enactive point of view, autonomy is a central aspect of organic life together with the continuous cohesion of life and mind. Both the enactive approach and phenomenology focus on the idea that consciousness and subjectivity have to be seen in relation to intentionality and autonomy in a continuous flow of life in which the organism is inseparable from subjectivity, body, the world, and life itself. Finally, Varela defines the direction to bridge the gap between biological science and experience, defining neurophenomenology, a branch of the enactive approach. (Thompson, 2010).

3.2 Enactive cinema

Pia Tikka's *Enactive cinema: simulatorium Eisensteinense* (Tikka & Taideteollinen korkeakoulu, 2008), is the main research that studies the biological and psychophysiological aspects of interactive cinema, starting from Eisenstein's research-based path on the idea of cinema as a psychological laboratory. This research is taken into account in order to study how a traditional fiction film can take a step forward to a new kind of form of interaction in terms of emotion-driven enactive cinema, through both research-based practice and practice-based research. Tikka's research revisited and extrapolated knowledge starting from Eisenstein's work as author, philosopher, and theorist. Actualizing his point of view with recent scientific knowledge, theories, and technologies. The core idea is that "*What emerges in the mind, in the form of an idea, corresponds to some structure of the body, in a particular state and set of circumstances*" (Damasio, 2003). The unconscious response in space and time precedes the conscious evaluation, any change reinforces the organism's awareness. "*From image to emotions, from emotions to thesis*" Eisenstein wrote in his 1930 essay *The principles of New Russian Cinema*. (Tikka & Taideteollinen korkeakoulu, 2008). The emotional survival kit humans have works enabling immediate responses to the changes in the surrounding environment or to the behavior of other entities, guiding the organism towards wellbeing (Damasio, 1994, 2000, 2003; Tikka & Taideteollinen korkeakoulu, 2008). Tikka was also inspired by Paul Eckman, in his study on the facial expressions of emotions, he showed up the similarity of emotions across different cultures. The FACS (Facial Action Coding System), is a system created to categorize human facial movements in the way they appear on the face, it is well used in the analysis of facial emotional expressions. "*The understanding of the psychophysiological dynamics of embodied simulation could enable discovering those aspects of the human perception-action system that are automated*" (Tikka & Taideteollinen korkeakoulu, 2008). According to Damasio, *the human mind is survival-driven, and sensory-based categorization forms part of this survival process*. (Ibid.). Cinema as an artistic audiovisual product can be a creative laboratory for modeling the world, in which the relationship between the author's embodied relation with the world (first-order modeling), enables cognitive mapping of the world for the observer (second-order modeling) who is determined to model a first-order mind in the act of modeling the world. (Ibid.). With this in mind, through deep research on many related fields such as psychology, cognitive science, cinema montage, mind engineering, socio-linguistic psychology, neurological factors, mind theories, and so on. Pia Tikka was able to create the enactive cinema installation Obsession, in order

to exemplify and show the application of her hypothetical model. But first, we will analyze some key concepts of her research.

3.2.1 Embodiment and naturalization of the mind

Pia tikka's research has paved the way for further research in this area, which thanks to technological development, finds many new possibilities. The starting point is Eisenstein's idea of *Embodiment of an emotional theme*. Embodiment, according to Valera as we saw in the previous paragraphs, becomes the keyword of enactive cognitive science. The roots of embodiment ideas are connected with the concept of naturalization of the mind. However, two different lines mainly contributed to fill the research of naturalization of the mind, Husserl's phenomenology and Jame's psychological pragmatism. Naturalization of the mind refers to the 'explanatory gap' between mind and body, however, according to tikka, it is still needed a scientific framework for juxtaposing the phenomenal (stream of thoughts, consciousness) and physical domains (brain and body). Furthermore, scientific research of the 20th-century considered emotions too "fuzzy" (Tikka & Taideteollinen korkeakoulu, 2008) and undetermined to be extracted with proper scientific methods. One line of naturalization can be the enactive naturalizing approach. "*The enactive naturalization of phenomenology applies two distinct methodological frames for developing a mind-modeling praxis: (1) advanced neuroimaging technologies that enable real-time recording and observation of the mind's neurobiological dynamics, and (2) phenomenological reduction that enables collaboration with test persons in their experientially meaningful, subjective framings*." (Tikka & Taideteollinen korkeakoulu, 2008).

3.2.2 Enactive cognitive approach in practice

According to *The Embodied Mind* (Varela et al., 1991), the notion of enactment implies the subjects continuous interaction with the surrounding environment in an inseparable embodied way, thanks to their multisensory experience and understanding of the world. We need to remember that cognition itself is not predefined, moreover "*Enactive, embodied cognition emerges in the interplay between unconscious, emotion-driven cognition, and conscious cognition*." (Tikka & Taideteollinen korkeakoulu, 2008). To put this into practice, Tikka suggests that in passive watching conditions, such as cinema, all physiological responses such as blushing, crying or shivering, can be defined as enactive because they are the subject's bodily response needed to self-regulate his condition. (Ibid.).

3.2.3 Perception, metaphors, mental models and dynamical systems

The active perception has a central role in the enactive approach because it is related to survival and goal-oriented exploration of the surrounding environment. According to Antonio Damasio's idea of interoception and exteroception, we can similarly divide perception in outwards to the surrounding world, and inwards to the inner bodily dimension. Moreover, Varela suggests us, unconscious cognition can be considered goal-driven, explorative, and active as the conscious cognition. An important concept to understand the survival-oriented cognitive dynamics, and the meaningfulness is the "uncanny valley" by Masahiro Mori (Mori, 1970). This model helps us in depicting the mental forking between a 'too complete' valley of 'maximum effort' or 'too open' valley of 'minimum effort' organization system. In this view, both polarities of the system cause that the spectator loses interest, as well as simplify the idea that meaningfulness comes from the organizational unity of the whole. Moreover, some interpretation of this model suggest that *unconscious recognizes micro-scale differences in the global organization*, this orientation focuses on anticipating friendly/hostile behavior from a biological and evolutionary point of view. Another model to take into account is the 'ontogenetic landscape' proposed by Esther Thelen in 1995 (Thelen, 1995), this model inspired Pia Tikka's study of cinema as a dynamical system. From Thelen's point of view, behavioral patterns can be shaped as an ontogenetic landscape. "*Behavioral patterns on the macro level emerge in reduction from continuous real-time interaction of micro-level subsystems*" (Tikka & Taideteollinen korkeakoulu, 2008). In Thelen's metaphor learning and therefore experience can be seen as a mountain stream running along the side of a mountain, sculpting its own way. This metaphor allows us to say that our state of mind is never the same, every thought we have is unique, it can only resemble other thoughts about the same fact. Nevertheless, we are always ourselves, conditioned by the differences in the following views of the same world. In this view, environments define the range of potential actions it's possible to take. Damasio, continuing James' theory (James, 1884, 1912), points out his 'movie-in-the-brain' metaphor, this metaphor shows us how the human mind is continuously conditioned by "sensory- portals", which are our senses, sight, hearing, smell, touch, and so on. This metaphor is also useful to understand how the same reality, or the same 'movie-in-the-brain' seen by several people together, will have some montage and editing differences, and will, therefore, be slightly different depending on the perspective of the viewer. (Tikka & Taideteollinen korkeakoulu, 2008). Consciousness corresponds to the dynamic of "*recognizing ourselves in interacting with the world*". (Damasio, 2000). We can divide consciousness into two different levels of self.

The core self-consciousness is a non-cognitive consciousness, which interacts subliminally with the environment, and it's detectable in bodily changes. The other level is the autobiographical self, based on the core self, is related to personality, cultural contexts, past and future experiences, needs and goals and so on, and it's identified from the subjective point of view. The metaphor of the 'movie-in-the-brain', therefore, describes this lived-by-story of the core consciousness, the person lives the story, and the autobiographic self extends the self-consciousness throughout the lived story. These metaphors by Damasio help us to explain the viewing experience of the film spectator. The consciousness during the vision fluctuates between emotional immersion which corresponds to the core consciousness and back-to-reality which is the autobiographic/extended consciousness. (Tikka & Taideteollinen korkeakoulu, 2008). All mental models, metaphors and cognitive forms of 'movie-in-the-brain' are considered as dynamical systems in terms of the enactive approach. In addition, the process of imagining things that are not real is not separable from experience and therefore occurs as a phenomenon during the experience. Eisenstein's idea of cinema as inner speech is now linked to Damasio's, according to which cinema is the most similar representation of the story-telling we constantly live in our minds. (Ibid.).

3.2.4 Emotions and embodied mind

Our senses in the course of evolution have evolved for survival because they allow us to perceive, to have the perception (hearing, smell, touch, taste) of danger and to prepare a defense, fight or flight. In particular, it has evolved with visual cells, cones, and rods, which allow us to see colors. Colors in nature do not exist as we see them, they are an effect of the electromagnetic spectrum of sunlight (the various colors), which is captured by retinal cells. Other living beings have other sensory channels, other than humans, and they orient themselves and adapt to the external world in relation to their senses and their brain. For example, the bat orients itself and moves according to the ability of its brain to perceive ultrasound and moves in the dark. Other animals have developed more other senses and are adapted differently than humans. Damasio gave a neurophysiological interpretation of the phenomenon of "*Qualia 1 and 2*" (perception of quality). An example of Qualia 1: seeing a sunset over the sea gives birth at the same time to a pleasant feeling that reminds of other images, a feeling that we can not prevent, and that arises spontaneously. Why does the same landscape arouse a feeling of sadness or anguish to another person? An example of Qualia 2: perceptual brain maps, which are physical and neural events, are actually "perceived, felt". Why billions of cells that are material, operate transduction from physical to mental, in this case, sentiment? He gives

a scientific answer to that, Damasio describes well emotions and feelings, in his book *The feeling of what happens: body and emotion in the making of consciousness*. (Damasio, 2000). The emotions are states of the body (in a material sense) of variation of physiological phenomena in relation to external and internal stimuli, we perceive anger, fear, joy because they modify the perception of our body. When emotions, which are complex and automatic action programs (facial expressions, etc.) become conscious then they turn into feelings. Thus, one has the feeling of an emotion. Emotions and feelings are embodied, i.e. states of the body that are modified by what happens to us, and are perceived by the internal viscera or enteroception that makes us perceive that particular emotion that becomes a feeling, and a sentiment as we become aware of it. Damasio describes these processes very well in his book *Self comes to mind: constructing the conscious brain*. (Damasio, 2010). Another fundamental theory is James's, according to which our feeling of the bodily changes that follow the perception of the exciting fact, is the emotion itself. (James, 1884). Moreover, emotions seem to correspond to the processes that take place in the sensory-motor centers. The central aspect of this theory is that emotions are seen as the elementary and fundamental constituents of the individual experience, and therefore of social behavior because they are born inside the neurochemical and sensorimotor body dynamics. (Tikka & Taideteollinen korkeakoulu, 2008). This approach, therefore, implies that the emotional process is an end-state of an unconscious bodily process, which, becomes conscious as an emotional state when it causes perceptual changes in the body. (Ibid). Furthermore, "*the relations that connect experiences must themselves be experienced relations, and any kind of relation experienced must be accounted as 'real' as anything else in the system*." (James, 1912). Tikka, in accordance with the naturalizing and Damasio, discuss emotions as the fundamental basis of all cognition. Damasio considers the consciousness of changes in the body and emotional expressiveness as an extension of the unconscious awareness in the neocortical environment. The unconscious anticipation precedes the conscious evaluation. (Tikka & Taideteollinen korkeakoulu, 2008). People's emotional system is made up of neurochemical and hormonal components, this system continuously guides the body towards well-being, adapting to changes in the surrounding environment. Despite the fact that emotions are generated in a unique way in each individual, Damasio claims that every emotion is the result of an evolutionary calibration. An important contribution to this field of research on emotion is given by Paul Ekman's research on facial expression, which suggests the similarity of emotions across different cultures. According to the Paul Eckman group, the Facial Action Coding System (FACS) is a comprehensive, anatomically based

system for describing all visually discernible facial movements. It breaks down facial expressions into individual components of muscle movement, called Action Units (AUs). The FACS can provide a tool to make sense of the emotional responses of the spectator to the cinematic content. Moreover, comprehending the psychophysiological mechanisms of the embodied simulation can foster the discovery of automatic perception-action systems of human beings. Cinema often uses facial close-ups to manage the mood of the spectator, thanks to the logic of embodied simulation, including aspects as mirror neurons, it is possible to impose a psychophysiological response on the spectator. (Ibid.).

3.2.5 Neuroscience and storytelling

Today's neuroscience confirms MacLean's theory of the "*Triune*" brain, according to which 'old' and 'new' brain circuits generate only one global behavior. To better understand this cyclical dynamic of the evolution of emotions, we can consider epistemological aspects of 'feeling' and 'knowing', that can be compared to the dimensions of 'understanding' and 'knowing'. (Tikka & Taideteollinen korkeakoulu, 2008). The human brain throughout its evolution has maintained a chemical and anatomical organization that reflects three structures, the reptilian, early mammals and late mammals. In the course of human evolution, the primitive reptilian brain evolved with the overlapping and integration of the emotional brain or limbic system that took command over the perceptual stimulus-response brain, giving an emotional coloring to events. Subsequently, the cortical brain, also known as the social or rational brain, was superimposed and integrated with the emotional brain, consisting of the frontal lobe and, above all, the prefrontal cortex, responsible for the Executive Functions also known as the Higher Mental Functions, taking control over the emotional brain, acting as a brake on impulsive reactions through the development of the Reflective Function that is located in the prefrontal cortex, the last area of the brain whose maturation occurs around 20-25 years of age. Hence, according to neuroscience, our brain is anatomically made of three parts: i) The reptilian brain is the deepest structure and manages instinctual needs such as breathing, heartbeat, intestinal motility. ii) Limbic System, is the paleomammalian structure that deals with the basic emotions of the individual, phobias, aggressiveness, motherhood, and so on. iii) Neo-cortical system is the neomammalian structure that manages the more human-specific operators of the individual, holism, causality, complex emotionality. Every individual manages the old limbic, socio-emotional system and must learn the ways of the new neo-cortical system from a cultural blank or untaught state. (Tikka & Taideteollinen korkeakoulu,

2008). "*A cyclic bio-cultural model emphasizes survival-based knowledge, the evolution of which is determined by the emotion-driven interaction of the action-perception system with its environment – and this acquired information becomes embedded in the system (via slow genetic mutations)*." (Tikka & Taideteollinen korkeakoulu, 2008). According to Tikka, emotions shape the socio-cultural environment that shapes them back in a reciprocal way. This logic is in line with Damasio's concept of 'movie-in-the-brain', which therefore becomes a scheme for managing emotion-driven enactment in a modern social context. (Ibid). Many neuroscientists including Grodal, have a holistic view of the body-mind system, which means that the simulations of reality such as fiction, share the same cognitive and emotional mechanism of real-life experiences. For example, the experience of watching a movie cannot be detached from the body as a homeostatic cognitive system embedded in an environment. Micheal Gazzaniga even suggests that storytelling is a universal and emotion-driven expression of how our brain works in interpreting reality (Gazzaniga, 1985). The concepts of story and storyworld come back here useful to contextualize the individual and his experience in the world. The storyworld is a mental construct shared between the author and the audience, in which plots can arise. Stories are arrangements of events that come to an end in a certain period of time. (Ciancia, 2016). Considering these concepts it is easier to understand why the structure of storytelling is a natural human construct, and a way that has our mind to work giving meaning, causality, and value to reality. The individual is immersed in a world that we can call primary which is reality, the storyworld is a secondary world within the primary world, whose credibility can be traced back to three variables, invention, completeness and consistency. (Ciancia, 2016; Wolf, 2012). The spectator identifies with the protagonist, sharing his objectives, emotions, passions, and fortune. The emotional response of the spectator is biologically determined by the sympathetic and parasympathetic nervous system, which, thanks to neurohormonal and sensorimotor functions, creates biological and affective experiences that could even lead to addiction as in drugs, from this, we can understand someone's favorite genres. In addition, thanks to mirror neurons it is possible to better understand the dynamics of embodied simulation. This is because they give us the ability to imitate, understand and anticipate the actions of others, creating a personal and body-related experience that allows us to understand therefore the emotions, feelings, and experiences of another person. From the point of view of the montage of interactive cinema intended as world modeling, we can describe the experience lived in first-person as a cognitive 'first-order' model. "*Cinema as an artistic product with audiovisual duration may serve as a creative laboratory, which provides a kind of first-*

order description of the author's embodied relation with the world.". (Tikka & Taideteollinen korkeakoulu, 2008). Therefore the act of reading and modeling a first-order model/artifact/movie (for example during vision) is a cognitive second-order model.

