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STEPHANIE GABRIELA AREVALO ARBOLEDA
INFLUENCING COLLABORATION TO ENHANCE KNOWLEDGE
WORK THROUGH SERENDIPITY: USER-STUDY AND DESIGN
CONSIDERATIONS

Master of Science thesis

ABSTRACT

STEPHANIE AREVALO ARBOLEDA: Influencing collaboration to enhance knowledge work through serendipity: user-study and design considerations
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We all were strangers to someone at some point and that is the starting point to analyze unexpected encounters. The busy pace of life has alienated people from each other, hence, this created an opportunity for technology to support social experiences. Meeting new people that one would not normally encounter in the vicinity or in the regular social sphere would expand the opportunities for establishing connections. Connections that go beyond establishing friendship bonds, but finding collaborators for the development of projects. This thesis was developed in order to understand the concept of serendipity in the context of computational systems and how it can be used to facilitate encounters among knowledge workers. The analysis of this thesis is conceived within the borders of Human-Technology Interaction, using psychological and sociality approaches from a technological perspective that allows a better understanding of the people's needs when developing tools to support social interactions.

The theoretical chapters start analyzing the phenomenon of serendipity from different perspectives, along with concepts about knowledge work and matchmaking. In order to understand the phenomenon of serendipity, the term is defined from social perspectives to psychological ones. The purpose of this is to set the basic premises of the study and introduce how serendipity is approached in terms of computational systems and knowledge work. Then, it analyzes matchmaking and grouping by presenting knowledge networks, social matchmaking with professional purposes and context awareness.

The user study is carried out by a set of interviews to participants in Demola (an ecosystem that joins students with projects from companies), followed by a comparison of different tools that already exist that help matchmaking. The purpose of the user study was to analyze manual matchmaking among strangers. It analyzes participants' experiences when working with strangers to carry out different innovation projects. It also intends to determine the expectations when forming a group. Added to that, the head of Demola Tampere was interviewed to understand the manual matching participants process.

The final chapter presents a set of considerations when designing for serendipity to enhance knowledge work. The conceptualization of serendipity and the user study are the basis for establishing a set of guidelines in design. Which intend to enhance matchmaking in knowledge workers by analyzing weak ties as a way of serendipity. This study emphasizes on the goals and expectations of the users when finding a professional partner. Based on the user study, a model is presented which shows a possible structure for matchmaking.

PREFACE

I applied to the Master's program in Human-Technology Interaction in order to explore another area of computer science, coming from a Software Engineering background I wanted to explore the creative side of computer science and I could not have chosen a more stimulating area. It combines technology with a more social and humanistic approach which is what I have been looking since I finished my bachelor.

My whole journey to achieve this master have been a self-discovery from the day I arrived to Finland. I learned about a new and fascinating area that combines design, psychology and technology which allowed me to finally discover the way I would like to orient my professional life.

I would like to thank the Ecuadorian Government for supporting my professional development with a scholarship. My parents, the most important people in my life who have stood by me in all the decisions I have taken, and my whole family for sending me their unconditional love from the other side of the world.

Finally, I would like to thank my supervisor Thomas Olsson for his guidance and patience on the process of writing this project.

Tampere, 15.6.2017

Stephanie G. Arevalo Arboleda

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LIST OF SYMBOLS AND ABBREVIATIONS

CV   Curriculum Vitae
AI   Artificial Intelligence
LDA   Latent Dirichlet Allocation
PLSA   Probabilistic Latent Semantic Analysis
UCD   User-Centered Design
CSCW   Computer Supported Cooperative Work
P-J   Person-job fit theory

1. INTRODUCTION

This thesis was inspired by a COBWEB project from Tampere University of Technology that aims to promote knowledge work with *analysis of weak ties in online services[1]*. The aim of this thesis is to understand the needs and perspectives of the users who have experienced multidisciplinary work with strangers. It starts by decoding the term from its origins to a more concrete definition and understanding from a technological perspective. However, for gaining a better understanding on the subject, a user-study was needed. The user study was carried out in an environment that enables encounters to pursue innovation projects called Demola[2]. Demola was chosen because it harvests different types of interactions that enable social serendipity and multidisciplinary collaboration. The following user study evaluates participants' expectations when developing a project. These expectations along with the theoretical research, will be translated into a set of considerations. Considerations that intend to guide the design of technology seeking serendipity with the purpose to enhance collaboration among knowledge workers.

This chapter describes the background of the thesis and the motive for carrying out this type of research. It provides a general outline of the approach that this project considers for presenting the relevance of establishing unexpected connections by analyzing the social environment in knowledge workers.

1.1 Background and motivation

The fast pace of life has pushed people to ignore the happenings on the surroundings, including other people that crosses their paths. Added to the social norms that induce people to limit their direct interactions with strangers, seems to alienate people from each other. In contrast with that, technology is trying to connect people in a virtual level, which has changed the way people act and perceive the world. The way people communicate and express themselves has evolved. Consequently, it has changed the way people meet, socialize and establish connections. In fact, it has unveiled a whole new way of building relations and interactions.