3.3 Obsession

Tikka's *Obsession* (Tikka et al., 2006) was the first experience in the field of enactive cinema. An installation that performed a continuous montage of indexed and classifieds cinematic elements using algorithms fed with viewer's data. This enactive cinema installation was "*designed so as to play with the anticipation and expectations of the spectator, that is, with those uncontrollable fears and desires that the author assumes the unfolding of the story to elicit in the spectator's experience.*" (Tikka & Taideteollinen korkeakoulu, 2008) using biological signals. Talking about the story, it's emotional load is set on a minimum story about the relationship between the females and males figures. "*The emotional set-up of Obsession assumed an innate, mutually shared ecological grounding for survival-based emotional anticipations, for example, those that are related to sex and violence*." (Tikka & Taideteollinen korkeakoulu, 2008). The installation's story is about the relationship between Emmi and her pregnant mother Jatta, that is about to give birth soon. This pregnancy cames from a 'date rape' and Emmi is going through the grieving and healing process on behalf of her mother in an obsessive manner. "*Enactive cinema involves creating, controlling, and maintaining complex emotion-driven interaction between an enactive mind and dynamical cinema montage*." (Tikka & Taideteollinen korkeakoulu, 2008). For this reason, the cinema montage is driven by the spectator's unconscious emotional experience. In order to achieve that, they organized the material in an ontologically classified database. To organize this space, the content was fragmented into different narrative units, every fragment was given a value for each established cinematic dimension, for each property, this value ranges from a maximum value of 1 that represents the maximal relevance, to a minimum of 0 that represents no recognized relevance. "*The ontological space included two kinds of ontological dimensions: framing-related dimensions (for example, speed of camera movement, or presence of one of the characters) and ontological dimensions related to enactive involvement (i.e. the emotional content of the particular fragment, as interpreted by the author)*." (Tikka et al., 2006). For generating narrative they developed an algorithm following a fuzzy logic formula, fuzziness according to Tikka, in this case, means that there's flexibility in applying the rules, and the influence of each parameter can be parametrically adjusted. "*Obsession's biosensitive interface is designed to*

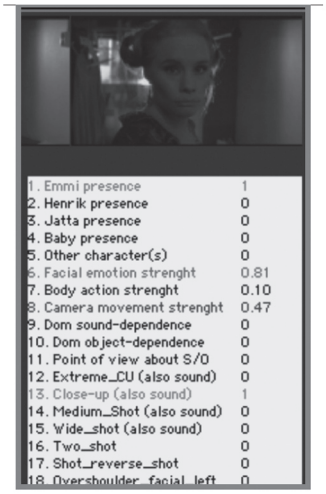


Fig. 17 *Annotation of a fragment by assignment of ontological dimensions with editable values (between 0 and 1) on the right. (Tikka et al., 2006).*

Note: Changes in **HR** involve synergistic counterbalance of opposing effects of sympathetic ('flight and fight') and parasympathetic ('rest and digest') cardiac activations (see Ravaja 2004)	**EDA+** Indicates intensity of stimuli; increased arousal, increased information processing capacity, supporting sensorimotor action tendency in threatening or exciting situations. (Dillon et al. 2000; see Ravaja n.d.)	**EDA-** Calm situation, media stimuli relatively long; indicates low stress condition; note that electro-dermal response habituates quickly (Dawson et al. 2000; See Ravaja 2004, pp. 213);
HR+ Emotional arousal, general preparation for action, defensive reactions, (Obrist 1981[i]; see Ravaja 2004, p. 201); increased sympathetic activity vs. decreased parasympathetic activity; in positive valence stronger than in negative (Lang et al. 1993; see Dillon et al. 2000; see Ravaja 2004, pp.209)	High values indicate high arousal; correlates to immersion; threatening or otherwise highly intensive stimuli; slow habituation; increased movements in response to high intensity stimuli; 'flight or fight'	EDA- relating to decrease in sympathetic activation of the autonomic nervous system (ANS), and particularly after a high EDA+, instead of indicating increased sympathetic activity, HR+ may indicate decreasing cardiac parasympathetic activity, i.e., attentional engagement is lost
HR- Increased automatic attention, if negative valence of stimuli is present (action readiness), information processing and stimulus identification; increased cardiac parasympathetic activity vs. decreased sympathetic activity (Graham 1992, p.6; see Dillon et al. 2000; Ravaja 2004)	Orientation to novel or unexpected stimulus, e.g. cuts, movements: elevating subjective ratings of emotional intensity; cognitive inhibition (Detenber, Simons & Bennett 1998; Simons, Detenber, Roedema & Reiss 1999; see Dillon et al. 2000)	HR- may indicate increased cardiac parasympathetic activity due to attentional engagement; yet, in correlation with decreased EDA-, HR- may relate to decreased cardiac sympathetic activity; no arousing stimuli involved; relaxing; neutral, habituation condition

Fig. 17.1 *Emotion-related interpretations of ascending and descending heart rate (HR), and electro-dermal activity (EDA). All interpretations are dependent on the narrative context. (Tikka et al., 2006).*

detect the emotional affect that the cinematic installation has on the spectator and to channel it back to control the installation's narrative dynamics." (Tikka et al., 2006). This interface consists of an infrared sensor for the fingertip that calculates the heart rate (HR), and a device under the spectator's hand, measured the electrodermal activity (EDA). The signal was interpreted according to the following assumption. "*One of the main principles was that the direction of the change, whether increase or decrease, was generally used to enhance the present emotional mood by means of directing the narrative flow instead of the alternative of dampening it*." (Tikka et al., 2006). In this case "*The data captured from the sensors was interpreted in terms of three emotion theoretical dimensions: valence, arousal, and dominance*." (Tikka & Taideteollinen korkeakoulu, 2008).

IF CURRENTLY			THEN		
c_j		$\mathbf{A}_t\mathbf{P}_t$	r_j	$\mathbf{A}_x\mathbf{P}_x$	w_j
HR	**EDA**	**Current property**		**Follower property**	**Influence**
-	+	10. DOMINANCE	ATTRACTS	11. ACTIVE-AVERSIVE-CONTROL	
-	+	6. POSITIVE	ATTRACTS	6. POSITIVE	
-	+	7. NEGATIVE	ATTRACTS	15. ABRUPTION-SURPRISE	
+	-	8. COMEDY-TENDENCY	REPELS	7. NEGATIVE	
+	-	6. POSITIVE	ATTRACTS	11. ACTIVE-AVERSIVE-CONTROL	
+	-	10. DOMINANCE	ATTRACTS	15 ABRUPTION-SURPRISE	
+	+	10. DOMINANCE	REPELS	12. PASSIVE-ACCEPTING	
+	+	6. POSITIVE	REPELS	11. ACTIVE-AVERSIVE-CONTROL	
+	+	7. NEGATIVE	ATTRACTS	11. ACTIVE-AVERSIVE-CONTROL	
+	+	11. ACTIVE-AVERSIVE-CONTROL	REPELS	12. PASSIVE-ACCEPTING	
+	+	12. PASSIVE-ACCEPTING	REPELS	7. NEGATIVE	
+	+	15. ABRUPTION-SURPRISE	ATTRACTS	11. ACTIVE-AVERSIVE-CONTROL	
-	-	12. PASSIVE-ACCEPTING	ATTRACTS	7. NEGATIVE	
-	-	10. DOMINANCE	REPELS	10. DOMINANCE	
-	-	15. ABRUPTION-SURPRISE	REPELS	15. ABRUPTION-SURPRISE	
-	-	7. NEGATIVE	ATTRACTS	11. ACTIVE-AVERSIVE-CONTROL	
+	+	38. EMBODIED-HIGH-FQ	ATTRACTS	38. EMBODIED-HIGH-FQ	
+	+	39. EMBODIED-MID-FQ	ATTRACTS	39. EMBODIED-MID-FQ	
+	+	40. EMBODIED-DARK-LOW-FQ	ATTRACTS	40. EMBODIED-DARK-LOW-FQ	

Fig. 17.2 *Examples of enactment logic rules. Variable names of the columns refer to the fitness function. (Tikka et al., 2006).*

In accordance with the proposed suggestions for future developments, "*Obsession (2005) pioneered the concept of enactive cinema and paved the way for more advanced technological elaborations of dynamical montage*." (Tikka & Taideteollinen korkeakoulu, 2008). One effective emotion-tracking method taken into account for obsession was the electromyography (EMG) of

facial muscle activity, however, it was not used in their installation because this measurement requires sensors to be applied on the skin, and therefore was an invasive form of measurement. "*The Facial Action Coding System and the Facereader methodology that is based on it, even though it is not so precise as the EMG measurements, has two big advantages. First it is less invasive for the respondent (no need to place electrodes on the respondent's face). Secondly, it is coding the activation of 44 muscles at the same time, therefore the information about muscle movement analysis is more complex (however less precise) than in the case of EMG which is delivering information about the activation of only one muscle at any single moment*." (Maison & Pawłowska, 2017) Furthermore, "*eye-movement tracking could potentially contribute to even richer access to the spectators' emotional involvement*." (Tikka et al., 2006).

3.4 Conclusions

In this chapter we talked about enactive cinema, analyzing the logic and the schemes of the mind from different perspectives. Obsession was the first case of enactive cinema, which paved the way and opened up a range of questions and possibilities within the interactive narrative experience. This work can, in my opinion, be a starting point for future developments considering some key aspects.

1. The theoretical basis that Tikka has provided, crossing different knowledge, is focused on research and development of enactive cinema experience. So it is undoubtedly a knowledge base from which to start to understand the key concepts and basic logic for the development of enactive products.

2. Tikka's research undoubtedly has many limits, the technological one for example. The range of technological possibilities that there was at the time when Obsession was developed is certainly different from today's, where it is possible to obtain more precise data using unobtrusive technologies.

3. Since the publication of Tikka's research to date, the world of cinema has experienced enormous changes, especially in terms of content fruition, and in some cases in terms of the form of the content itself. Today, in fact, the fruition of films takes place at home for the most part, and movies are increasingly becoming 'tv' Series within the Netflix paradigm.

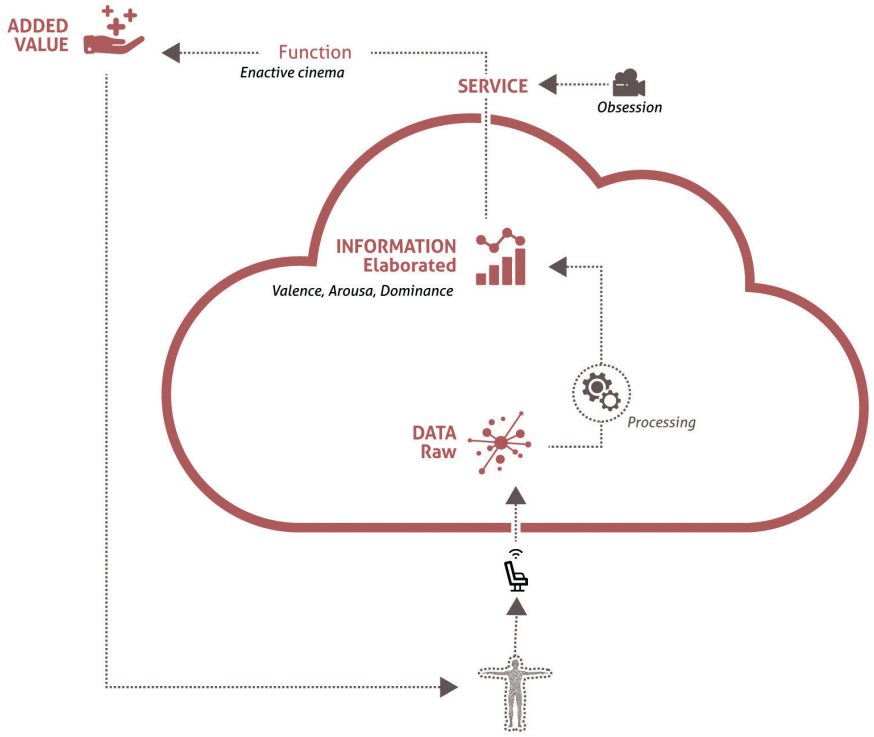


Fig. 4.11 *Model of the process of knowledge creation in digital services for Obsession.*

4. Moreover, not only technologies have evolved rapidly, but the whole data and information system has seen a very rapid evolution, which as discussed in the first chapter has created new paradigms of products and services in terms of function and awareness. In a context like this one where technology is more and more invisible, pervasive and precise, domotics is becoming more and more present, and the tailoring not only of services but also of the products themselves is more and more present, just look at the example of Netflix. The basic context in which to insert an artifact of enactive cinema is certainly different, and can, therefore, offer new possibilities, just thinking of the new eye-tracking devices integrated into some laptops, or smart TVs increasingly sensorized.

These key aspects are the basis of the study discussed in the second part of the thesis, which tries to push forward the research on enactive cinema. The possibilities opened up by this research open up a very complex landscape in various fields such as language, interaction, and design. Although this study opens up many paths in the research field. This research aims to start defining a grammar to manage enactive storytelling, using non-invasive and affordable technologies.

In the next chapter we will go to see what approaches were chosen to conduct this research, understanding the reasons that led to the choice of this approaches and analyzing the process and structure of the whole approach to research.

4 - Research Methodology

Intro

In the second part of the thesis, I try to push forward the research on enactive cinema in a practical way. As seen in the previous chapters, from here we will go into some aspects of enactive cinema trying to explore some questions. This critical approach to Tikka's research has allowed to raise some issues about the possibilities of expression and engagement, narrative, technology, and languages. The basic challenge in dealing with this kind of issue stays in the management of the enormous complexity that this topic brings with it. It is, therefore, necessary to remember that in this case, the point of view of the researcher is a Designer's point of view. To be more specific is the perspective of an interaction designer, that within the limits of technology and available resources, tries to generate explorative knowledge for design rather than scientific guidelines for the neuroscience and psychophysiology field. Having this clear in mind, the methodological approach chosen for this second part of the research is the "research through design" approach, which as we will see in the following paragraphs is an approach that relies on the iterative use of prototypes, in this case, to explore the possibilities of enactive narratives and generate knowledge.

4.1 Approach

The methodological approach chosen for this thesis is the **Research through Design** (RtD) one. First of all, it led to the division of the thesis into two main stages. The first can be identified as *research clarification*, in this phase research and an analysis of the literature was carried out, allowing us to create a solid background and to define goals to be obtained in the second part of the thesis, which is a *practical research* shaped as an iterative structure built on the principles of **user-centered agile software development** (UCASD). In the Research Clarification stage, we worked in order to have a clear overall

research plan. It helped us in focusing the research and clarifying goals. So to focus on the unconscious and enactive interaction with unobtrusive measurement. This first stage led us to choose the ucasd methodology within the Research through Design approach for the second part of the thesis because this approach relies on the use of prototypes, iterations and design activities to generate knowledge. The goal of the second stage of the research is to create a working prototype useful to do research in the enactive movie experience field, generating possible interaction models through the use of eye-tracking and emotion detection technologies. Obviously the principles of the ucasd methodology are included in the overall RtD approach.

4.2 Research through design

Design and Research are two well-defined fields with different purposes, but also sharing many aspects so that they can become complementary and synergistic with each other, some scholars even argue that design is a form of research, and that research and design are essentially the same. Both are intentional processes aiming at creating something new, in the research case is knowledge in abstract form, in the design case is a concrete solution. For many years research and design have gone their separate ways. Over the years, however, in the discipline of design, research has become fundamental for the development and creation of products and services. Moreover, design activities and artifacts are today established as the main elements in the creation and communication process of knowledge. These considerations developed over time have led to the rise of the *research for design* and *research through design* approaches. (Stappers & Giaccardi, 2017). The research for design approach includes the application of scientific knowledge, technological information and user studies for the design purpose. This approach allows for obtaining specific information useful for the development of the final design by conducting ethnographic studies, interviews, measurement, observation, questionnaires, and other research methods. Instead, the research through design approach relies on design activities as a source to generate knowledge. The development of prototypes or artifacts following an iterative pattern is an essential part of this approach. This is because, in the act of designing, the designer has to face the constraints of the real world and find the best way to create a prototype, facing various challenges between reality and the desired world. It is necessary to highlight the difference between prototypes and artifacts. While all prototypes are artifacts, not all artifacts are prototypes. This is because by artifacts we mean just a man-made physical object. By prototype, we mean instead 'like products' that give the possibility to be interacted and experienced. (Ibid.).

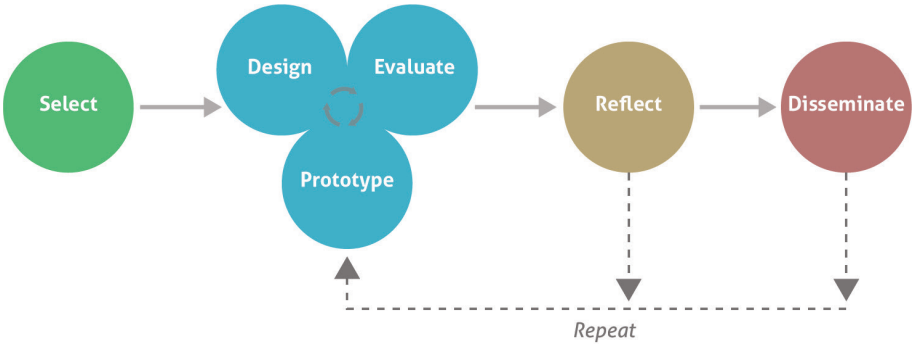


Fig. 18 *Research through Design Process (Varisco, 2019).*

This approach has been chosen because being an interaction designer my skills and interest are basically directed to the design and development of interactive prototypes. The creation of an interactive prototype in this field can be very useful to conduct an exploratory research activity focused on some objectives:

- Explore some technologies that can make enactive storytelling possible today.

- Analyze the data related to the involvement of users, collected through technologies.

- Trying to understand how to use this collected data to create an enactive experience.

- Attempt to figure out how this kind of narrative possibilities affect authorship.

To break down the complexity of this study, the use of an iterative structure helps us as it allows to explore one factor at a time, going in increasing complexity in research. To better understand the direction and potential of the RtD method, we will take a look at the model for interaction design within HCI (Human-Computer Interaction) developed by Zimmerman, Forlizzi, and Evenson in "*Research Through Design as a Method for Interaction Design Research in HCI*" in 2007 (Zimmerman et al., 2007). This model was born to be applied to a research context in which interaction designers and HCI practitioners collaborate to produce knowledge, by stressing the use of

prototypes with the aim of transforming the world from its current state to the desired state. While the RtD method proposed by Zimmerman et al. involves the figures of interaction designers and HCI practitioners working together as a team in the context of HCI research. In our case for obvious reasons, the personal thesis work was carried out by a single person, not having a team of HCI practitioners available, the research was conducted in an exploratory way. For the first iteration the work was carried out within a team during a workshop, for the second iteration there was the support of the bioengineers of the Pheel® laboratory of Politecnico di Milano. Moreover, the research carried out here serves also as a hypothesis on how to deal in the future with the complexity of this topic. In this context, designers work with the goal of developing a prototype that easily shows the research contribution. The critical design is a model that can be taken as a research model, in which each artifact stimulates questions, to design the artifact it is necessary to carefully design the questions, these discourses on a topic place the design researcher in

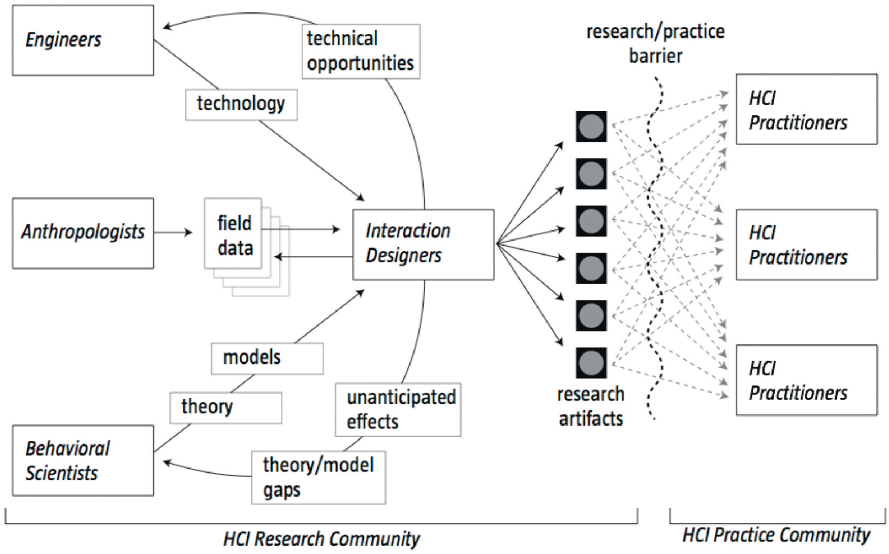


Fig. 19 *An illustration of the pathways and deliverables between and among Interaction Design Researchers and other HCI Researchers. The model emphasizes the production of artifacts as vehicles for embodying what "ought to be" and that influence both the research and practice communities. (Zimmerman et al., 2007).*

the role of a critic. (Zimmerman et al., 2007).
This design research model pushes the work of design research by including making as a method of investigation to address wicked problems. Thanks to this model interaction design researchers can integrate *true* knowledge (from literature and theories) with *how* knowledge (technical aspects). A fundamental aspect is that design researchers can find opportunities for new technologies and motivate and inspire engineers, as well as frame problems in order to find gaps in *true* knowledge. "*Through an active process of ideating, iterating, and critiquing potential solutions, design researchers continually reframe the problem as they attempt to make the right thing*." (Zimmerman et al., 2007). Therefore, interaction design researchers create artifacts to concretize and embody technological theories and opportunities. Thus the use of this model gives, as a result, a holistic contribution to research that combines the framing of the problem with different perspectives. Another important tool proposed by Zimmerman is the criteria for the evaluation of interaction design research within HCI. To help formalize this method, four criteria are proposed to assess the contribution of research: *process, invention, relevance, and extensibility*.

4.3 Iterative process

The reason we chose an iterative structure was basically the possibility to incrementally investigate the use of a prototype for exploring some aspects of the enactive approach in narratives. An iterative structure, unlike a classical development structure, allows us to analyze practical results at each step, allowing to acquire a greater knowledge of interaction and a mastery of the tools. Opening up new possibilities and/or answers at each step, breaking down the complexity. At the end of each iteration, an analysis of the results obtained was carried out, using different methods. After the first iteration, through participant observation, we were able to obtain the basis for the second iteration, and after the second iteration, we used user-testing techniques to come up with the basis for further developments. This research path was born from a workshop on "*New Paradigms for human-computer interaction*" carried out during the second year of the Digital and Interaction Design Master Degree course at Politecnico di Milano. The starting point for the creation and development of the prototype is the Netflix interactive movie "*Black Mirror: Bandersnatch*" (Slade, 2018) which we analyzed in the previous chapters. In chapter 5, we will see how the prototype was conceived and how it has progressively evolved.

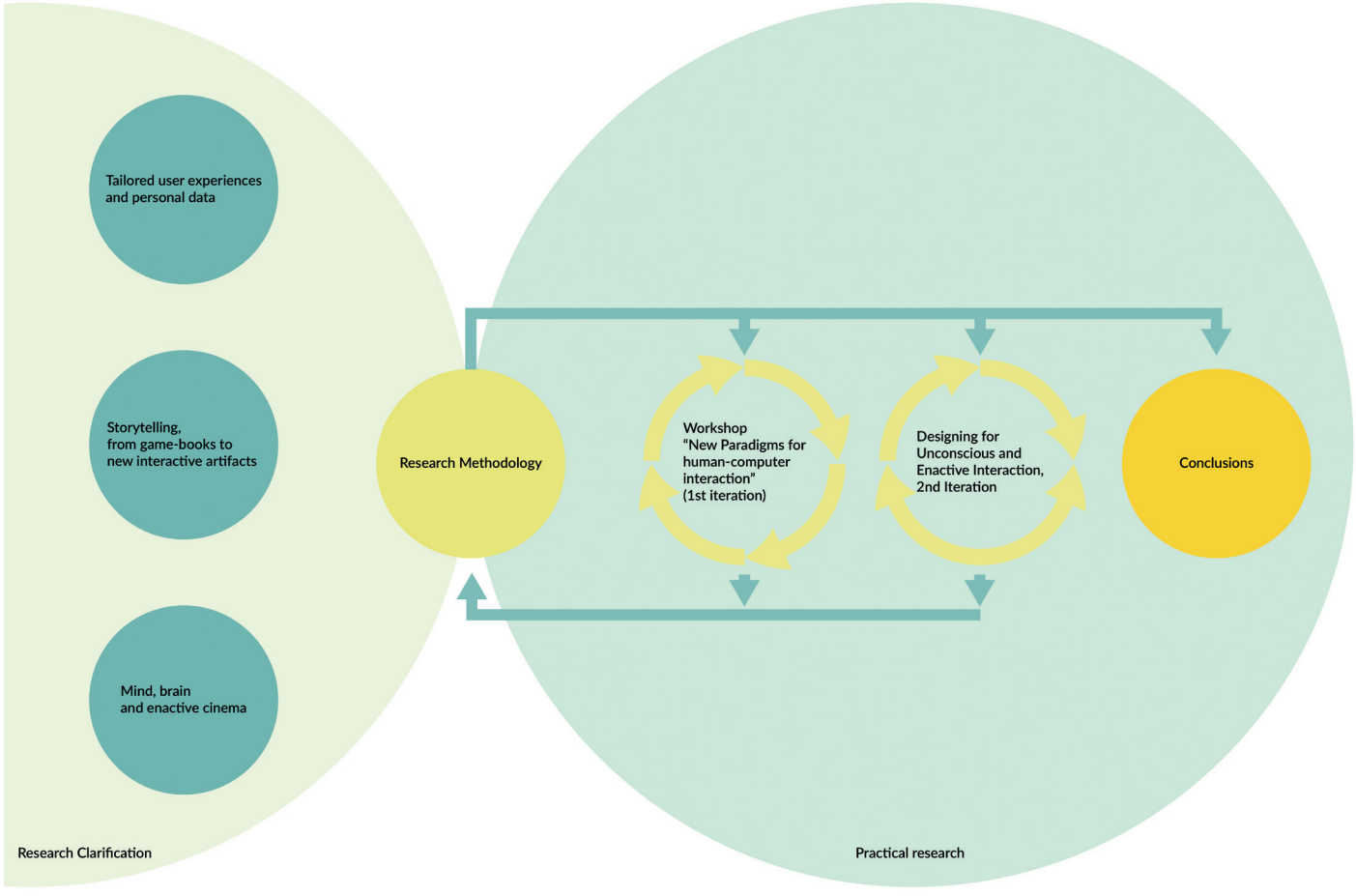


Fig. 20 *The Research through design approach applied to this research thesis.*

4.4 Research and user research

As a starting point for user research methods, we consider the concept well expressed in the paper *From Human Factors to Human Actors* (Bannon, 1991). Which underlines the need to understand people as actors, in our case this concept is of even greater importance since it is inserted in an enactive context. This approach suggests considering people as active agents, giving them the full possibility to try and explore, in our case the prototype. In HCI it is important to design a user interface between the machine and the person, the better the tasks and controls are designed, the less physical and mental effort is required and therefore the performance will be improved. With the term *user interface* in this study, we intend to conceive the concept of the term in a broad sense, not reducing it to a graphic visual or audio interface issue, thus we intend a new paradigm of user interface that works on an unconscious level. In this context it is important to consider work on *usability*, which can provide "quick and dirty" methods, to get rapid feedback from users. (Bannon, 1991). It is, therefore, necessary to find representative users that allow to iteratively prototype the design, consider the contribution that some disciplines can make to the design process, and take users as the starting and ending point of the design process. (Bannon, 1991). From the point of view of the general methodology used for the entire thesis, we can say that the RtD methodology was applied. On the other hand, in the second part of the thesis, for each iteration, an investigation was carried out through different methodologies, which however fall within the general methodology. For the first iteration, after doing initial research and creating a prototype, we applied the participant observation method, either by observing our colleagues and teachers or by trying the experience ourselves. Obviously, the time and tools were limited because the workshop takes place in a few days, but anyway, this activity gave rise to the conclusions, results, and knowledge that led to the development of the second iteration. For the second iteration, it was useful to consider some principles of user-centered agile software development (UCASD). First, it provides a coding system that is "*a comprehensive overview of aspects relevant to UCASD*." (Brhel et al., 2015).

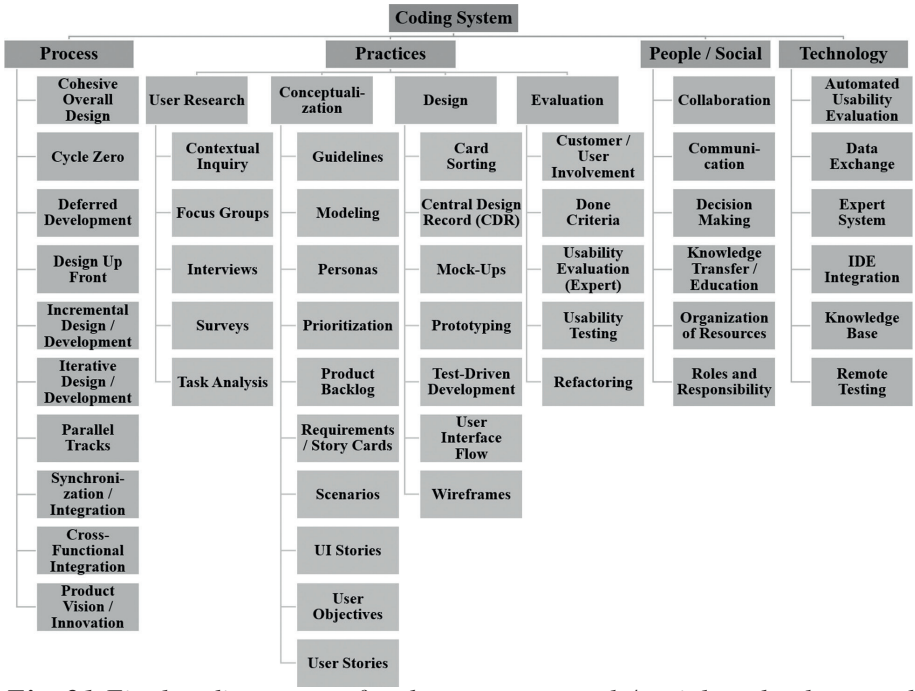


Fig. 21 *Final coding system for the process, people/social, technology, and practices dimensions. (Brhel et al., 2015).*

Moreover, considering some principles can be very useful, for example **Principle 1** suggest to consider separately the phases of product discovery and product creation, acknowledging the deep difference between the two. In **Principle 2** they claim that software design and development should be done in short iterations and in an incremental manner. **Principle 3** says that design and development activities must be synchronized and integrated in parallel, placing design one sprint ahead. **Principle 4** concerns the continuous involvement of stakeholders, in our case it was not considered because we do not have a company or sponsor behind us, and as there is no idea of service I did not consider fitting this study. However, this principle can be applied for future iterations, the limits of the current situation, and the very experimental level of the thesis are not suitable for the consideration of this principle. **Principle 5** is supporting *artifact-mediated communication*, artifacts are central both as a means of communication as well as documentation and in our case, the prototype is the core of the research. It is also well known that usability methods are usually adopted too late in the development process. (Brhel et al., 2015). So, for the second prototype, we adopted techniques used both in usability and market research fields, making an analysis of both qualitative and quantitative data, with the resources we had at our disposal. From the qualitative point of view, a semi-structured recorded interview was carried out, while from the quantitative point of view we were able to obtain data both from the prototype and from the instruments provided by the Pheel laboratory. We will explain in detail the application of these user research methods in chapters 5 and 6.

In this chapter we talked about the methodology used to conduct this research, focusing on the approaches and how they have been considered and applied. In the next chapters we will see the iterations of the prototypes, and the corresponding user research techniques applied.

5 - Workshop “New Paradigms for human-computer interaction”, 1st Iteration

Intro
In this chapter, we will look at the first design iteration of the research thesis. This chapter is particularly relevant because the idea of the whole thesis project was born from a workshop experience whose theme was Technology Inspired Innovation.

Fig. 22 *A picture of students, teachers, and company staff at the end of the workshop.*

5.1 Workshop Experience

During the last year of the master’s degree course in Digital and Interaction Design at Politecnico di Milano, we attended a workshop with the companies *The Qt Company* and *DeepGlance*. The workshop was divided into two parts, the first part was held from 13 to 15 February 2019, during these three days we had an intensive course about *Qt* (Qt, 1995), a software to create cross-

platform applications and user interfaces. One of the most interesting aspects of Qt is that it consists of an ecosystem of multiple software that manages to put together different technical aspects for design and development purposes into QML files. The purpose of the Qt Project is to close the gap between design and development by exploiting the Qt application framework software architecture that puts together multiple tools. In particular, the course content was regarding *Qt Design Studio* (Qt, 1995), *Qt 3D Studio* (Qt, 1995), Local Variants, and Simulation Backends. These three days of intensive course allowed us to explore the software in detail and to understand its potential and limitations.

5.2 Deep Glance and eye-tracking technology

The second part of the workshop took place in the five days following the first part, from 18 to 22 February. In the second part we worked together with *DeepGlance* (DeepGlance, 2018), a company specialized in eye-tracking technology integration, human-computer interaction, computer vision, and deep learning. Deep glance has developed a plugin within the Qt framework, this tool allows for hands-free interaction based on eye-tracking technology. When we talk about hands-free interaction, the most common thing we think about is voice commands, but even though it is an extremely simple and natural interaction, it is not effective for all types of operations and in all environments. Each technology has its own peculiarities and characteristics, and this implies that HCI and UX are subject to continuous research, exploring interactions, and often combining several different and sometimes complementary technologies. Eye-tracking technology is an advanced technology that is becoming more and more widespread thanks to its cost reduction, miniaturization, high accuracy and reliability of devices. This technology works by detecting instant by instant the gaze of a person, to understand which element is focused, avoiding to use a cursor or touch a surface, moreover the gaze is directly related to the attention of the user. The difficulty in using this technology lies in the fact that to manage it, it is necessary to have specific knowledge about eye-movements behavior, the device, and the resulting data. Eye-tracking technology, therefore, works by detecting eye movement states and events. The core of this data consists of two metrics that create the most important information it's possible to get from this technology: saccades and fixations. A *saccade* is a rapid eye movement from one point to another, from a digital point of view it's a sequence of raw gaze points. It has a start and endpoint in order to measure their duration and which points on the surface were involved. *Fixation* is the time period in which the eye dwells longer than the saccade, also in this case, it is a set of

raw gaze in which it is possible to have a start and an endpoint and a duration for each fixation. With this two information related to the gaze, it is possible to obtain many interaction solutions that allow the navigation and the use of an interface without touching it, an example is the *Deepglance Explorer* (DeepGlance Explorer, 2018), a tool that allows experiencing the hands-free features and potentiality of the technology.

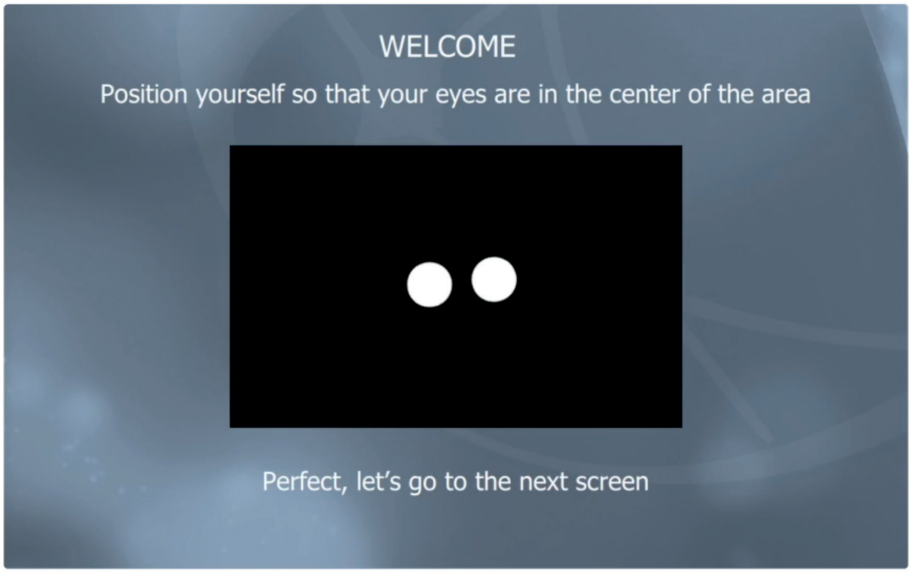


Fig. 23 *A screenshot from the DeepGlance Explorer calibration process.*

One of the first features is eye-detection, which shows how technology "sees" our eyes. Then it is possible to access the home page of the tool, which shows us various types of hands-free and mixed interactions, the *dwell selection* works just by looking at an element for a certain period of time in order to select it, this period of time can be set from very fast to very slow. We have then the *scrolling* function, which scrolls automatically following the gaze, the *drag and drop* function works by selecting the element to drag by looking at it, pressing and holding a key is possible to pick it, and looking at its destination is possible to drop it by releasing the pressed key. The *zoom* is performed in a natural way by slowly approaching or moving the head away from the screen. Then we have the *distraction detection*, able to detect user presence or distractions. These are just a few examples of how it is possible