Serendipity refers to fortuitous happenings with positive outcomes and it plays an interesting role in promoting unexpected encounters. Thus, the importance of its analysis and the basis of this thesis. For some authors it involves certain spark in random events and the awareness of it (Rubin et al. 2011). Serendipity is also related to innovation, when it takes place in a networking environment where people is actively seeking for connections (McCay-Peet & Toms 2010). Andre et al. (2009) expand the concept for the computer

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[1] http://www.cs.tut.fi/projects/COBWEB/
[2] https://www.demola.net/about/

science context, affirming that serendipity is related to creativity, innovation and discovery. Although, it is mentioned that serendipity in computer science started as a way of suggesting information with an exploratory purpose. This purpose has evolved into seeking serendipity when establishing connections among people.

A way of connecting people in the virtual world is through social matching systems. These, intend to connect people beyond the online world and support collaboration (Terveen & McDonald 2005). Serendipity has been present in the online world through recommender systems and now it has taken over the grounds of recommending people. Recommender systems select within a set of information what might be interesting for a person, hence, a matchmaking system should maintain the same premise.

There have been several attempts to promote people socializing with nearby strangers. However, in the field of knowledge workers there are few tools that enhance their collaboration. Therefore, it is important to attempt to increase social serendipity among knowledge workers, and it could be achieved by analyzing the potential of weak ties for finding a suitable partner for project collaboration. Added to that, establishing connections among knowledge workers might help in the process of innovation, since different abilities and insights about a problem can present a wide range of solutions. Therefore, there is a need to study how these connections can be prompted.

1.2   Research Objectives and Methodology

The development of this thesis lies within the context of human-technology interaction. This study intends to translate the concept of serendipity into a matchmaking system by establishing connections in the context of knowledge work. It intends to identify user's needs and expectations when looking for professional partners. Furthermore, analyzing weak ties in their social environment will help to identify those partners.

Sociality is in the center of the investigation by trying to understand the dynamic of grouping and working with strangers, the aim of this thesis is to present a set of design considerations that might lead to a computational system that enhances social serendipity in knowledge workers.

The general goal of this project is: *"Propose design implications based on the understanding of the phenomenon of social serendipity, through a study of people's expectations in matchmaking for professional purposes"*.

Based on the general goal, two supporting objectives that intend to reach that goal were established:

"Discover ways to enable serendipitous encounters among knowledge workers"

"Understand the circumstances that will enable an encounter to be successful from the user's perspective"

The focus of the thesis is the user study that was held in order to understand the dynamics and expectations from people. Expectations that serve as the main source to define a set of aspects that should to be considered when designing for serendipity to facilitate connecting knowledge workers.

1.3   Structure of the Thesis

Since this thesis aims to investigate matchmaking among knowledge workers, it is important to understand some terms that are mostly used in psychological or sociological fields from a technological perspective, therefore, Chapters 2 and 3 aim to unveil those concepts and provide a solid theoretical background to the study.

The theoretical part of the thesis starts with Chapter 2 by presenting serendipity from different angles to provide a better understanding for a concept that can be abstract. Then, it explores its presence in the computational area and presents how this concept merges with knowledge work.

Chapter 3 focuses on presenting knowledge networks and its structure in order to provide a better understanding of matchmaking and grouping people. Also, it presents how different concepts of computer science collide in order to mediate social-matchmaking.

Chapter 4 presents the user study that was conducted through a set of interviews, the results are discussed in this chapter along with a brief analysis of a few software and mobile applications that seek to connect with professional networking purposes.

Chapter 5 presents a set of guidelines to be considered when designing a tool that enhances knowledge work by connecting them. The guidelines are presented with a prototype of a possible design.

Finally, Chapter 6 discusses the findings and the contribution of the thesis to field of Human-Technology Interaction and User-Design, as well as the extent to which the goals and objectives of the thesis were fulfilled.

2. SERENDIPITY

Serendipity is a term that has been debated often and it presents a wide range of definitions going from philosophical to more pragmatic ones. The term first appeared in a fairy tale from 1754 by Horace Walpole called "The three princes of Serendip", where he described a series of discoveries that happened by accident. Thus, the characters experienced unexpected results from each happening. Thenceforth, the term has acquired certain level of popularity, especially, to present a series of phenomena that took place unexpectedly. A definition given by the Oxford Dictionary relates serendipity to "happy chance, happy accident or happy coincidence" (Oxford Dictionary 2008). The first conclusions from the two approaches presented is that serendipity relates to some sort of events that have a pleasant outcome.

Serendipity is present across disciplines such as sociology, mathematics, literature, chemistry or biology, where multiple discoveries have taken place because of serendipity (Foster & Ellis 2014). For instance, Austin (2003) attributes some of her discoveries in neuroscience as "happenings of special sort", where she describes how she found interesting results without following a scientific method. Following the same line, Burt (2004) defines serendipity as an "unintended consequence of innovation", emphasizing that multiple experiments result in a different outcome than what was expected, like the accidental discovery of penicillin.

Lasry (2014) presents serendipity as the importance of "seeking without even knowing what it is that one is looking for", where she tells about the unexpected mathematical bifurcation on her path that led to brilliant results on her research. Burt (2004) presents a similar approach, which summarizes serendipity as an attitudinal characteristic "to see bridges where others see holes". Relating different ways of interpreting facts and understanding them in order to build connections even if there is no apparent relation.

To support Burt's conceptualization, serendipity can be also understood better than a mere series of events that took place by chance, it can be seen as a consequence of identifying relevant factors in the surroundings. In fact, Foster & Ford (2003) mention the importance of serendipity in science by defining it as "the product of mental preparation of an open and questioning mind". This emphasizes on the attitudinal aspect and predisposition to let things happen by connecting dots and speculating on possible findings.