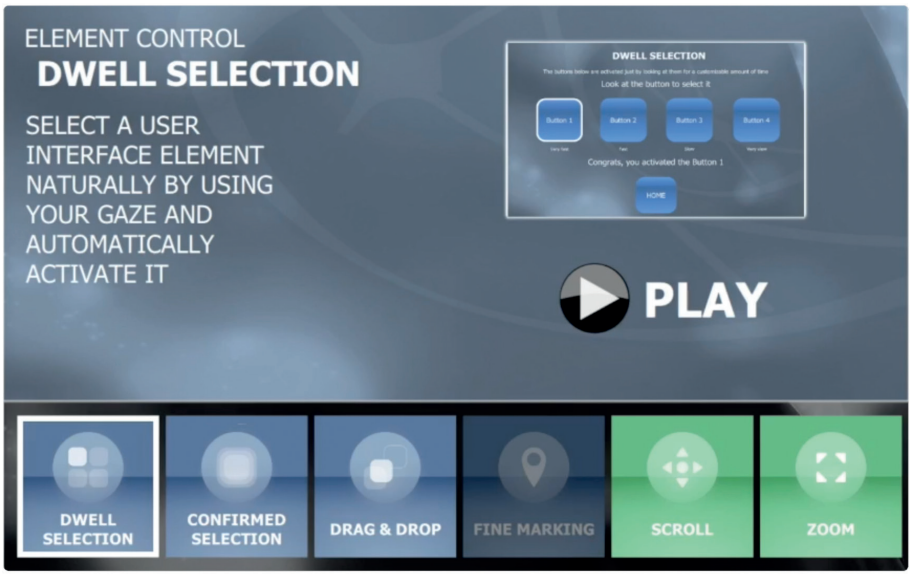


Fig. 23.1 *The DeepGlance Explorer homepage.*

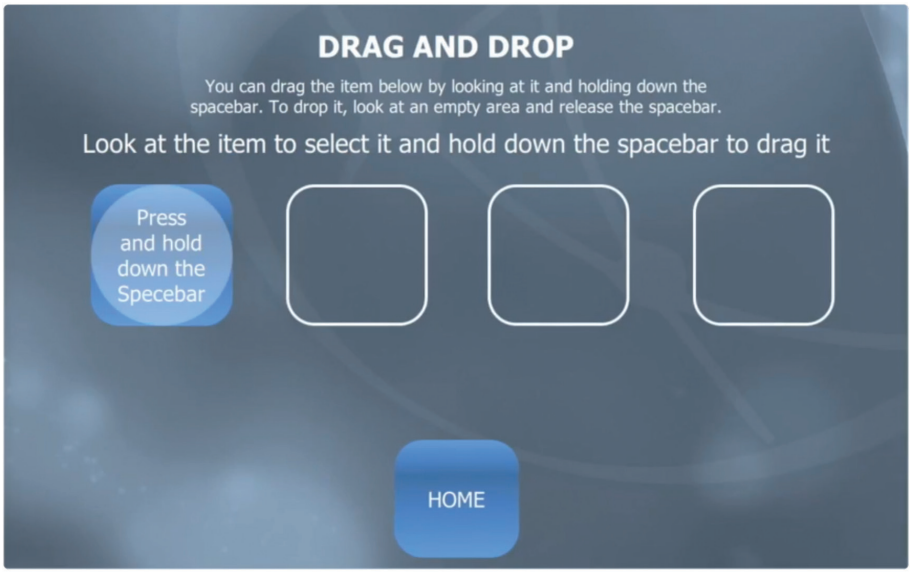


Fig. 23.2 *The drag and drop function of the DeepGlance Explorer.*

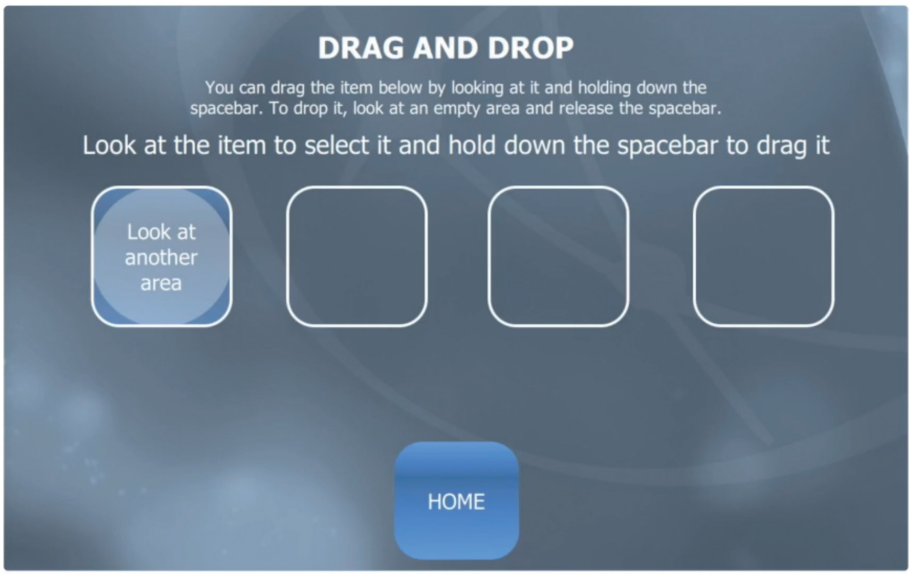


Fig. 23.2.1 *The drag and drop function of the DeepGlance Explorer.*

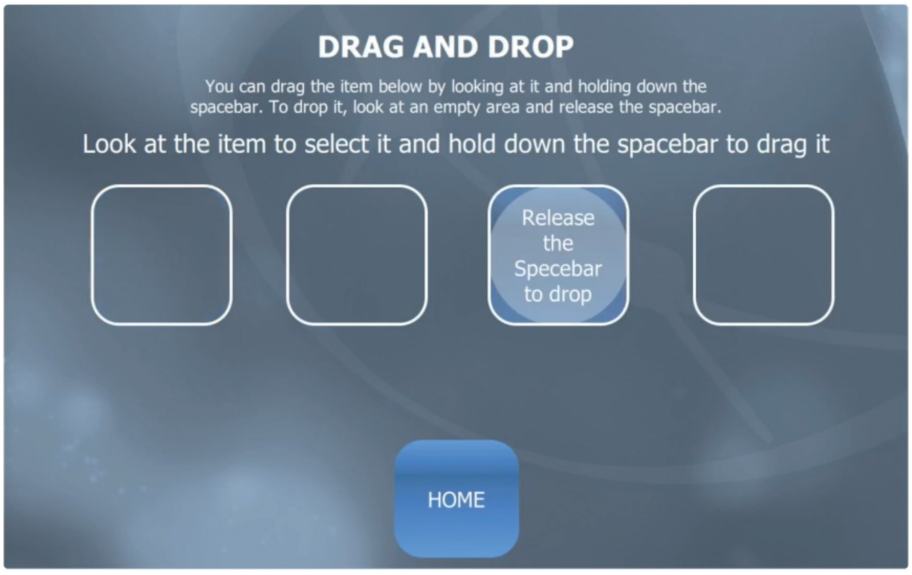


Fig. 23.2.2 *The drag and drop function of the DeepGlance Explorer.*

to interact only with the gaze, but they are a great starting point, also because the deepglance explorer is developed in Qt. DeepGlance has in fact provided us with *DeepGlance Quick* (DeepGlance Quick, 2018), a QML plugin that allows us to integrate the eye-tracking technology quickly and seamlessly within a Qt Quick application, to easily create a gaze-controlled interface within Qt Design Studio.

5.3 Topic

This second part of the workshop was dedicated to ***New paradigms for H-C interaction and eye-tracking driven interfaces***. The workshop was about the Design and implementation of a GUI that makes possible a natural interaction with kiosks, information points, and vending machines just using eye-gaze. An eye-tracking device needs to be used to estimate in real-time the observed elements on the interface which react and adapt accordingly. The relevant markets are marketing, retail, and entertainment. The workshop was oriented to the implementation of a working prototype in collaboration with the Qt company and DeepGlance. The design goals were:

- Develop the concept of an application of eye-tracking technology: the what, why and how for hands-free HCI in a specific context and for a specific final user.
- Develop a prototype of the application
- Communicate the concept
- Test and evaluate the concept using the prototype

While the educational goals were:

- An experience of blue-sky creativity
- An experience of technology-driven innovation
- Prototyping - testing - evaluating - discussing
- Familiarize with a new technology
- Explore the realm of hands-free HCI

So the design brief was to design an application of eye-tracking technology (hands-free HCI), within these constraints:

- The application is meant for a public space, and should be used by any users (able-bodied people); the reference space can be open (stores, supermarkets, airport halls, restaurants, shopping malls, train stations, museums, gym club, showcases, shopping windows, …) or meant for private purposes (changing rooms, hotel rooms, public toilets, fitness rooms, …);
- The application should have one main purpose (i.e.: information,

booking, payments, entertainment, advertising/promotion, gamification, …);
- The application should be addressed to one specific target user and optimized coherently with the goals of the interaction;
- The application should not necessarily be new or very innovative; the interface can also support hybrid interaction (hands-free + hands-on);
- The application should be developed for one specific support (large/small screen, vending machine, touch screen, tablet, …), depending on the context, the functions, and the target users.

The project must, in any case, follow one of these four directions: entertainment/gamification; information point; vending machines; marketing in-store, advertising, interactive marketing, personalized offers, and so on.
In our case, the direction chosen for the *what* was the entertainment one, for this reason, it was also necessary to specify a *where* (shopping malls, museums), and a *why* (engagement, increase the time in the location, wow effect). Each direction (*what*) had a range of possibilities for *why* and *where*, different from the other directions. In the end, as final delivery, three things were required:

1. A video presentation explaining the concept (the expected scenario including the target user, the context, the reasons why for the use of the technology, the expected experience);
2. Evidence of the prototyping and testing activities (video, pictures, prototypes, …);
3. A presentation summarizing the results of the workshop (learning, prototyping, evaluation), and of the discussion about the suitability of the eye-tracking technology for the specific purposes of the project developed during the week.

5.4 Idea

With only five days available for ideation, design, and development, we immediately started brainstorming and diverging as widely as possible to get some good ideas to compare. Among the many ideas that we had, the one that won was to hypothesize a *Black Mirror's Bandersnatch*-like (Slade, 2018) interactive movie, in which the choice of the actions of the protagonist, instead of being chosen consciously by pressing a button, were chosen through unconscious visual triggers. The reasons why we have chosen to work on this topic are many, one of the first is that the Black Mirror series (Brooker, 2011) is a dystopian series that reflects on the disruptive use of technologies, applied in a creepy and strongly dystopian manner. Moreover, it had recently been demonstrated that Netflix saved every choice made by the user during

interactive movies and stored it together with the other data it already had about the user, in order to enrich its profiling. Another reason that pushed us in this direction is that Netflix plays mixing the narrative storyworld with the real one, an example could be the immersive experience "*Black Future Social Club*", an event created for the Italian launch of the fourth season of Black Mirror (Brooker, 2011). This social and human experiment has managed to hybridize the dystopic dynamics of the series, taking it to a real-world level. First of all, the entrance has been allowed just to those who could share more than a thousand followers on Instagram, during the experience the digital interaction of the guests has determined in real-time the permanence or not of the users in the room. This experiment that was held at BASE in Milan is not only an example of how often the film world and the real world overlap, but also a reflection on digital interaction and social status that were the real currency of exchange during the event. Black mirror specifically has caused so much attention and stir in viewers because often and willingly they show in a realistic way some technologies or dystopic futures that are in development or already existing in the world. This ground was therefore fertile for our idea because it fully reflects the narrative and conceptual reality of the black mirror series, moreover, we wanted to deal with this topic in a slightly different way, inserting an ethical element and an awareness in this dystopian landscape. For this reason, our **challenge** was to "*design an interactive experience to face how new technologies can know you better than you. Much better.*" To accomplish this challenge we have therefore chosen to use an eye-tracking device to let the user interact and affect the storyline unconsciously. The *what* of our project was a catchy kiosk for which we created some graphics and communication strategies, such as positioning it next to each big tech company office based in Milan (Apple, Google, etc.). Then the *why* was to raise awareness about how personal information is collected today. In our *how*, people will go through a crescendo of restless emotions, only in the end, we will reveal them the back scene of the experience, how we were able to collect their personal information by following their eyes. We also defined a target, designing and delivering this project to people with digital attitude (*who*). In our concept, users were invited to enter the kiosk, unconsciously interact with the hacked version of *Bandersnatch*, and discover the final message and the rationale behind the experience. The main purpose of the first exercise during the workshop was to speculate and raise awareness in the spectators about both the possibilities and the issues, in terms of privacy, of modern technologies' trend of increasing automation in providing content.

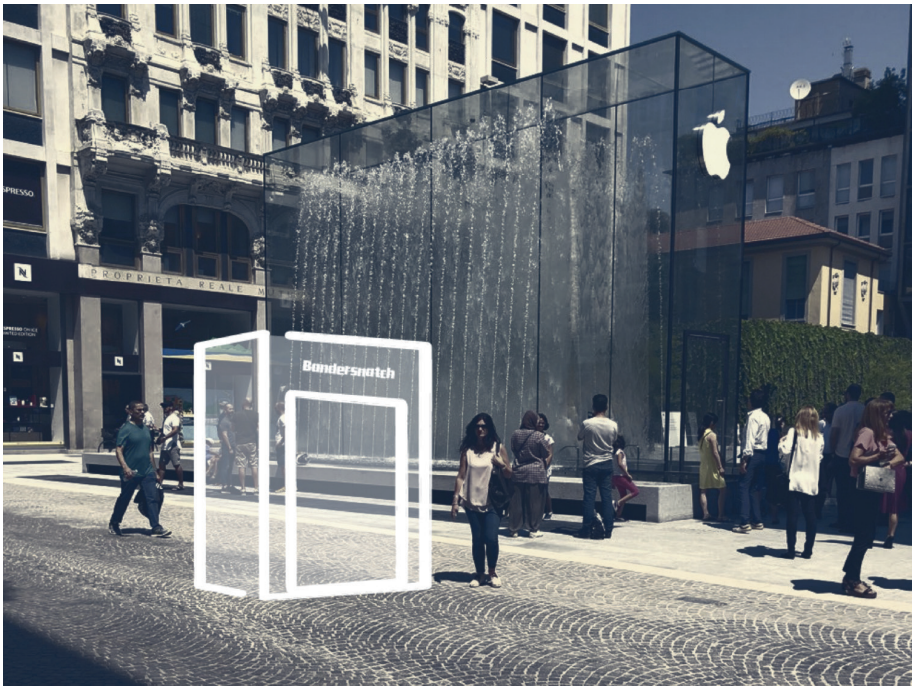


Fig. 24 *A graphic work that shows the kiosk concept made during the workshop days.*

5.5 Prototype

To practically do that, we had to "hack" Netflix, hence the title of the "Hacking Netflix" project. We then proceeded by downloading and selecting some paths within the story, to create a short story path in which our user was subjected to scenes of high emotional impact, which involved the choice of taking or not taking drugs, and the choice of whether to commit a murder or suicide, obviously these two choices were made unconsciously through the eye-tracking device. In order to track the viewer's gaze, we placed several invisible trigger areas accordingly to the decision-making crossroad. We have then created an algorithm that counts the milliseconds spent looking at these eye-areas, determining the choice of the next scene according to the area that has been looked at for the longest time. We also had to iterate the prototype several times during the workshop to finally get the desired result, correcting mistakes and perfecting the experience. The prototype was entirely made in Qt Design Studio (Qt, 1995), obviously it was not easy to work on a software learned a few days before, but we still managed to create an engaging and working prototype that led us to make some important reflections and

Fig. 24.1 *A graphic work done during the workshop days.*

Fig. 24.2 *A graphic work showing the eye-areas, done during the workshop.*

considerations for further development.

5.6 Results

For this first prototype, we applied the *participatory observation* method to conduct user research, both because time and resources were very limited and because it is a first exploratory phase of the prototype. The properties of participatory observation are many, the ones we take most into consideration are: the *double purpose* of being able to participate and observe; the *explicit awareness* of the participating observer who tries to become aware of the things that generally are not considered; the *wide objective* given by a wider perspective as an observer; the *experience as an insider/outsider* given by the double value and meaning that a situation can have from the social point of view, as well as from that of a research. The considerations derived from this prototype are many, but almost all of them converge in the fact that the eye-tracking technology alone, although it can already provide an unconscious mode of interaction, is not enough to have a valid and effective choice in all cases. In fact, the eye-tracking data alone can show us which eye-areas have been seen, and for how long. We have therefore drawn the conclusion that a possible hypothesis of further development could be to combine the data of eye-tracking with that of emotion-detection through facial recognition. In this way, it is possible to continue to have a hands-free and unconscious interaction because the emotion detection technology through face tracking is easily implementable with the use of a simple webcam. Obviously the design complexity increases a lot, especially because from the know-how point of view there is the need to have wide knowledge in the psychological and maybe even neurological field. Moreover, this experiment has allowed us to open up many alternatives and ideas. It has to be said in fact that today this technology is usually applied in the medical field for disability or for mere advertising or marketing purposes. Our "creative" approach has posed new questions, such as the use and integration of these technologies within the world of cinema entertainment and in general. In fact, it is likely that Black Mirror fans would willingly and consciously buy a device to enjoy content interacting unconsciously. In addition, a company like Netflix (Netflix, 1997) would have the power to create a new approach that in line with *black mirror* would be a source of further overlap between the film world and the real world. This approach could also increase the possibilities of expression and engagement in a critical way, experimenting with languages and understanding how this technology can contribute to the narrative. It would also be a source of very valuable data, which could provide extreme value in economic terms and in terms of how to return this data to users in the entertainment industry.

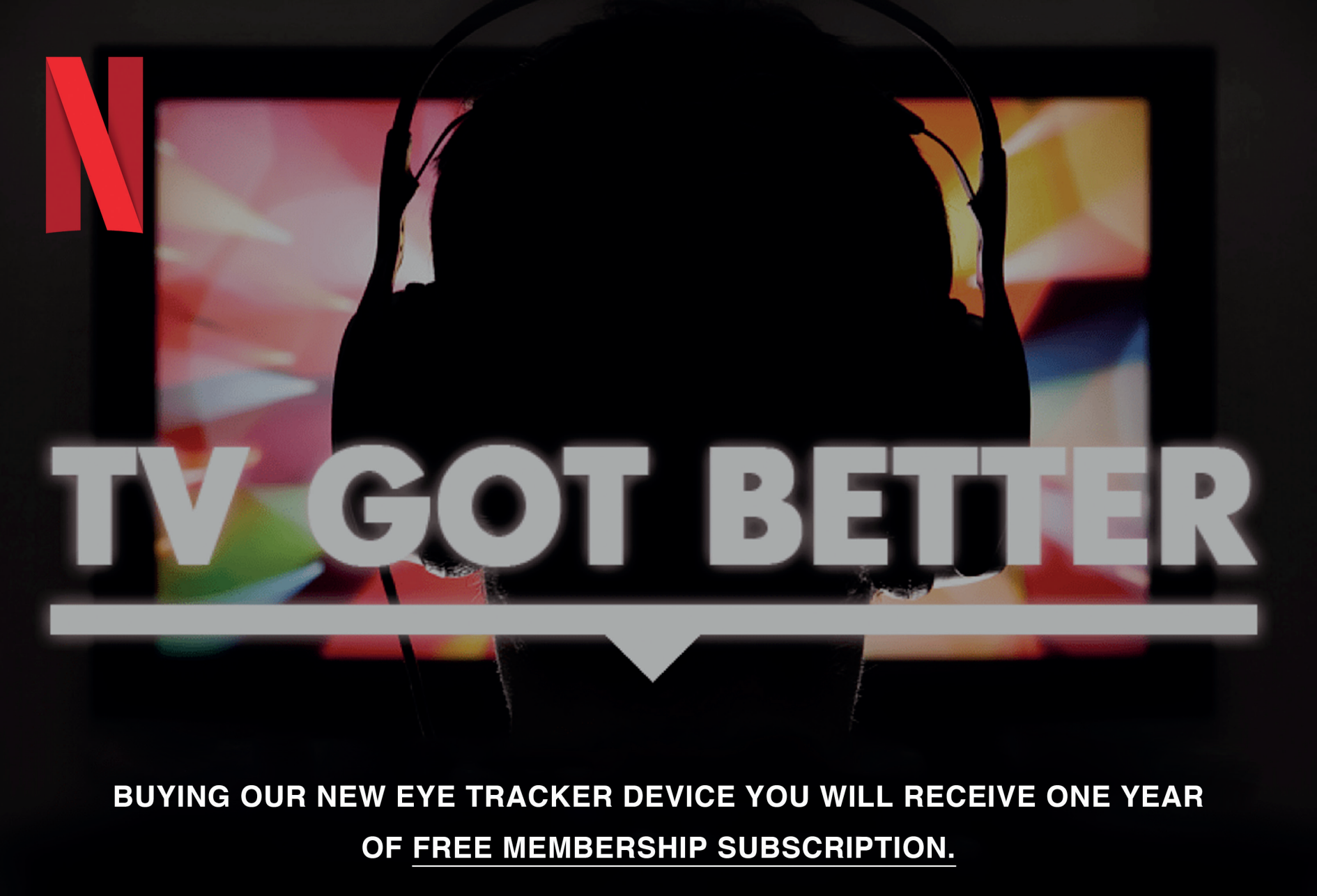

TV GOT BETTER
BUYING OUR NEW EYE TRACKER DEVICE YOU WILL RECEIVE ONE YEAR
OF FREE MEMBERSHIP SUBSCRIPTION.

Fig. 24.3 *A graphic work done during the workshop days.*

In the next chapter, we will talk about the second iteration, understanding how the results and reflections derived from this first experiment were the basis of the next experiment within an iterative logic that allowed the project to evolve progressively.

6 - Designing for Unconscious and Enactive Interaction[1], 2nd Iteration

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Intro

This chapter deals with the second iteration of the project, here we will discuss in-depth how, starting from the conclusions that came out of the first prototype, research was done together with the bioengineers of the Pheel laboratory who helped us to collect and interpret biological signals thanks to their instrumentation and experience. Furthermore, a research paper on this iteration has been produced and is in the process of publication.

6.1 Second Iteration

The second iteration stems from some reflections that arose as a result of the first one. First of all, we said that eye-tracking alone cannot be considered as a valid tool for enactive interaction in all cases, this is because the information that can be derived from this technology only concerns eye movement, and therefore can be valid to understand just the user's attention and which elements have been focused and for how much time. In fact, some of the choices are triggered during scenes that have a high visual component (e.g. the choices between two cereal boxes), while other choices mostly rely on emotional triggers (e.g. the choice to take a drug or not). We have therefore hypothesized that emotion-detection technology through face-recognition can be an excellent tool to be combined with eye-tracking in order to obtain more data in cross-referencing and thus obtain more information that could push forward the research and progression of the prototype. For this reason, we decided to create a new prototype in order to study through an evidence-based exploration whether it is actually possible to use emotion detection and how

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[1] *Most of the contents of this chapter can be found also in "Designing Unconscious and Enactive Interaction for Interactive Movie Experience" by Laura Varisco and Giulio Interlandi, (HCII 2020, in publishing).*

this tool can contribute to enaction in a cinematic context. Also here the core idea is that "*what emerges in the mind, in the form of an idea, corresponds to some structure of the body, in a particular state and set of circumstances*" (Damasio, 2003). As we have seen in Tikka's research, the emotional and therefore neurochemical and hormonal survival kit humans have, works enabling immediate responses to the changes in the surrounding environment or to the behavior of other entities, guiding the organism towards wellbeing (Tikka & Taideteollinen korkeakoulu, 2008). Moreover, Paul Ekman's research on facial expression suggests the similarity of emotions across cultural borders of humanity. (Ekman, 1992). As we said before, to conduct user research we used two techniques that are often applied in usability and market research. We chose to do qualitative research through the use of semi-structured recorded interviews, to get an idea of the emotional dimension and perception of the prototype, and to explore the choices made by the user in a conscious and unconscious way. From the quantitative point of view, we have obtained two types of data, those provided from the prototype, which consists of a log file with the data related to the eye-tracking tool and the choices and paths made by the user. Moreover, we have collected all the data related to the face reader, which in this case served as a data collection and analysis tool. The strength of the research conducted on the second iteration is that the tools that we intend to adopt for further development as input (eye-tracking, emotion detection), are also widely used tools to do research on user behavior. They can then provide data that can be analyzed over time to make quantitative research on many users, as well as being valid tools for interaction in real-time.

6.2 Aim of the study

To better understand whether the hypothesis derived from the results of the first iteration might make sense, evidence-based research has been conducted in order to explore emotion-detection through face recognition technology in relation to eye-tracking. This study was carried out with the help of the bioengineers of the Pheel® laboratory of Politecnico di Milano, who provided their equipment and their experience and expertise in the field. Pheel is a laboratory that brings together the expertise of three Departments of Excellence of the Politecnico di Milano: The Department of Bioengineering, Electronics, and Information, the Department of Design, and the Department of Management, Economics, and Industrial Engineering. The research we conducted thanks to the *face recognition integrated prototype* focuses on new possible paradigms for tailoring experiences that leverage on eye-tracking technology as well as looking for a step further and exploring and reasoning on the introduction of emotion recognition through built-in cameras. This

technology provides two important data on which we focus, valence and arousal. According to the study conducted by Patricia E. G. Bestelmeyer in 2017, valence and arousal are interdependent, and it is possible to understand the emotional state of a person from these values only. (Bestelmeyer et al., 2017). We aim to take advantage of the ability to collect biodata and biological evidence such as eye-gaze, saccades and fixations and merge it with emotion analysis so as to personalize the providing of content for storytelling experience.

6.3 Evidence-based exploration of interactive storytelling

For this purpose, we have written a research paper that reports the results of an evidence-based exploration aimed at formalizing knowledge regarding the use of passive and unconscious interaction to control the fruition of storytelling artifacts. Through the use of both gaze-based active and passive interaction together with the collection of emotional states during the fruition, the reported experiment intends to explore and understand the possibilities offered by the merging of the two technological solutions as providers of meaning carried by the knowledge that can be extracted from the data they collect. As anticipated, starting from Tikka's approach, we conducted an exploratory evidence-based test using modern already implementable gaze

Fig. 25 *The eye-tracking device and laptop used for the research.*

interaction (eye-tracking) and including the promising emotion recognition to understand further development of passive and unconscious interaction of storytelling content's personalization that merges the two technologies. The purpose of the experiment is to understand how modern, less invasive and more affordable technologies can be used nowadays as enablers to support an enactive interaction with storytelling experiences.

6.3.1 Prototype

The feedback received by users of the first prototype confirmed that the gaze's fixation could be a contribution in terms of data for the detection of a decision-making process. However, we realized also that, due to the emotional component of the choices, the eye gaze cannot be considered as symptomatic of a decision or of a willing. For this reason, We created a second prototype specifically to perform an experiment aiming at extracting knowledge on how to include emotion recognition in the unconscious interaction and create enactivity. The second prototype consisted of a sequence of scenes during which the users has to make four choices in total. Considering both high visual and high emotional components, two of the selections were made consciously by clicking on the choice with the mouse, the other two were triggered passively by using the detection of the eye gaze on a dynamic invisible area

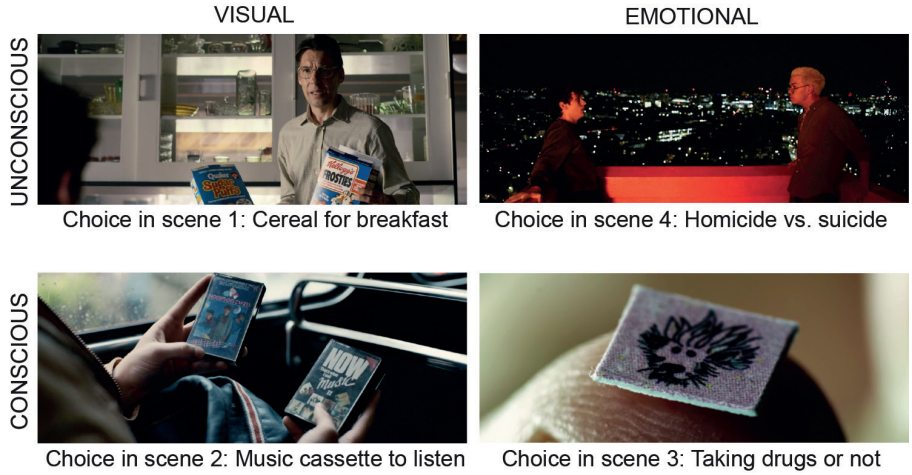


Fig. 26 *The scenes' choices matrix of the second prototype.*

(eye-area). Fig. 26 shows the matrix of the choices the viewer makes while experiencing the second prototype that consider both the visual or emotional prominent characteristic of the scene and the type of choice (unconscious or conscious). During the test, the face of the subject was monitored through a webcam connected to a face reading software. We included both conscious and unconscious selection to compare the two results of emotion recognition.

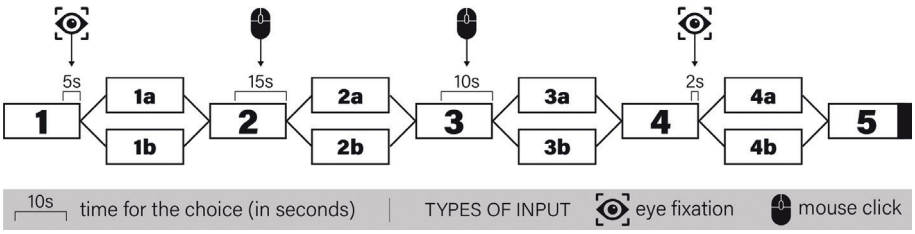


Fig. 27 *Flow of the scenes in the narrative sequence of the prototype.*

The narrative of the prototype follows the scheme described in Fig. 27 and the 4 choices' interaction are performed as following:

- **Scene 1 -** Cereal for breakfast. The scene contains the unconscious visual choice. Two invisible eye-areas have been created above two packs of cereals (Sugar Puff & Kellogg's Frosties) that one of the characters is showing to the protagonist. For the selections made using the eye-tracker as a triggering device, the prototype counts the duration of eye gazes on each of the areas and a script selects the most fixated one through the comparison of the two values.
- **Scene 2 -** Music cassette to listen. During the conscious visual choice, the protagonist extracts two music cassettes from a bag, at the same time two buttons appear allowing the subject to choose one with the mouse within 15 seconds (if no choices are made, the first option is chosen automatically).
- **Scene 3 -** Taking drugs or not. The conscious and emotional choice is contained in a scene in which a drug (LSD) is offered to the protagonist. The subject has the possibility to choose whether to take it or not by clicking on one of two buttons (same as for scene 2) within 10 seconds.
- **Scene 4 -** Homicide vs suicide. This scene contains the last choice of the experience, the unconscious emotional one. Here the subject face an unconscious choice with a high emotional impact. He decides (without knowing) which one of two characters will jump from a balcony going for a sure death. The choice is determined by the ocular fixations as for scene 1, but this time the moment in which the two eye-areas are shown is shorter (about 2sec) so to avoid a broader exploration of the scene with the eye-gaze.

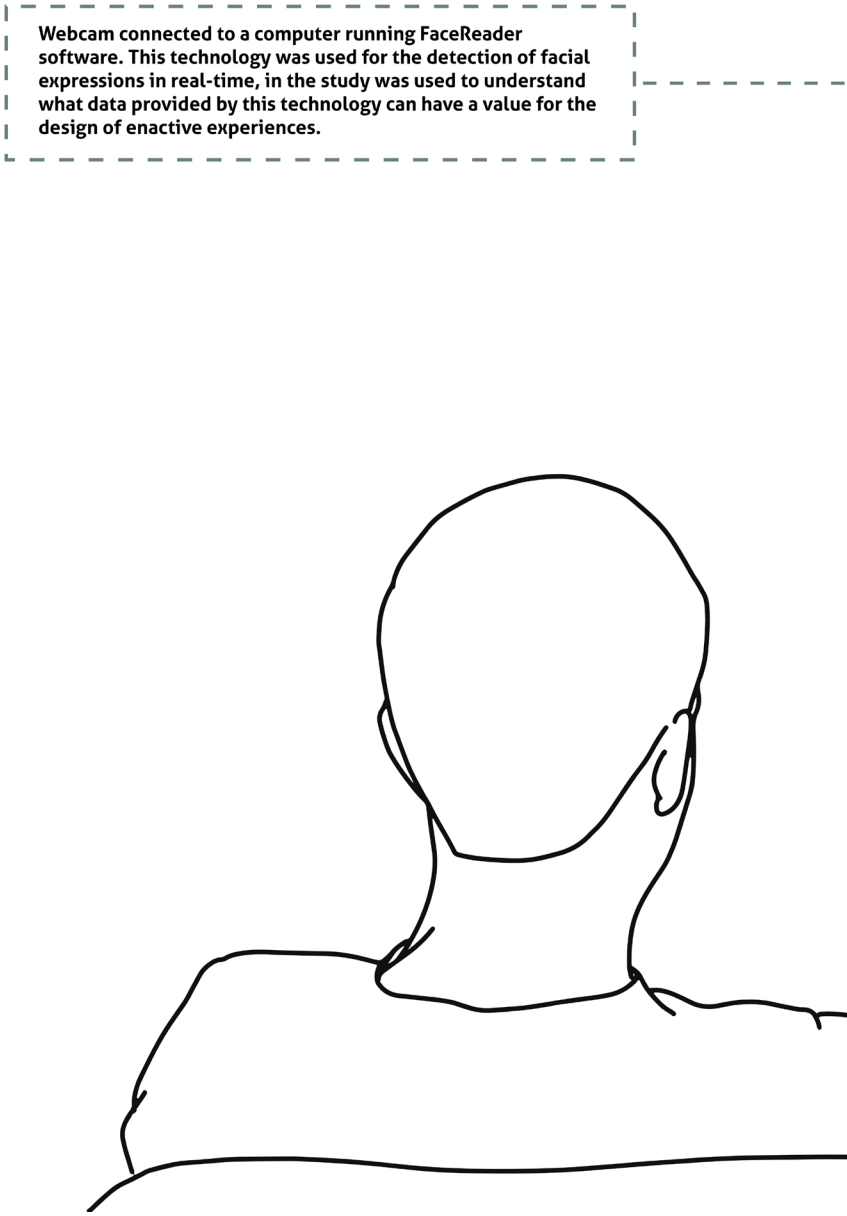
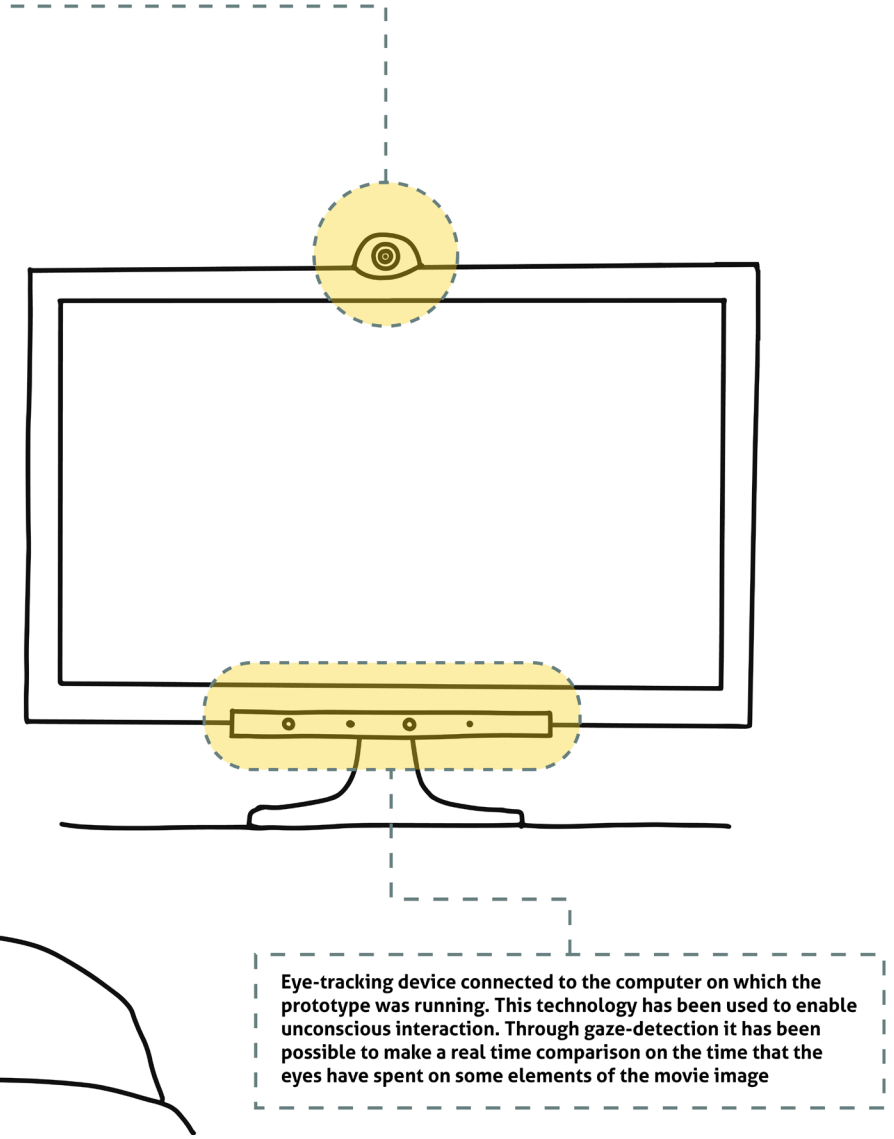


Fig. 28 *A representation of the prototype made for the second iteration.*



Eye-tracking device connected to the computer on which the prototype was running. This technology has been used to enable unconscious interaction. Through gaze-detection it has been possible to make a real time comparison on the time that the eyes have spent on some elements of the movie image

6.3.2 The evidence-based test

We conducted the experiment on 20 subjects so to capture their emotional involvement during the fruition. We group the subjects into two main categories: the first group was composed by 10 people who didn't see Bandersnatch (G1); the second one was composed by 10 people who have seen Bandersnatch before (G2). We decided to consider people who already experienced the storytelling experience even with a different interaction so to have evidence on the value of the use of emotion recognition on multiple experiencing for the same artifact.