De Rond (2014) presents a different approach by individualizing the term chance from serendipity, by considering serendipity as a capability, and chance as an event. Thus, if serendipity is a capability, it can be achieved and induced in a certain way in a given moment. This statement opens the door for researches to conceive serendipity in a way

that it can be manipulated and influenced for the sake of achieving diversity in their results.

In general, serendipity can be presented as that sparkle that appears in plain daylight and that only an attentive and curious mind can notice it. A curious mind should be open to the different elements that are around and one of the most relevant is the other people around. Humans are social by nature and interacting with others can provide different perspectives and ideas which can result in a final 'eureka' moment.

2.1 Instances of Serendipity

Serendipity focuses on establishing a new a new mental connection between what is being perceived in the surroundings. Fine & Deegan (1996) defined three instances of serendipity that are presented in Figure1, "temporal serendipity (happening upon a dramatic instance), serendipity relations (the unplanned building of social networks), and analytic serendipity (discovering concepts or theories that produce compelling claims)". Therefore, if serendipity can be decoded into some elements, it might be reproduced and achieved, even if it seems that it goes against the very first conception of the term where unmeasurable factors like chance or accidents were mentioned.
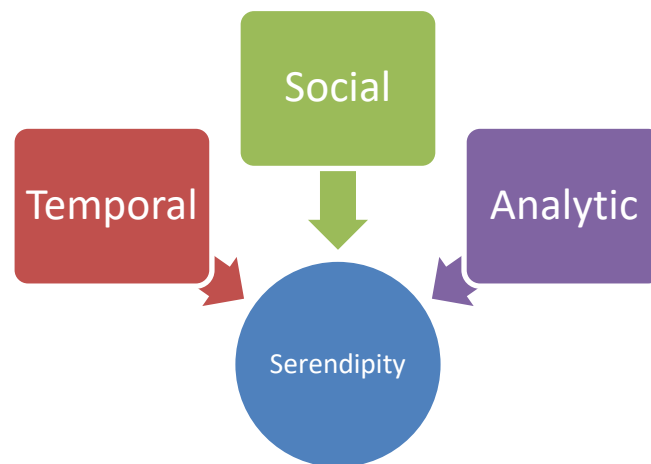
Figure 1. Representation of the instances of serendipity

Figure 1 shows a graphical representation of Fine & Deegan's statements. The alignment of certain factors is time depending, therefore time plays an important role in serendipity. Serendipity can be social and this thesis will focus on this factor of it. Finding unexpected connections with other people, and the analytical approach that considers data analysis and connecting theories and information to produce new sets of information. This instance has been explored through recommender systems and will be presented in section 2.4.

2.2   Emotions in Serendipity

Serendipity can be a social concept, where the human factor is the center of it. Therefore, it is important to study it from the human's inner state. Humans are emotional beings by nature and emotions can play an important role in a serendipitous moment. These can increase motivation or avoid seeing relevant connections. In fact, emotions determine the perception of an experience, therefore, a certain emotional state is required for allowing serendipity.

Let's start defining emotions, Hockenbury & Hockenbury (2007) present emotions as a "complex psychological state that involves three distinct components: a subjective experience, a physiological response, and a behavioral or expressive response". In this context, serendipity can also be considered an emotional response, since it presents all the aforementioned elements. Hence, it can be said that serendipity is also an emotional happening, where all the rights elements have aligned in a certain way to produce a result both inside a person's psyche and the surroundings.

However, a specific set of conditions related to the emotional human need to be considered. In fact, affective states can be the key of finding a serendipitous moment since they modulate behavior, moreover, a certain state of mind is required to find opportunities in the least expected places. That specific set of conditions is called context and it is defined as: "the circumstances that form the setting for an event, statement, or idea, and in terms of which it can be fully understood" (Oxford Dictionary of English 2010). Context and affective states go hand in hand when decoding serendipity, it can be said that context modulates and shapes the different affective states, and it also locates a person in terms of identity, place and time (Vlachostergiou et al. 2014).

Another important factor is the role of emotions in making decisions (Tkalčič et al. 2014). Emotions do not last long and are constantly changing depending on the different stimuli humans perceive. For this reason, the specific emotion a person is experiencing in a specific moment can determine the result of a happenstance. For example, working on an experiment for a long period without finding the expected results, can lead to frustration and depression, which might lead to ignoring other relevant results. In the same way, being over confident and positive about results can induce people to ignore other findings.

Likewise, delight is an important factor in serendipity (André et al. 2009). The feeling of delight is related to unexpected positive discoveries that will please the person who is experiencing it. Thus, it is the result of achieving serendipity and one of the goals when designing for serendipity. On top of that, Liang (2012) considers serendipity as an experiential quality highly important in interaction design.

Designing for emotions is an important concept in UCD (User-Centered Design) (Norman 2007), humans have a natural emotional reflex towards what is perceived. In fact,

emotions have the power to change the current state of mind and enable the creation of new connections, thus, new are particularly relevant in the ground of serendipity because it enables curiosity (Maxwell et al. 2012).

2.3 Creating Opportunities to enable Serendipity

To illustrate how opportunities can be created, one must consider different factors that will be explained in the following paragraphs. However, a serendipitous context can be understood as finding a momentum. That is to say, opportunities can be created by mixing a set of factors where context plays a vital role.