Fig. 29 *The research setting, on the left the researcher, on the right the user during the experience.*

In order to keep the entire process under control and to gain as much insights and comparisons as possible, we defined the following protocol for the test:

- **Before the beginning of the storytelling experience** (*5 minutes*). The test was set in a laboratory office in which the subject was sitting on a

chair in front of a desk on the top of which there was the laptop running the prototype with a mouse device, a webcam, and a fixed eye-tracker connected to it. This step consisted of welcoming the subject, reading a brief introduction to the experiment, signing the consent and calibrating the eye-tracker device. For the introductory text, we kept relevant information on the scope and aim of the test, as well as the role of the eye-tracker and the camera for the end of the test so to avoid spoiling the use of emotion recognition and the passive triggering of choices. This helped us to have as less biased data as possible.

- **The experience with the prototype** (*10 minutes*). This phase consisted of the main experience of using the prototype. During the experience, the subject is contributing to the development of the story during the four trigger moments as described previously. At the beginning of the experience, we start running the emotion-analysis software that collected the data about facial expressions. The emotion-analysis was set so to keep data only about the triggering times (in which the subject has to make a choice) including the part of the scene that introduces the choice.

- **After the experience** (*5 to 10 minutes*). At the end of the experience with the prototype, we conducted a semi-structured interview for each of the subjects so to collect insights about self-report of the experience and compare them with data collected during the test. We investigated previous experiences of storytelling in general, about conscious feelings emerged during the experience, and the choices they would have done in scenes 1 and 4 if they had the possibility to choose consciously. Right after the interview, we declared the real purpose of the test and informed the subject about the unconscious choices on scene 1 and 4.

6.4 Results obtained

The experiment results, as we explained above, are divided in the two groups of subjects, both groups consist of ten subjects and we followed the same protocol for all of them. The data we analyzed are the ones gathered from Noldus FaceReader and from the prototype developed using the video game engine Unity (Unity, 2005), and from the audio-recorded interviews. Concerning the data obtained from the emotion-analysis, we used Noldus FaceReader (FaceReader, 2016), a validated automated facial coding (AFC) software, for the recognition of specific properties in facial images and classification of people's emotions into discrete categories of basic emotions (Lewinski et al., 2014). AFC algorithms use a set of fixed rules to code facial expressions on the 20 webcam recordings (one for each subject). The software

estimates human affective states making interpretations through theoretical methods supported by the literature (Lewinski et al., 2014). For each of the subjects' choice, we extrapolated a graph that visualizes the data related to emotional values analyzed by the software of 6 emotions (happy, sad, angry, surprised, scared, disgusted - Fig. 30, valence and arousal - Fig. 31. In the graphs, we represent, on the x-axis, the timespan of the choice as inclusive of the part of the scene that introduced the selection, while the y-axis represents the emotional value as defined by the software. Consistently with the data gathered, we considered as significative the values that reached the minimum threshold of 0,1 for any emotional value, and of 0,5 for the arousal. For the valence, we considered as relevant the values smaller than -0,1 and bigger than 0,1 to determine if it is negative or positive (Jansen, 2015). Both of the figures report these thresholds as colored areas so to highlight whether the value is considered as a relevant emotional engagement. The valence value reveals whether the emotional state of the subject is positive or negative. The only positive expression that the software recognizes is 'Happy', while negative expressions are 'sad', 'angry', 'scared' and 'disgusted'. 'Surprised' could be considered either positive or negative. Arousal indicates whether the

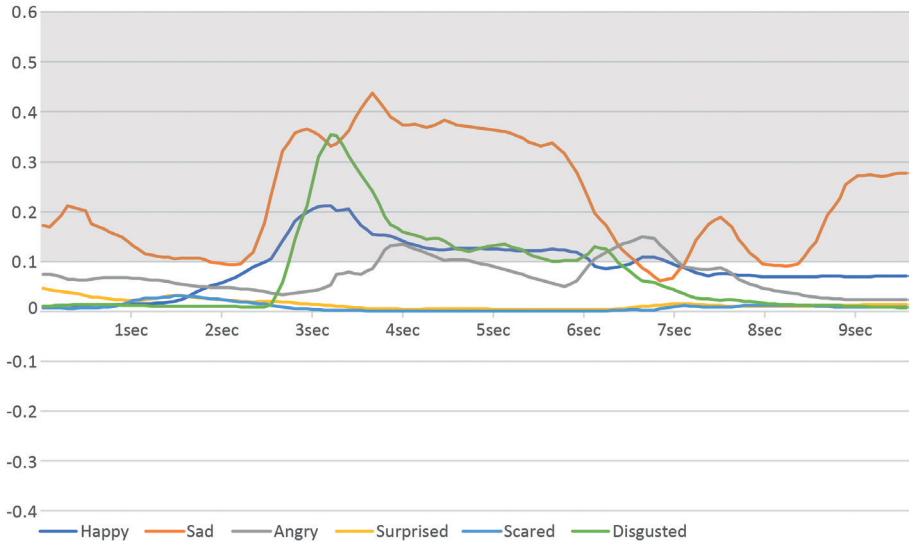


Fig. 30 *Example of a graph for the conscious emotional decision (subject 13, choice during scene 3) for the 6 emotions. The x-axis represents the time in seconds, while the y-axis represents the recorded value.*

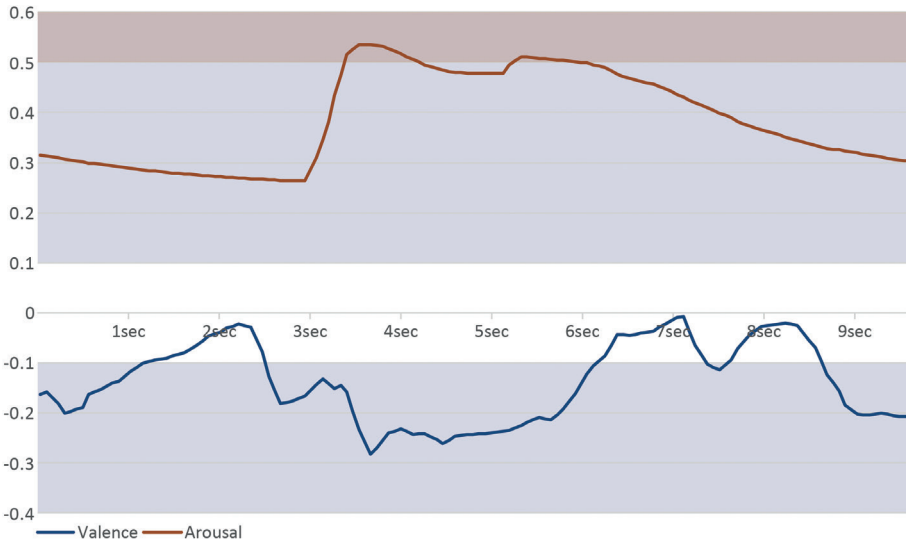


Fig. 31 *Example of a graph for the conscious emotional decision (subject 13, choice during scene 3) for valence and arousal. The x-axis represents the time in seconds, while the y-axis represents the recorded value.*

subject is active or not active.
The visualization of the logged data into graphs helped our investigating and understanding enabling the identification of patterns and emotional peaks. Being the purpose of the study to identify significant data from the emotion recognition during decision moments, to gather insights and improve our investigation, we matched the data coming from FaceReader with the experience proposed in the prototype relating each type of choice (as in the matrix proposed in Fig. 26 with the emotions recognized. For each of the subjects, we related emotional values to each of the choices of the experience that have been recorded in a log file. For scene 1 and 4 we logged the input from the mouse click, while for scene 2 and 3 we logged the most fixated area between the two proposed. Furthermore, we compared the outcomes with the results of the interviews to identify both consistent and misleading unconscious choices.

6.4.1 Data outcomes

In order to be able to compare the data between emotion recognition and choices made during the experience, we summarized the emotional values as number of overcoming of the thresholds for each of the emotions and for valence and arousal (if any) and assigned a 'TRUE' value for each of the

emotions that overcame the threshold at least once during the timespan of the choice (an example is shown in Table 1). Then, knowing which of the options the subject chooses, we related the two data aggregating the subjects of each group. Fig. 32 and Fig. 33 show the number of subjects (y-axes) that overcome the thresholds for each of the 6 emotions, valence and arousal (x-axis). Additionally, they report the data in relation to the choice made (a or b).

Happy	Sad	Angry	Surprised	Scared	Disgusted	Valence	Arousal
60	123	30	0	0	55	91	25
TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE

Table 1 *Number of overcoming of the thresholds (subject 13, choice during scene 3).*

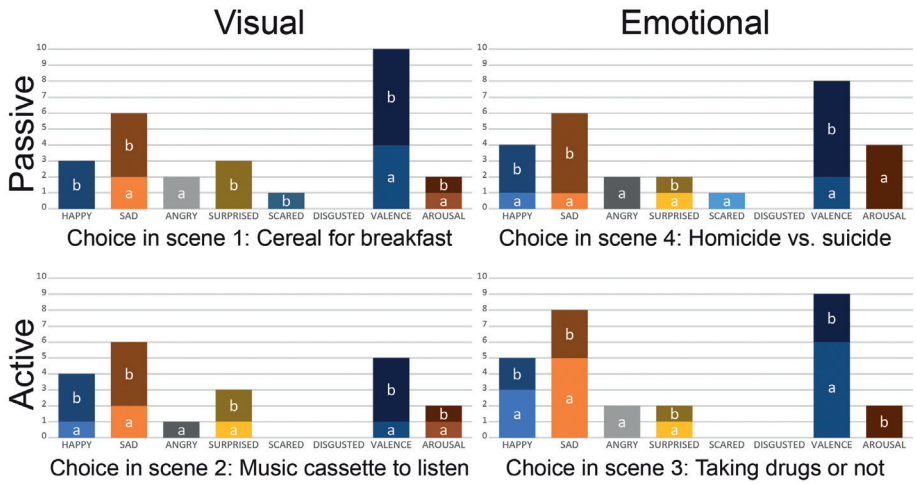


Fig. 32 *Aggregation of values of G1 for all the 4 choices made considering the overcome of the threshold (number of subjects) and the option chosen.*

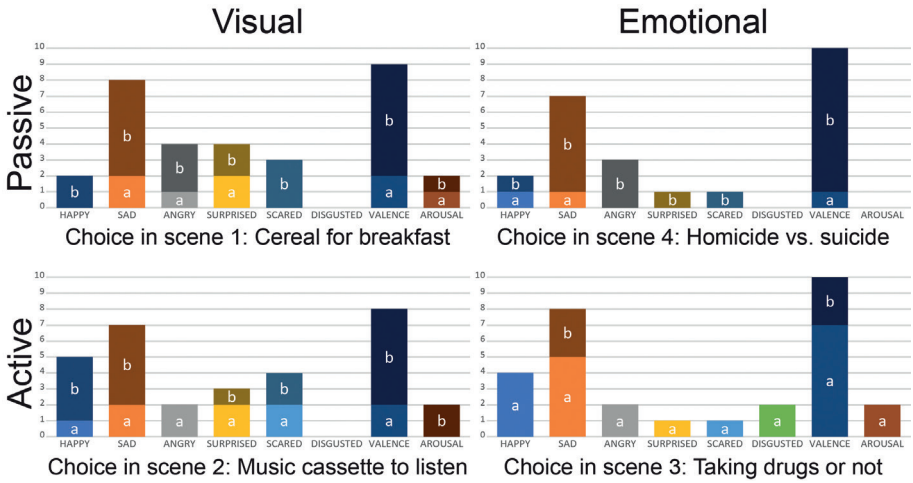


Fig. 33 *Aggregation of values of G2 for all the 4 choices made considering the overcome of the threshold (number of subjects) and the option chosen.*

6.5 Discussion and conclusions

The aggregation of the values shows that for both the groups of subjects (the ones that are seeing Bandersnatch for the first time, and the ones that have already experienced the interactive storytelling through the Netflix platform), is possible to identify significant emotional engagement during the choices. It also shows that there's no significant difference in the engagements between the unconscious and the conscious choice, so the value of engagement during unconscious choice can be taken into account for further development of the prototype of the experience aiming at integrating a real-time evaluation of emotional engagement and triggering of choices according to it. The "*unobtrusive measurement*" (a solution that is non-invasive and functions seamlessly (Mandolfo, 2006)), as an evolution of Tikka's approach is way more affordable nowadays and it is possible to start thinking on the design methods and tools that can be useful to the process of creation of enactive experiences. However, as designers we aim at creating functional and standardized approaches to the design of innovative solutions. Concerning the evaluation of biodata for the design of enactive experiences, we face a lack of knowledge in the literature to establish a reasonable and common threshold for the emotional engagement in users. We currently base our evaluation of thresholds considering what FaceReader software identifies as an emotional variation (lasting more than 0.5sec). According to Sumi and Ueda (Sumi & Ueda, 2016), more research is needed in relating not only facial expression, but

also facial micro-expressions (rapid change of facial expression and appears only in a short period) to emotional states. We consider it as a future challenge in defining parameters related to emotion recognition for the creation of enactive experiences. Furthermore, the comparison between the prototype's data and the declared opinions coming from the interviews supported our assumption that the exclusive use of the eye-gaze as a source of data is not representative of the choice of the user. In fact, many of the interviewees stated that the choice made 'by the prototype' wasn't the one they would have made if actively asked for both the visual and the emotional unconscious choices. It must be discussed that the design of enactive experiences cannot be carried on without considering the emotional values of the whole movie experience. In this study, we took advantage of an already existing storytelling artifact that, as all the movie experiences, embeds its own emotional load and communicates moods and leitmotiv influencing the viewer's emotional state. In line with Pia Tikka's research who, in agreement with Eisenstein, considers the surrounding environment part of the film product, we need to consider the whole context as possible factor of influence (Tikka & Taideteollinen korkeakoulu, 2008). So, while creating an enactive experience we should consider emotional states as both influenced and influencer of the whole experience without taking any variation for granted. For this reason, further experimentation and investigation on this iterative process is needed to be carried on so to start defining a grammar of emotional experiencing of enactive storytelling that can be leveraged on during the design process. We can state that today's face analysis technologies are reliable enough to be used as a tool for designing enactive experiences considering it as both a tool for emotional analysis of the elements of the artifacts, and a tool for enabling the enactivity of the experience.

The conclusions of this research have produced suggestions and guidelines for a possible application of the knowledge that has been generated through this experiment. In the next chapter, we will see how this research has laid the foundations for a new enactive paradigm enabled by the technologies under examination, and how to manage these guidelines to generate a third iteration, moreover the ethical concerns that arise from this kind of experiences and technologies will be addressed.

7 - Conclusions

Intro

The research conducted in the previous chapter rised both some answers and conclusions as well as many new questions and possibilities. In this chapter, I will summarize both the conclusions drawn from the first two iterations, in terms of possibilities and possible directions/guidelines, and to show some new questions that emerged thanks to this iterative approach. Unfortunately, today's social and health situation (March, 2020) does not allow the development of a third iteration of prototyping and testing that could certainly be useful for exploring directions and start establishing a basic grammar for enactivity with unobtrusive measurement. Due to coronavirus disease, all university facilities have been closed and gatherings of all kinds and types are prohibited, unless for reasons of health or essential work. Smart working has become a mandatory reality today as well as smart teaching. This, however, does not stop the fact that it is still possible to design some solutions to develop in the near future.

7.1 Suggestions and guidelines

By comparing the data provided from the technologies we chose (saccade, fixation, single emotion value, valence, and arousal), with those used in the Obsession installation by Pia Tikka (HR, EDA), I started creating guidelines and suggestions to consider while creating enactive interactions. These elements have been identified thanks to the results of the described study that demonstrated the possibility to find significant emotional engagement from face analysis and combine those values with the use of an eye-tracking device to target the focus of the visual area. They can be considered a starting point for further experimentation on real-time gaze and emotional analysis to enable enactivity. These experimentations could contribute to knowledge not only in the field of interaction and experience design, but also in the field of cinema

authorship. (Varisco, Interlandi, *in publishing*). There are three possible guidelines identified by this study: **Direction of change**, **Areas of focus**, and **Unexpected interactive elements**. These possible guidelines can be intended as an initial cue, they are not definitive guidelines but they can be an excellent starting point for an approach to enactivity. ***Direction of change***. Aligned with Tikka's (Tikka et al., 2006) principles, consider the increase or decrease in the values to affect the emotional mood through the management of the narrative flow including or excluding scenes and other ontologically organized content. Positivity or negativity of the valence and the value related to arousal can be particularly useful to detect the direction of change, especially for scenes with a predominance of emotional characteristics. ***Areas of focus***. The eye-tracking can provide a further focus on the user's gaze when the emotion analysis is performed. In scenes with a high visual component, the eye-tracking data can be crossed with the facial ones to understand the user's emotions with respect to a single eye-area. This means that from the author's or designer's point of view it is possible to know the valence and arousal, as well as the single emotion involved respectively to a visual element of the montage. Therefore, there is the possibility to compare different visual elements both in terms of duration of the fixation and in terms of comparison of emotional analysis. Hence psychology and bio-marketing studies can be useful in the design of emotional triggers and could provide an analysis of the like or dislike of the visual elements. ***Unexpected interactive elements***. In order to open new scenarios, it is possible to work on placing visual "Easter-eggs" within the enactive experience. Thanks to eye-tracking technology, it is possible to know if a single visual element has been looked at by the user and for how long. These guidelines are to be understood in a broad sense, as possible directions to use from the designer's point of view to produce enactivity. There is a strong need to support the project with knowledge about biosignals, psychology, and neurology. Also from an artistic point of view, these guidelines can be useful in the creative field in areas even very different from the cinematographic one.