The conditions for people to create a cooperative environment start with a mental state coming from "the sagacity to derive insight from the encounter" (André et al. 2009). In fact, Mayer et al. (2015) mention a set of circumstances for cooperative action: first, people need to identify each other; then, they should be willing to meet again in the future; finally, in order to evoke interest in each other they need information about previous behavior. This set of circumstances might seem obvious; however, it is relevant to mention them to specify the scenario for an encounter to be fruitful.

Furthermore, Mayer et al. (2015) proposes a framework for recognizing opportunities for meaningful encounters in the following contexts: social, referring to the external elements of a place, such as, people's intentions or reputation; personal, individual elements inherent to a person's psyche; and relational, considering affinity and social ties. The experiment conducted by Mayer was carried out to confirm the relevance of these factors in encounters, it is important to mention that the purpose of the encounters was merely social and the study was presented in a general level.

Another significant approach is understanding serendipity as a tool for enabling connections, multiple findings and creativity (Foster & Ford 2003). It can be said that serendipity is the path towards creating opportunities, going beyond finding new people to work with, but to harvest new ideas and influence each other. All in all, a creative outcome is the result of an open and curious mind that is constantly looking for new paths to solve problems.

Personality plays an important role in serendipity. Apparently some people are more prone to experience a serendipitous encounter than others (Erdelez 1997), it has been already mentioned that serendipity is the result of a questioning mind, which implies certain personality traits. Heinström (2006) uses the Big Five personality traits (Openness to experience, Conscientiousness, Extraversion, Agreeableness, Neuroticism) to explain this through a study that showed that people with a high level of openness to experience, extraversion and agreeableness are more likely to experience serendipity. The fact of

questioning problems and being constantly looking for new discoveries enable serendipity to take place, therefore, people with certain personality traits might encounter serendipity more often, but it is not limited to it.

2.3.1 Creativity and Innovation

There are many different factors that play a role when considering about ways to generate ideas, however, innovation and creativity are often mentioned when ideating. The following paragraphs will present an analysis of those terms and how it connects with serendipity and generating ideas.

Creativity is a term that is usually related to surprises, presenting something in a way that will surprise the audience. Runco (2004) presents it as a process that results in a solution with "insight and novelty", thus it can be said that it is the process of creating something aiming originality. Creativity and serendipity are two concepts that are closely related, since they both include an unexpected factor in it. A creative process involves connecting unrelated ideas (Rubin et al., 2011). For instance, Mäkelä (2016) combines this two terms to illustrate the process of creative thinking in her exploratory experience and how serendipity played an important role in her process of creation. She emphasized about spontaneity and looking further than the regular places for her creative process. In this context, serendipity and creativity seem to have a lot in common.

Innovation is a term that is closely related to technology, usually when a new artifact comes to the market the term "innovative" is often used to describe it, focusing on new or different attributes that it might possess. Costello & Prohaska (2013) starts defining it by its Latin root *Innovare* or *in Novus* which means "into new", which relates to create something in a different way. Existing literature shows different definitions for innovation; however, the following definition plays an important role in the context on this study. "Innovation is fostered by information gathered from new connections; from insights gained by journeys into other disciplines or places; from active, collegial networks and fluid, open boundaries. Innovation arises from ongoing circles of exchange, where information is not just accumulated or stored, but created. Knowledge is generated by connections that weren't there before. When this information self-organizes, innovations occur" (Wheatley 1992). This particular conceptualization has the approach of finding connections in order to achieve a goal, and in this scenario, it is innovation.

Kingdon (2013) presents serendipity in close relation with innovation, but far from creativity. Innovation involves achieving a goal that might not seem clear at the beginning, thus, in the path for achieving that goal innovation can take place, since it implies looking for solutions from the most varied perspectives. Serendipity is closely related to innovation for its way of establishing connections between unexpected elements. Therefore, it can be said that serendipity and innovation can be conceptualized in a similar manner.

Moreover, he mentions a set of stories of serendipitous discoveries that were not a result of 'luck', but the result of hard-work testing and determination towards finding solutions.

2.4 Serendipity in Computational Systems

In computer science, serendipity has been tried to be interpreted in order to find a way to replicate it with the purpose of producing discoveries. The quest for achieving serendipity started to be mentioned in information retrieval (Foster & Ford 2003) and recommender systems (Tkalčič et al. 2014) or web-browsing, systems that also ease the process of decision making.

The main goal in these areas is to find relevant information whithout explicitly looking for it, achieving serendipity in browsing infromation. According to André et al. (2009), the potential of serendipity lies in its capacity to influence creativity and result in innovative findings. An example of this efforts is by a system called "Max", that intends to evoke findings by inducing lateral thinking (Campos & Dias De Figueiredo, 2001), since it is inherent to browsing activities, they developed a system that in their words intends to "program for serendipity" with positive results. Their system takes words from their profile, mix them and send them to a search engine and send the results by email to the users.

A very interesting statement is presented by Corneli et al. (2014) who mention using machine learning techniques to find serendipity in the data, and encouge it through different computational methods. An example of this is a system developed for browsing exploration that seeks for serendipity is Haiku (Beale 2007). It uses ambient intelligence and data mining to achieve relevant information retrieval, and present them using 3D dynamic visualization.

It is important to highlight mobile social matchmaking and recommender systems, which is a field that has been rapidly developed in the last years. A recommender system can be defined as a way to "turn data on users and their preferences into predictions of users' possible future likes and interests" (Lü et al., 2012). The availability of data and the collection of it can enhance the quality of recommendations and tailor them for each user. Moreover, the widespread of smartphones have opened a wide range of opportunities for recommender systems of different kind. In the context of serendipity, there are several different applications for enabling chance discoveries depending on the purpose of it. The following paragraphs present a sample of what people is using as a recommender system.