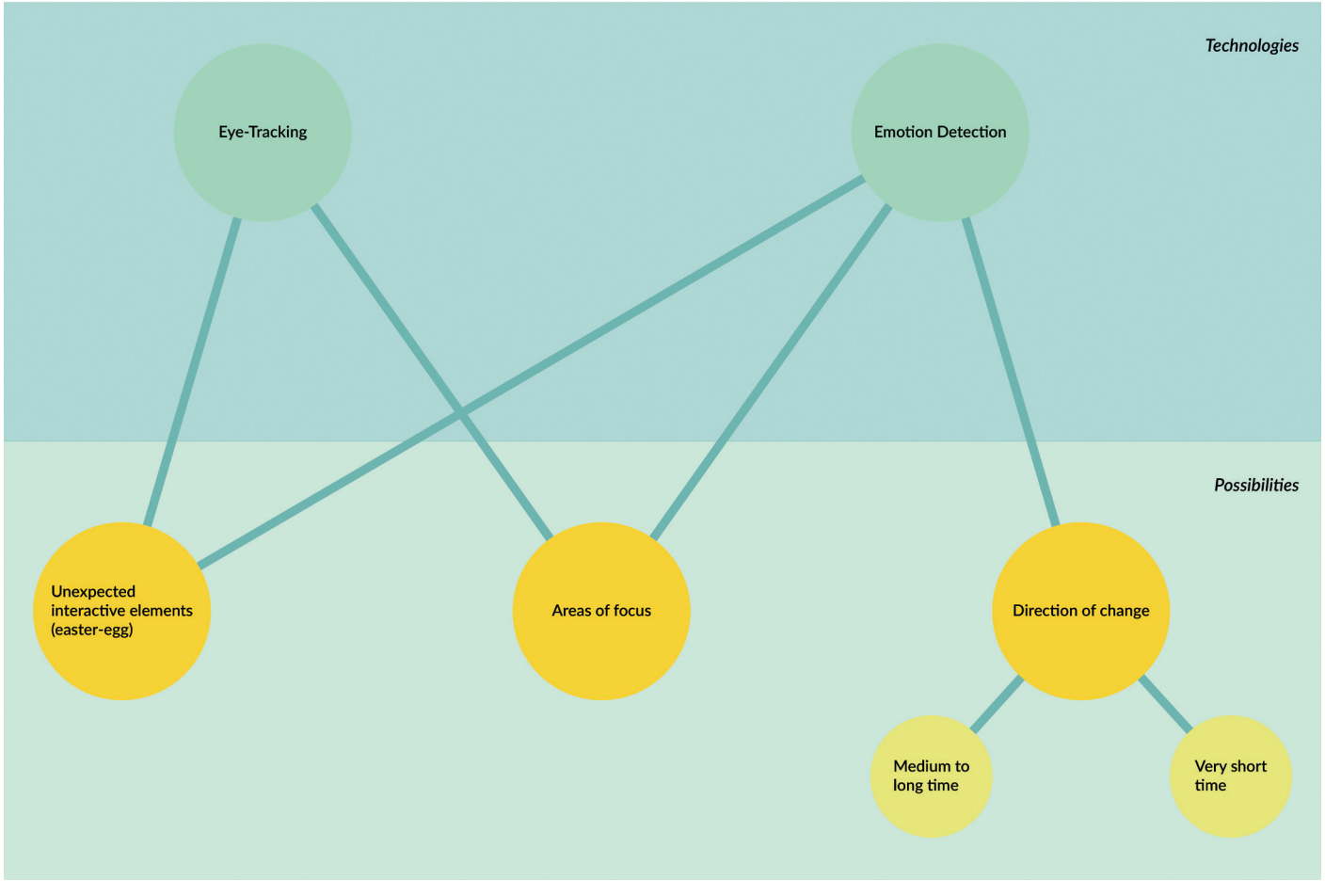


Fig. 34 *A diagram that shows the relationship between the technologies taken into consideration and the possibilities that arise from the resulting guidelines.*

7.2 Need for further iterations

In line with the first two iterations, in my opinion, there would be a need to develop other iterations and even better other projects to further explore the possibility that these tools can enable in the field of enactive interaction. As an integration and verification for some of the assumptions emerged in this research, it could be useful to perform a third iteration to further explore and experiment with the guidelines produced in the field of interactive narratives seeing them as expedients to explore specific enactive interactions. Moreover, it would be appropriate to design and research with other movie genres to explore the general emotional mood in relation to the watching, so to further test these first guidelines in specific narrative moods and contexts. One of the possible options could be further iteration in a third prototype as an evolution of the second one, using the four choices that were previously implied to create a four-dimensional matrix. In this case, everything could be brought to the passive dimension, and the emotional dimension could also be included in the visual one. Keeping the same narrative structure, the four choices can be used as a test for the guidelines identified by the research on the second

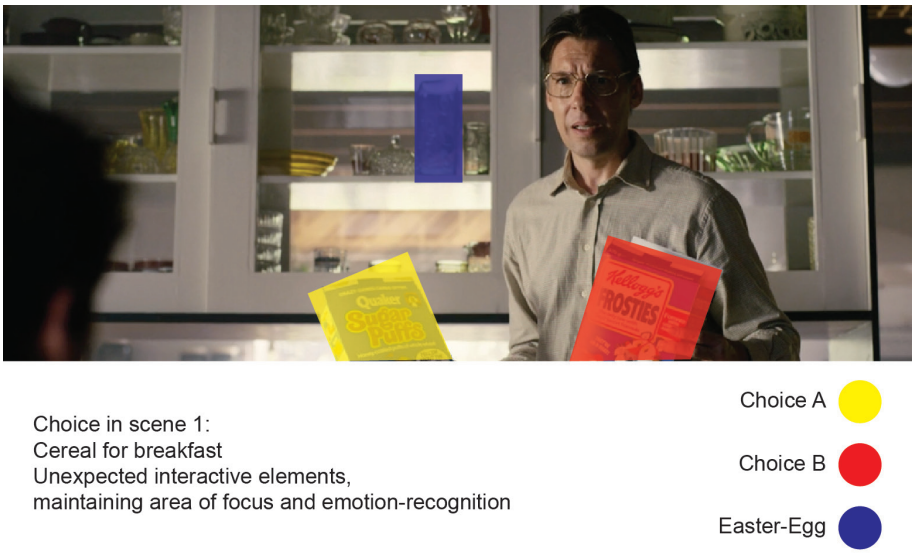


Fig. 35 *Frame of scene 1 of the prototype, updated according to the new guidelines.*

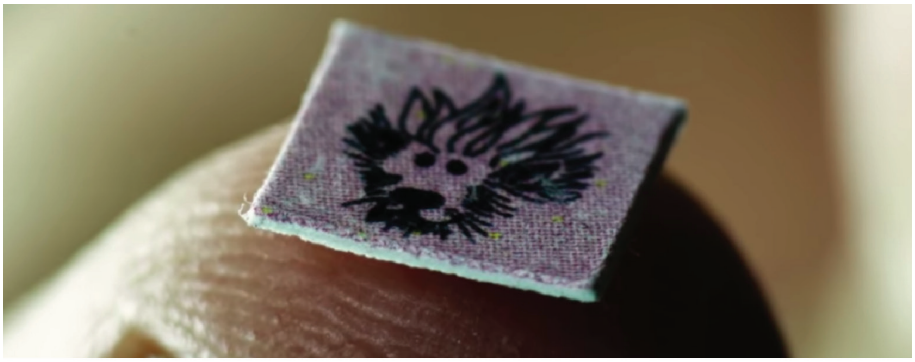
iteration. The first choice could serve as a test for an unexpected interactive element or easter-egg.

An easter-egg is an unexpected feature that can lead to bonus content or a

joke. In our case it's a secondary element that can alter the narrative while not being strictly part of it. Its value lies in the fact that it is an element that could change the path of the narration depending on the predisposition/attraction of

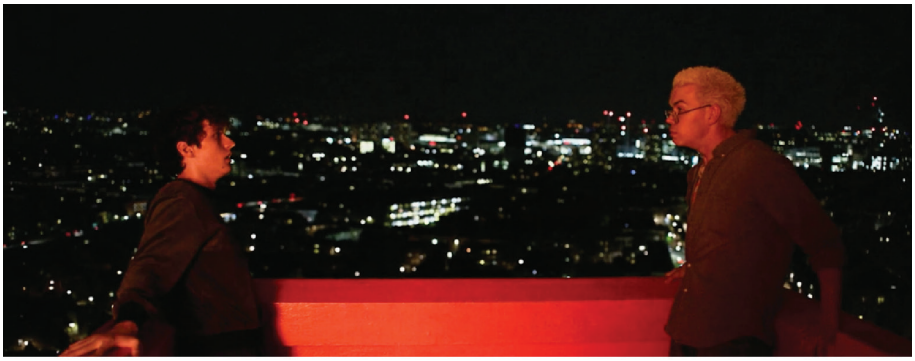
Fig. 36 *Frame of scene 2 of the prototype, updated according to the new guidelines.*

the person on some elements that are not part of the primary narration, so it could also be understood as an additional profiling element.
In the second scene, as well as in the first, it is possible to use the values of valence and arousal, crossing them with those of the gaze provided by the eye-tracking device. In this way it is possible to have an idea of the emotional response of the user regarding the visual elements. The third choice is included in a scene with high emotional impact, in which the protagonist is asked to take drugs. The only analysis of the values of valence and arousal can be valid to understand the emotional involvement of the person in an average time span (10sec). So that a choice can be deduced even without considering eye-tracking data, even because in this case there are no explicit visual elements that can be compared. The logic of choice of scene four is the same of scene three, with the only difference that in scene four the choice is made considering the data of a very short timespan.



Choice in scene 3:
Taking drugs or not
Direction of change in a medium timespan to explore the mood
using emotion-recognition values (valence, arousal)

Fig. 37 *Frame of scene 3 of the prototype, updated according to the new guidelines.*



Choice in scene 4:
Homicide vs. Suicide
Direction of change in a short timespan to explore micro-expressions
using emotion-recognition values (valence, arousal)

Fig. 38 *Frame of scene 4 of the prototype, updated according to the new guidelines.*

For the second iteration, we used the *Unity* real-time development platform (Unity, 2005). This platform not only worked very well with Tobii eye-tracking devices but also had the possibility to use the Affectiva Affdex library (Affectiva, 2009). This library, as well as the face reader's one used for the experiment in the second iteration, is a real-time automatic facial expression recognition toolkit, which detects emotion expressions (Anger, Disgust, Fear, Joy, Sadness, Surprise, and Contempt), as well as valence and arousal. Unfortunately, this technology seems to have become closed a few months ago and no longer accessible in the form of free SDK on *Unity*. However, it is still possible to access the Affectiva site to see its features, today Affectiva produces automotive, media analytics and biometric lab solutions in partnership with iMotions (IMotions, 2005). However, since it has been possible to manage both technologies on development platforms like Unity, and surely it is possible to do it also with other platforms such as Qt, it is necessary to clarify the program logic that will have to be at the base of the prototype. The following points show some possible rationale to take into account for future 3rd iteration development, having as a starting point the example provided by the 2nd iteration. The algorithms of a 3rd iteration prototype should:

- Detect and record the general mood throughout the experience, in order to store it and be able to manage it in terms of design awareness and solutions.

- Register the emotion detection values (valence, arousal, and single emotions) regarding the eye-areas, during the choices.

- Allow enactive fruition by cross-referencing the data in order to have a "winning" choice for each scene: In scene 1 and scene 2 it could be equivalent to the element that has received a positive valence for the longest span of time, and also the record of the valence's value needed to create a weighted calculation. In scene 1 it should be considered that any easter-egg can be hidden within a scene and that it has to be an algorithm to take this into account, giving more or different value to the emotional values and time spent on the relative eye-area. In scenes 3 and 4, it is instead possible to explore the emotion-detection related to the timespan of choice, 10 seconds for scene 3, 2 seconds instead for scene 4. This difference could help us to better explore the difference between an average and a very short choice timespan. We are confident that the investigation of emotions in a short time reaction could be useful to explore the field of micro-expressions, especially in fight or

flight perspective. It is important to remember that as we have seen in the previous chapters, there is a lack both at the technological and theoretical level in the field of micro facial expressions because a "*detailed description of micro-expression or relationship between emotion and micro-expression is not yet established*." (Sumi & Ueda, 2016). The micro facial expressions are determined by involuntary micro-movements and for this reason it is not possible to suppress them, moreover their duration is very short because they appear only for a small part of a second. For this reason the task of their detection is complex from the technological point of view, instead from the theoretical point of view they consist in the significant amount of information of the true human emotions. (Sergeeva et al., 2019). The scientific community lacks very little to have valid tools and knowledge regarding the detection of micro facial expressions, we believe that this study can provide ideas and suggestions in this area.

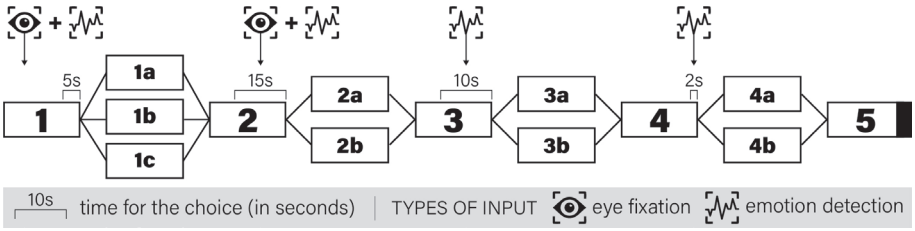


Fig. 39 *Flow of the scenes in the narrative sequence of the prototype, updated according to the new guidelines and types of input.*

From a design point of view, it is certainly useful to consider the study conducted by Patricia E. G. Bestelmeyer at al. which demonstrates the interdependence of the valence and arousal dimensions. "*Arousal (or intensity) is the level of autonomic activation that an event creates, and ranges from calm (or low) to excited (or high). Valence, on the other hand, is the level of pleasantness that an event generates and is defined along a continuum from negative to positive*." (Bestelmeyer et al., 2017). Although conducted with tools other than the face reader, the results of this study, and specifically fig. 38, show that with only valence and arousal values it is possible to have an idea of the emotional state of the person, in this case on 4 dimensions: Neutral, Pleasure, Anger, Fear.

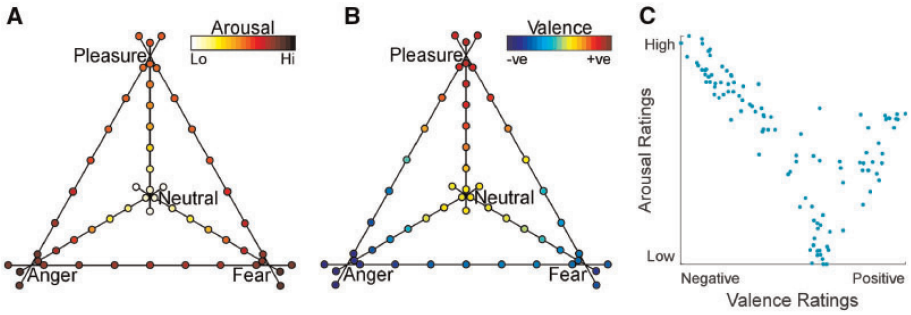


Fig. 40 *shows the behavioural results of Bestelmeyer et al.'s research in 2017. Behavioural ratings of (A) arousal and (B) valence of the stimulus set. (C) Scatterplot illustrating the quadratic relationship between valence and arousal ratings. (Bestelmeyer et al., 2017).*

The same study also points out that pupillometry can be useful in this area because the pupil size is larger during positive and negative sounds and smaller during neutral sounds. In this context, face reading and eye-tracking tools are an excellent option for designing enactive experiences, first of all, because these tools allow obtaining real-time very accurate data, and also because they provide this wide spectrum of data in an unobtrusive way. In addition, these tools, which we intend to use as input to create interactivity, are mostly used as output tools able to provide user data in a usability and user research context, allowing to kill two birds with one stone. Obviously, one of the most important, if not the most important, component remains the authorial one, in which there are two important aspects to consider: the choice of how to manage this information in order to enable a choice for the user, and the choice of the not only audiovisual elements that affect the emotional state of the person. Furthermore, this study on the enactive approach is an exploratory research on how unobtrusive technologies are able to go far beyond the trivial use in advertising and marketing. Thus, they are able to provide a tool for the design of enactive scenarios not only in creative fields such as enactive narrative/cinema but in many others. Obviously one can never disregard human's faculty of choice, or the right not to have a clear choice, for example, someone will like both the choices proposed, and someone else none. It is precisely in these cases that it could be interesting to take advantage of the value of the data, to make a conjecture on the reason why one path has been made rather than another.

Today some devices have already embedded eye-tracking technology, and to implement the technology needed for emotion-analysis is necessary only a webcam. With the data obtained from these two technologies (valence, arousal, emotion-analysis, and eye-gaze) it is already possible to design an enactive experience.

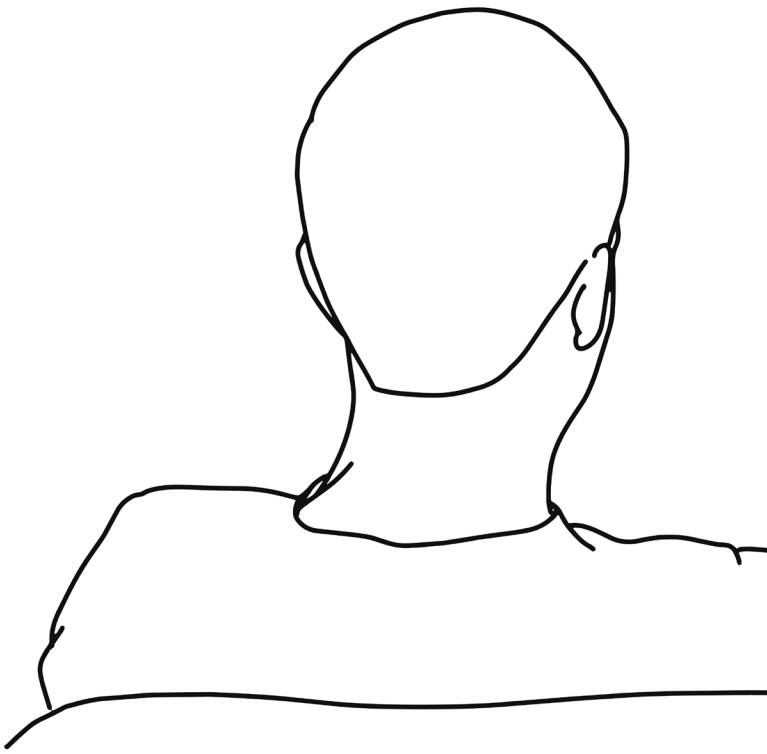
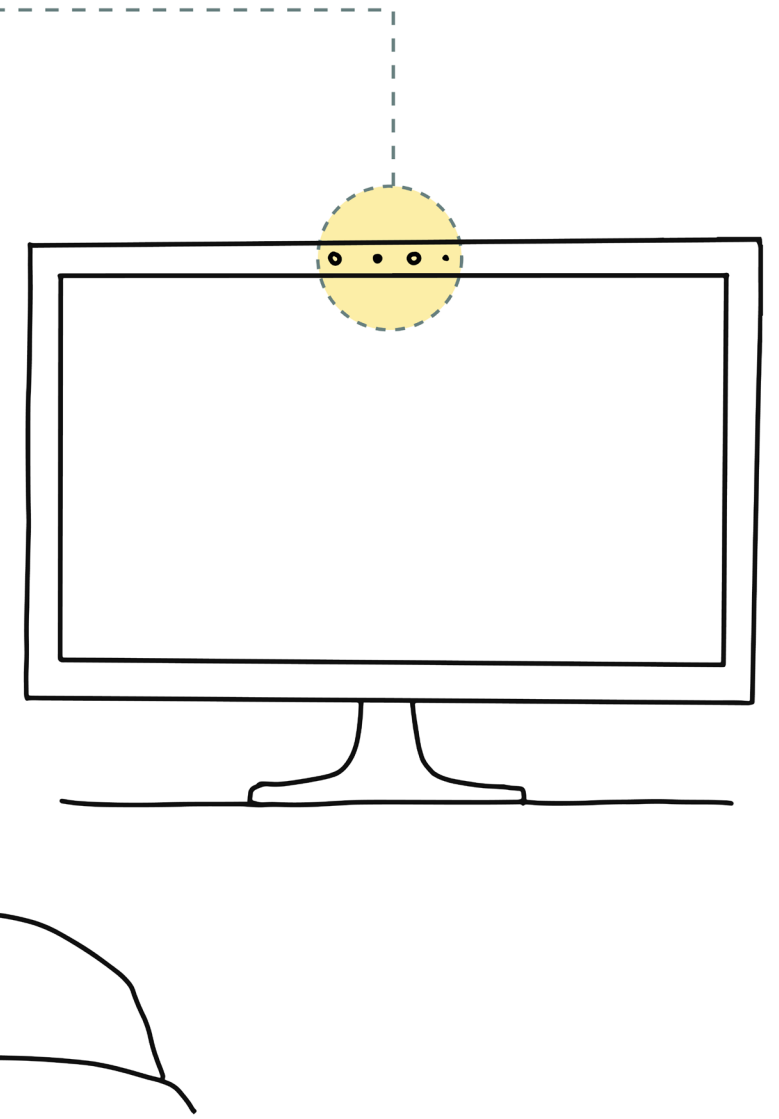


Fig. 41 *A representation of one of the possibilities of technological application today.*



Also from the point of view of functionality, the use of this kind of technology in services like Netflix could be a big step forward, just think of functions like "are you still watching?" implemented with a distraction-detection function. You could also open a long discussion about profiling and its database, for example when a user watches a movie with another customer, the latter could be detected and then Netflix could leverage on this information for the creation or implementation of other functions.