Some applications are focused in recommending people to others with different purposes. Facebook[3] opened a whole new door to the way people interact with others online, and popularized social networks. In the mobile applications field the most explored area is

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[3] https://www.facebook.com/

finding people for romantic purposes and dating, applications like Tinder[4] or Grindr[5], show to be very popular and have changed the way people meet for love purposes, they establish a "match" between two persons based on liking the pictures and a brief information about each one. Some others broaden up this by introducing people that they can be friends with, Meetme[6] or Badoo[7] show different people to chat and connect. These systems focus on the location on the person in order to present options of people to meet. Moreover, these mobile applications are based on swiping as the interaction used to produce a match. LinkedIn[8] is the most used and popular when looking for job opportunities and networking. It presents suggestions of friends that you might want to connect with based on other social networks, the places that you have worked or studied, and it even presents job opportunities. LinkedIn is not proximity based, but focused on the profile and skills to increase the contacts network.

Some recommender system that focus on interests and places are: Foursquare[9] or Foodspotting[10], which help to identify new restaurants or bars in the vicinity; they are based on ratings and reviews from other people who have visited the place. They present a small set of characteristics of the places that one might be interested and help discovering new places.

Another aspect focuses on presenting current news and informational articles, Flipboard[11] or Rover[12] present a set of information that is constantly changing, and focuses on the visualization of that information and categorizes it depending on the user's interest.

Creating awareness of events in the surroundings has become an important part of recommender systems, for instance: Meetup[13], Facebook or Saambaa[14] are popular for checking different happenings and forming groups that share an interest or skills.

Discovering new music through different platforms is a way of enabling musical exploration. Slacker[15], Soundcloud[16] or Spotify[17] had been used to discover new artists and see what friends or other acquaintances are listening. It allows to share musical tastes and it is a form of publicizing artists.

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[4] https://www.gotinder.com/
[5] http://www.grindr.com/
[6] https://www.meetme.com/
[7] https://badoo.com/
[8] https://www.linkedin.com/
[9] https://foursquare.com/
[10] http://www.foodspotting.com/
[11] https://flipboard.com/
[12] http://www.roverapp.com/
[13] https://www.meetup.com/
[14] http://go.saambaa.com/
[15] http://www.slacker.com/
[16] https://soundcloud.com/
[17] https://www.spotify.com/

The aforementioned applications are a sample of the panorama in serendipity, and in the mobile area the trend indicates to be going towards sociality. The key for serendipity in technology can be approached by matching people without explicitly searching for a specific type of people (Mayer et al. 2015). Thus, it can be said that the future of serendipity lies in the way technology is merged with the people's needs.

2.5   Serendipity among Knowledge Workers

The previous sections of this chapter intended to decode serendipity in a general level and presented how computational systems blend with the topic. At a first glance knowledge workers and serendipity might not be concepts that can be easily related to one another. Nevertheless, knowledge workers are presented as the information manipulators that use it to produce information, within this context serendipity can draw the paths towards that information. This section presents in a more specific level the focus of this thesis when looking for serendipity. It was mentioned that the study will focus on enhancing knowledge work, thus, this chapter will explain how this can be done.

It is important to start this section by defining what involves the term knowledge worker. It can be said that it involves anyone who is engaged in an activity that handles information as its main tool, the term has been related to people working in computer science and researchers (Business Dictionary 2017). A more pragmatic introduction is presented by Beale (2007) who suggests it comes from a chain of consequences, created from information deriving from data, which in turn, comes from observation and measurements. Henceforth, here lies the importance of studying knowledge work and its structure, since it can be a path towards discoveries and advances that will ease and improve people's lives.

McCay-Peet & Toms (2010) conducted an experiment to try to decode serendipity in knowledge work, and evaluate its results. They developed a model to represent the process of serendipity in knowledge work.

Figure 2 presents the aforementioned process. Knowledge workers start with a defined problem and start the path towards a solution to that problem. In this quest for finding a solution there are a set of "precipitating conditions" that are present along the whole process. These conditions can be divided into three: time and place, active learning, in terms of the action of trying to solve a problem, and social networks. Also, there are a set of triggers that emphasize certain precipitating conditions on different ways and levels of intensity. The triggers and the precipitating conditions give place to a bisociation, which in this scenario refers to identifying a connection between an idea and an unrelated topic.
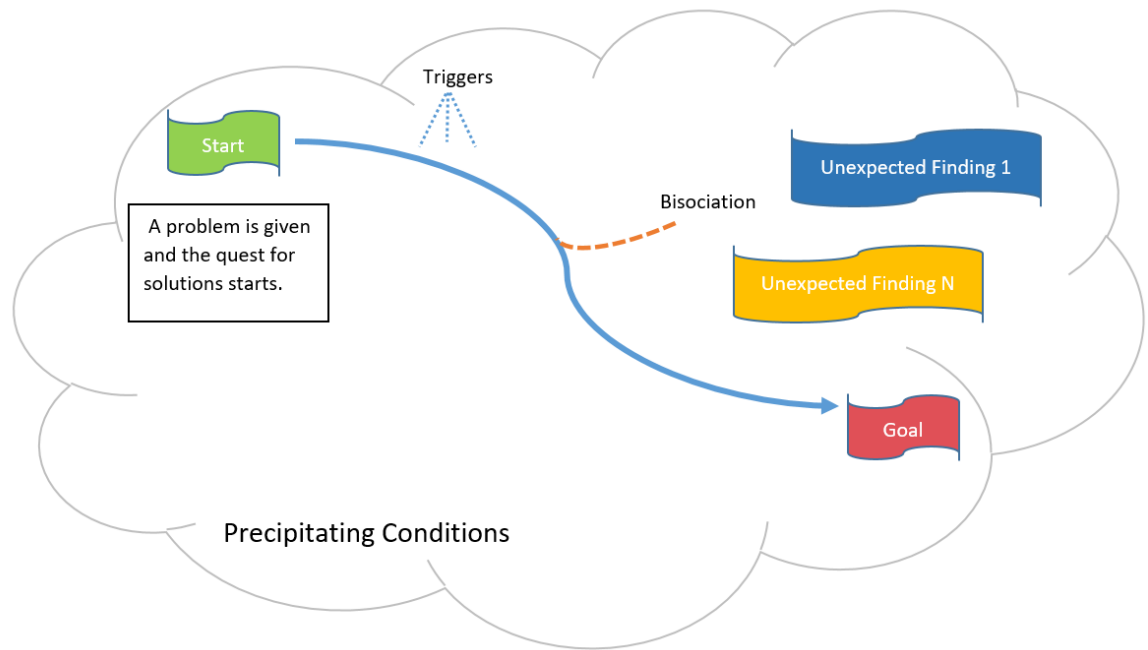
Figure 2. *Process of serendipity in knowledge work. Elements that interplay for finding a solution based on the McCay-Peet & Toms representation*

The bisociation factor can be identified as the key factor towards serendipity, and McCay-Peet & Toms (2010) concluded that decoding serendipity will help to understand the way people process information. In fact, they highlight the formation of a new train of thoughts created by acquiring information from unconventional sources. This translates into approaching problems in unexpected ways that might result in creative and innovative solutions.

2.6   Summary

Serendipity is a term that is used in different disciplines to define an unexpected happy encounter. There have been multiple discoveries that have been attributed to serendipity, therefore, the importance of analyzing different conceptualizations of serendipity and its place in this research area.

People are emotional beings, thus, when people experience an unexpected happening there are a different set of emotions that get involved before and after the occurrence. Those emotions might influence the type of the outcome that is obtained and lead a person to either a positive of negative state, which might ease the process of establishing connections that leads to unforeseen findings.

There have been efforts to induce it in information retrieval, recommender systems, web-browsing and socializing. Mobile technology has facilitated the process of connecting

people who are in our surroundings and has influenced chance encounters with different purposes that go from finding a job to finding a romantic partner.

Generating ideas is a step in the quest for knowledge, therefore, creativity plays a vital role when looking for ideas. Finding connections between unrelated ideas might be an exploratory process wherein the creational hype might lead towards serendipity. It is important to mention that serendipity in knowledge workers can lead to ideas that can result into innovative approaches to a problem.

This chapter presents the theoretical ground of serendipity and presents the boundaries of the research, specifying how serendipity unfolds in computer science and introduces it in a knowledge work context.

3. MATCHMAKING AND GROUPING

It is widely known that people tend to build groups since primitive times. The nomadic human tended to group in order to increase the chances of survival through gaining strength by number. The common characteristic in the group was their goal, survival. Humanity have come a long way evolving from survival concerns to more hedonic needs. This brings the interest in the way that people tend to form and build connections. Connections that can happen while travelling on a train and talking to the stranger who is in the next seat, a connection can also take place on a business meeting where everybody attends with the purpose of networking. Apparently, it seems that connections can happen everywhere and they are natural to people, therefore, the way people create a match with a peer and form a group needs to be elaborated.

People form and build connections in many ways, however, people tend to surround themselves by people who are similar. For this thesis, the focus goes towards producing matches and the process of matchmaking. A match will be treated in terms of linking people or finding a counterpart; and matchmaking, in the context of connecting people with professional purposes.

An important factor when talking about generating relevant matches is affinity, which goes beyond similarity, but the degree of relatedness (Mayer et al. 2015). Defining the level of affinity between people will determine the degree of connection between a match, and finally will define its success. The natural tendency to form groups of like-minded people that receives and process information in a specific manner is called homophily, which determines the way people form a network (McPherson et al. 2001).

Now let's consider serendipity, when De Rond (2014) conceptualizes it, he mentions about *matches* for explaining the structure of it. He mentions the analysis of similarities among people as an important factor in the matching process. Although, it is also important to look beyond similarities. Mayer et al. (2010) mentions the importance of rarity when establishing connections. This term is evaluated from two perspectives: general rarity, for determining a specific characteristic from a person in a broad environment, for instance, a biologist in a group of engineers; and contextual rarity, for identifying a person that present a specific characteristic that differentiates from the rest, for example, a person that draws portraits in a group of psychologists. These types of rarities in a group have a stand out effect, hence, it has been proven that people have a preference towards the rarity factor in certain types of matches.

As discussed above, homophily and rarity are important factors in social matching, since they will determine the quality of the connection. Although, the rarity factor can be present in any type of match and the result of it might create serendipity not only in the

encounter, but in the quality of results that can be achieved when working together. For instance, diversity when matching two persons from different fields might lead to innovative results when combining efforts towards a common goal.