7.3 Applicability of the new paradigm

Considering the enactive interaction with storytelling artifact as a new paradigm for an unconscious and/or passive control of interfaces, we can speculate on possible further applications of such interaction within different solutions belonging not only to the field of cinema and movie experiences. It is easy to imagine how unconscious and passive interaction that leverages on emotional statuses of the users, could be a contribution in several fields. The most promising ones are interactive spaces and digital environments such as ambient intelligence. We foresee future technological advancement that will allow a multi-user interaction for both eye-gaze and enactive control of contents and information creating a personalized space that considers all the inhabitants and users of an environment.

7.4 Ethical concerns

From the point of view of ethics, it is necessary to discuss the possible consequences of the future spreading of enactive experiences in everyday entertainment (such as embedding the necessary devices in smart TVs). Considering current technological trends that move fast to the hyper-personalization of services and systems so as to create tailored experiences (e.g. recommender systems, personalized suggestions, adaptive solutions), we see enactivity as a possible way to influence both the artifact and the viewer. We strongly believe in a need of future in-depth investigation of such an interactive paradigm seen as an agency for possible individual and social consequences of the use of bio-information (emotional state) in everyday life in terms of privacy, and individual and social issues. (Pillan et al., 2017). In order to foster the solutions' resilience (Varisco, 2019), we can address the possible individual and societal impacts of the use of this new paradigm according to criticalities that emerged from previous research on the possible consequences of the use of personal information. (Schneier, 2016) (Polaine, 2013). First, on the topic of data privacy, we have to consider that the awareness of the user of the tracking of emotions and the subsequent use of such information is key to foster the social acceptability giving to the individual the power to decide

if and when to be tracked as well as the control on data access management. Secondly, the users should have the right to access the knowledge extracted from the analysis of their data so to increase their knowledge about both themselves and how the system decided for them. However, the amount and depth of this knowledge that the users get back has to be carefully balanced to avoid dangerous misperception of the self, due to self-mirroring into data and to avoid information overload that could increase psychological impacts leading to changes in the attitude and disposition of the individuals due to the raising of concerns on problems derived from self-analysis through data. Third, the knowledge extracted from the data analysis by the system can make social labeling and misuse of data even easier than before, leading to the increase of effectiveness of targeted subliminal messages as well as nudging and influencing for improper purposes. However, it has to be noticed that, especially for neuroscience and cognitive science researchers that work on human emotions, the information gathered from the systems that embed enactivity, can represent an interesting source of value in terms of massive amount of data for research purposes and a voluntary donation of the data from the user should be taken into consideration as a possible option so to allow them to contribute to the public good.

The topic of enactivity is a niche one but has enormous potential in many areas. First of all, in the culture of interaction design, it is fair to say that all interactions already involve attention to the senses and therefore it may seem almost a tautology to talk about emotions. In truth, however, the awareness of the use of the enactive approach is already a big step forward and goes far beyond Gestalt theory and functional interaction. Compared to classical theories, enactive interaction shifts the attention to what happens to people's minds through and during multisensory interactive processes, highlighting some reasoning on the root of interaction, and paying more attention to the unconscious side. Moreover, only in recent years it has been possible to seamlessly contextualize and implement the enactive approach in the design world. Today, thanks to the contribution that technological progress fosters to the design field, it is possible to design taking into account technologies that it was not possible to consider only a couple of years ago. The model presented in Fig. 42 shows the process I followed for the design and iteration of the prototypes within a Research through Design approach. In addition, I propose four iterations that developed according to this process can lead to the creation of an enactive storytelling artifact.

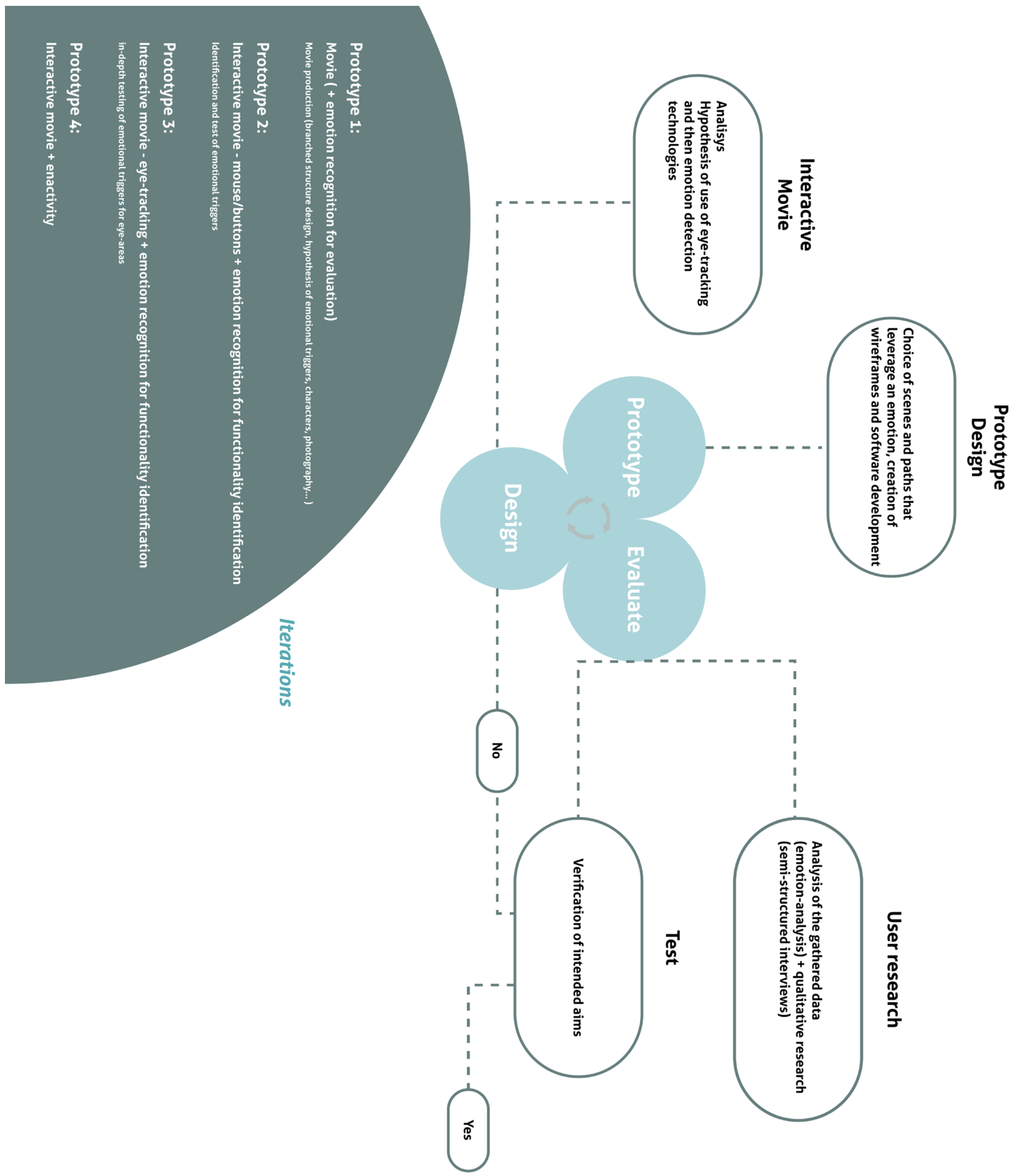


***Fig. 42** The model showing the process I followed for the design and iteration of the prototypes within a Research through Design approach.*

This research thesis was an opportunity to be able to conduct research independently on a theme dear to me, with an approach that fully matches my interests and skills. I feel lucky to have been able to grasp this opportunity and for the support that the Pheel Lab and the Professors have given me. This thesis has been a source of learning and reflection on several fronts, first of all I was able to challenge myself by setting one foot in the field of research. This work is certainly a first step towards a new paradigm of interaction using advanced technologies affordable to all. Obviously there is a need for further research and experimentation because such a complex and delicate field would need a higher level of research. A reflection arises spontaneously about the Affectiva company, which by closing its libraries has caused a huge loss for the world of research, design, and art. Indeed, if before it was possible to use public SDKs, now they have become inaccessible, closing the way to many possibilities of research, exploration, and artistic production in the field of emotion-detection. This also makes us reflect on how, on the other hand, open source technologies have increasingly become a valuable resource for research and development. One last thought comes to mind about the figure of the designer in the world of research. The designer is a figure who solves problems with creative solutions. In the world of research more than in any other, there is a need for curiosity and creativity, for subverting the rules and risking to come to conclusions that are not trivial. Creative and scientific thinking have been apart for a long time, but now more than ever there is a need for them to meet again.

References

Bibliography

Bannon, L. J. (1991). From Human Factors to Human Actors. 11.

Bestelmeyer, P. E. G., Kotz, S. A., & Belin, P. (2017). Effects of emotional valence and arousal on the voice perception network. Social Cognitive and Affective Neuroscience, 12(8), 1351–1358. https://doi.org/10.1093/scan/nsx059

Brhel, M., Meth, H., Maedche, A., & Werder, K. (2015). Exploring principles of user-centered agile software development: A literature review. Information and Software Technology, 61, 163–181. https://doi.org/10.1016/j.infsof.2015.01.004

Ciancia, M. (2016). Storytelling & Worldmaking: The World-building Activity as a Design Practice. In The Pearl Diver. The Designer as Storyteller. https://archive.org/details/ThePearlDiver_DESIS

Damasio, A. R. (1994). Descartes' error: Emotion, reason, and the human brain. Penguin.

Damasio, A. R. (2000). The feeling of what happens: Body and emotion in the making of consciousness (1. Harvest ed). Harcourt.

Damasio, A. R. (2003). Looking for Spinoza: Joy, sorrow, and the feeling brain (1st ed). Harcourt.

Damasio, A. R. (2010). Self comes to mind: Constructing the conscious brain (1st ed). Pantheon Books.

Ekman, P. (1992). Facial Expressions of Emotion: New Findings, New Questions. Psychological Science, 3(1), 34–38. https://doi.org/10.1111/j.1467-9280.1992.tb00253.x

Eriksson, M., Fleischer, R., Johansson, A., Snickars, P., & Vonderau, P. (2019). Spotify teardown: Inside the black box of streaming music. MIT Press.

Gazzaniga, M. S. (1985). The social brain: Discovering the networks of the mind. Basic Books.

Gomez-Uribe, C. A., & Hunt, N. (2016). The Netflix Recommender System: Algorithms, Business Value, and Innovation. ACM Transactions on Management Information Systems, 6(4), 1–19. https://doi.org/10.1145/2843948

Hallinan, B., & Striphas, T. (2014). Recommended for you: The Netflix Prize and the production of algorithmic culture. New Media & Society, 18(1), 117–137. https://doi.org/10.1177/1461444814538646

Hellpach, W. (1923). Geopsychische Erscheinungen.

Hobbs, J., Fenn, T., & Resmini, A. (2010). Maturing a Practice. 2(1), 18.

James, W. (1884). What Is an Emotion? Mind, 9, 188–205.

James, W. (1912). A World of Pure Experience. http://fair-use.org/william-james/essays-in-radical-empiricism/a-world-of-pure-experience#e2s1p2

Jansen, J. (2015). Automated Identification and Measurement of Suppressed Emotions using Emotion Recognition Software. 16.

Kahneman, D., & Riis, J. (2005). Living, and thinking about it: Two perspectives on life. In F. A. Huppert, N. Baylis, & B. Keverne (Eds.), The Science of Well-Being (pp. 284–305). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198567523.003.0011

Krueger, M. W., Gionfriddo, T., & Hinrichsen, K. (1985). VIDEOPLACE--an artificial reality. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '85, 35–40. https://doi.

org/10.1145/317456.317463

Krug, S. (2000). Don't make me think! A common sense approach to Web usability (2nd ed). New Riders Pub.

Lewinski, P., den Uyl, T. M., & Butler, C. (2014). Automated facial coding: Validation of basic emotions and FACS AUs in FaceReader. Journal of Neuroscience, Psychology, and Economics, 7(4), 227–236. https://doi.org/10.1037/npe0000028

Maison, D., & Pawłowska, B. (2017). Using the Facereader Method to Detect Emotional Reaction to Controversial Advertising Referring to Sexuality and Homosexuality. In K. Nermend & M. Łatuszyńska (Eds.), Neuroeconomic and Behavioral Aspects of Decision Making (pp. 309–327). Springer International Publishing. https://doi.org/10.1007/978-3-319-62938-4_20

Mandolfo, M. (2016). You trust me, and I feel it. 268.

Mariani, I., & Ciancia, M. (2019a). Building Interactive Narratives: Characters, stories and in-betweens. Experimentations and critique. In EDULEARN19 conference proceedings.

Mariani, I., & Ciancia, M. (2019b). Character-driven Narrative Engine. Storytelling System for building interactive narrative experiences. 20.

Mori, M. (1970). The uncanny valley. Energy, 7, 33–35.

Pillan, M., Varisco, L., & Bertolo, M. (2017). Facing Digital Dystopias: A Discussion about Responsibility in the Design of Smart Products. In M. B. Alonso & E. Ozcan (Eds.), Proceedings of the Conference on Design and Semantics of Form and Movement—Sense and Sensitivity, DeSForM 2017. InTech. https://doi.org/10.5772/intechopen.71121

Pine, J., & Gilmore, J. H. (1998). Welcome to the Experience Economy. Harvard business review.

Polaine, A. (2013). Service design: From insight to implementation. Rosenfeld Media.

Porter, J. (2019, February 13). Netflix records all of your Bandersnatch choices, GDPR request reveals. The Verge. https://www.theverge.com/2019/2/13/18223071/netflix-bandersnatch-gdpr-request-choice-data

Quesenbery, W., & Brooks, K. (2010). Storytelling for user experience: Crafting stories for better design. Rosenfeld Media. http://VH7QX3XE2P.search.

Sitography

Affectiva. (2009). https://www.affectiva.com/

Beast. (2014). https://www.thisisbeast.com/

Boersma, P. (2004). T-model: Big IA is now UX. http://beep.peterboersma.com/2004/11/t-model-big-ia-is-now-ux.html

Brooker, C. (2011, 2018). Black Mirror (series). Netflix. https://www.netflix.com/title/70264888

Buchta, R., Grylls, B., & Shoopman, D. (2019). You vs Wild. Netflix. https://www.netflix.com/title/80227574

Burdine, R., & Castuciano, J. (2017). Puss in Book: Trapped in an Epic Tale. Netflix. https://www.netflix.com/title/80151644

Cage, D. (2010). Heavy Rain (videogame). Quantic Dreams. https://www.quanticdream.com/en/heavy-rain

DeepGlance. (2018). http://www.deepglance.com/

DeepGlance Explorer. (2018). Deep Glance. http://www.deepglance.com/

DeepGlance Quick. (2018). Deep Glance. http://www.deepglance.com/

Envis Precisely. (2009). http://envis-precisely.com/

Envis Precisely. (2013). The Disciplines of User Experience Design. https://

github.com/envisprecisely/disciplines-of-ux

FaceReader. (2016). Noldus. www.noldus.com/facereader

Fitbit. (2007). Fitbit Official Site for Activity Trackers & More. https://www.fitbit.com

Gault, M. (2019, February 12). Netflix Has Saved Every Choice You've Ever Made in 'Black Mirror: Bandersnatch".' Vice, Tech. https://www.vice.com/en_us/article/j57gkk/netflix-has-saved-every-choice-youve-ever-made-in-black-mirror-bandersnatch

Google Maps. (2005). https://www.google.com/maps

Happn. (2014). https://www.happn.com/

IMotions. (2005). https://imotions.com/

Interaction Design Foundation. (2002). User Experience (UX) Design. Interaction Design Foundation. https://www.interaction-design.org/literature/topics/ux-design

ISO 9241-210:2019. (2019). https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-2:v1:en

Jack, A. (2011). Emergent Systems as a Narrative Device. https://www.slideshare.net/alanjack/emergent-systems-as-a-narrative-device

Klimas, C. (2009). Twine. https://twinery.org/

Minecraft: Story Mode (series). (2018). Netflix. https://www.netflix.com/title/80227995

Mojang. (2011). Minecraft (videogame). https://www.minecraft.net/

Netflix. (1997). https://www.netflix.com/

Newman, L. H. (2019, April 21). Hackers Can Tell What Netflix Bandersnatch Choices You Make. Wired, Security. https://www.wired.com/story/netflix-interactive-bandersnatch-hackers-choices/

Paredes, G. (2019). Consider the consequences (review). Demian's Gamebook Web Page. https://gamebooks.org/Item/11406/Show

Qt. (1995). Qt Group. https://www.qt.io/

Unity. (2005). UnityTechnologies. https://unity.com/