Turning now to the question of understanding which factors need to be considered in matchmaking and how they can be weighted for establishing a match. There is a wide set of factors that can be taken into account for a match: personality, context, experience, goals or interests. Therefore, it is important to determine the ultimate goal with the match to determine an order to prioritize those factors.

3.1 Matchmaking Systems

In general terms, a matchmaking system is an automated process that connects people together with different purposes. A matchmaking system increases social awareness, for this study the focal point is to achieve successful collaboration by finding professional partners. There is a wide range of systems that match people for gaming, finding friends and partners. It is important to classify matching systems from different perspectives. Terveen & McDonald (2005) divide them according to their purpose: information needs, in terms of their social relations and a specific need of information; implicit social making, related to finding a specific piece of information and people who can help them when further information is needed; and opportunistic, depending on specific scenarios and common interests.

When talking about matchmaking systems is important to mention CSCW (Computer Supported Cooperative Work) since it aims to create awareness about the information of people in the surroundings. According to Gross et al. (2005) it is important to distinguish a CSCW sociotechnical system with a software system, because the first one emphasizes on the interplay between humans and a computational system. Thereby, a matchmaking system could belong to the sociotechnical analysis of CSCW, because it has the potential to increase the awareness of the people who are around with collaborative purposes.

People connect to their peers to cover a specific need, and there have been multiple studies about systematizing the process of selecting pairs. Pairs that are normally selected among the social circle of a person. The social circle is formed by relatives, friends and strangers. However, it can be expanded to the people that are unknown at the moment, but there is a connection through someone already known. And the focal point of matchmaking will analyze a person's social circle.

As an introduction to the topic, Kutty et al. (2014) insist on the relevance of studying the relation between a person and its network when developing a matchmaking system. Moreover, they mention that the methods for matchmaking are based in psychological theories, social networks and recommendation systems.

Matchmaking systems are based on the small world phenomenon, that sustains that there are a small number of persons that separates two individuals (Kleinberg & Jon 2000). In this context, people can be mapped in order to find a suitable match, since there is already an existing connection inside one's network. Even though a connection might not be that simple to establish. Kutty et al. (2014) presented an experiment to identify significant matches through an online dating example, using a graph mining technique where the matches are found determining compatibility between them.

On the other hand, Constant et al. (1996) insist in the power of weak ties for obtaining information, since they can be "information bridges across cliques of strong ties" and provide new resources to a data collection. Added to that, they present the importance of weak ties due to a higher probability of finding useful information, because weak ties outnumber the strong ties' relations, and the diversity of results that this type of ties can produce.

3.1.1 Finding Data

The main step towards producing a match is information. Nowadays, people is bombarded by information from different sources, and this knowledge is also spread in different places. Forthwith, different methods for acquiring and processing big chunks of information need to be used.

There is a large amount of information that needs to be processed in order to acquire knowledge from the users: data from their preferences, routines, interests, demographics, places and statistics. This information can be obtained from their online behavior, through technological artifacts and information systems. A person's information can be tracked through social media, internet browsing habits and IP geolocation. Begoli & Horey (2012) suggest some methods for acquiring knowledge from big data through: data preparation and analysis, processing structured and semi-structured data, and using techniques from data mining and machine learning.

Machine learning techniques have been explored when producing automated matches. Cassar et al. (2014) present a method for matchmaking by using machine learning techniques such as: Probabilistic Latent Semantic Analysis (PLSA), to determine the co-occurrence of data and Latent Dirichlet Allocation (LDA) to improve the performance in determining latent factors and analyze machine-interpretable semantics, they evaluate the algorithms in semantic service matchmaking.

Data mining in social networks is another field that has already been explored, especially analyzing social network recommender systems and the social influence of preferences between the members of the network for marketing purposes (He & Chu, 2010). However, a social network analysis and social data mining can help to determine not only affinity among people, but it will allow to analyze social mapping.

Another key element in data exploration is visualization. Visualizing information in different forms can lead to identifying several types of findings. On top of that, allowing users to freely explore and navigate through information can diversify the approaches on a specific set of data, which in turn might lead to unexpected discoveries (Beale 2007).

3.1.2 Knowledge Networks

The previous section presented the topic about finding data, now the focus will go towards how information about the people in the surroundings unfolds and how it is structured, which is important when trying to find matches. Understanding the context where knowledge workers interact is relevant to identify the elements and actors that interplay when a network is formed. A knowledge network can be defined as "a set of nodes— which can represent knowledge elements, distributed repositories of knowledge, and/or agents that search for, transmit, and create knowledge—that are interconnected by relationships that enable and constrain the acquisition, transfer, and creation of knowledge" (Phelps et al. 2012). In fact, they group in the term nodes: human actors, technological tools and databases, merging together in a social context to produce knowledge.

Now, Amine Chatti (2012) illustrate the role of an individual in the knowledge network as a unique set of nodes (information and connections) and its own way of performing using those nodes. Therefore, the know-how of everyone is important when forming a group, and every skill might be needed for different purposes. That is why it is important to form a diverse network with people that possess different abilities that can be used in a specific scenario.

A knowledge worker performs in a knowledge ecology, which Pór & Molloy (2000) define as "a field of theory and practice that focuses on discovering better social, organizational, behavioral, and technical conditions for knowledge creation and utilization". A knowledge ecology is the ground for cooperative work to happen where knowledge workers can locate connections, communicate and interact with them.

This brings up the importance of forming a knowledge network that is willing and available for collaborative and supportive work, where different members in the network can beneficiate of the connection.

Phelps et al. (2012) identified some elements in the structure of a knowledge network. First, network position, referring to the social proximity, defined in terms of similarity and social cohesion distance between individuals in a network. Then, ego networks, which is a component often mentioned in social networks as a node or actor in relation with its ties to other egos, known as alters (Everett & Borgatti 2005). Inside an ego network it is mentioned that diversity is relevant for big ego networks, since it has been proven that it increases the individual's production of knowledge,

due to the collaborative work for achieving results in an individual's own area of expertise.

3.1.3 Interpersonal Ties

From a sociological perspective, an interpersonal tie is given by the structure of a social-network. There are different types of ties that are determined by the closeness or the lack of it with the other people on the surroundings in terms of "amount of time, emotional intensity, intimacy, and reciprocal services" (Granovetter, 1973), which is called strength of a tie. A direct relation between two people corresponds to a strong tie and a bridge that connects two groups of people is considered a weak tie. Also, an absent tie is represented by the absence of contact between two people (Granovetter, 1973). The representation of interpersonal ties can be seen in Figure 3.
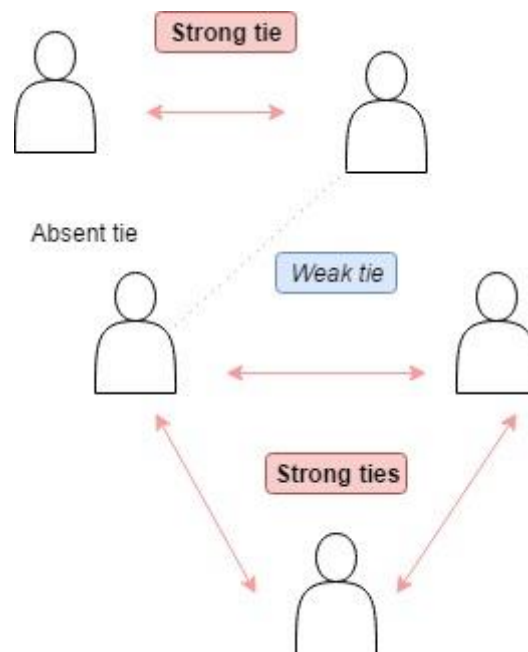
Figure 3. Representation of the strength of ties

Phelps et al. (2012) insist that weak ties provide access to "disconnected partners and thus diverse information". In fact, a weak tie represents a connection to a new social circle, full of new other possibilities for connections. Conversely, a strong tie presents a collection of redundant connections with similar characteristics, that might or might not help in the creation of new knowledge (Perry-Smith 2006).

Perry-Smith (2006) highlight the importance of nonredundant information as it increases the exposure to other perspectives that can lead to potential solutions, when a strong tie perspectives might lead to a confirmation bias effect. Additionally, he insists that weak

ties increase the odds for creativity, since it enables lateral thinking and promote exploring new grounds that will provide new ideas. Forthwith, the relevance of weak ties lies in creating knowledge and enabling creativity for knowledge workers.

Geographic distance between ties is also important, geographic proximity might ease the communication and work process, although, the information transmitted tends to be similar due to the similar grounds in culture and customs (Phelps et al. 2012). Therefore, the distance in terms of location might help to find new approaches to problems and find novel solutions.

3.2 Existing Professional Matchmaking Tools

The idea of using software or mobile applications for connecting people with the purpose of networking in a professional level has already been explored to some extent. Hence, it is important for this study to show some of the existing tools for matchmaking with professional purposes.

The emergence of applications specifically designed to support networking in events has been on the rise on the last years. For this reason, there are a wide range of mobile applications developed to suit this purpose. Table 2 presents some information about the tools that are analyzed.

Table 1. *Tools for matchmaking knowledge workers*

Name	Webpage	Event matchmaking	Country
B2match	https://www.b2match.com/	x	Austria
Brella	https://www.brella.io/	x	Finland
SpeedNetwork-ing	http://www.speednetworking.com/	x	United States
Shapr	http://www.shapr.co/		United States
Betobee	https://www.bebee.com/		United States
Converve	http://www.converve.com/converve-event-networking-software/	x	Germany
Jublia	https://jublia.com/	x	Singapore
Grip	https://grip.events/	x	UK

Xing			Germany
Meeting.gs	http://matchmaking.meetin.gs	x	Finland

The tools mentioned in Table 2 are described in Table 3 to provide a better understanding about the aspects that have been considered in their development. Most of the analyzed tools focus on event matchmaking, which targets meeting other people in a specific event. This has the characteristic of finding other professionals who are carrying out projects related to the type of event, which helps to find connections within a specific area of research. Moreover, the presented tools handle a person's agenda and allow scheduling to attend to the different presentations and meetings in the event. Notwithstanding, this does not add an unexpected or out of the box connection that a serendipitous encounter might bring. Although, it is important to consider events as an important place for match-making.

Table 2.   _Description of the Applications_

Name	Description
B2match	Focused on matchmaking in events, management of an agenda, scheduling.
Brella	Networking application for events, matchmaking based on business needs. Agenda management. Customizable
SpeedNet-working	Enables participants to pre-select the types of people they are interested in meeting, which is based on customized matching parameters
Shapr	Matches based on interests, location and professional experience. Matching based on swiping.
Betobee	Social network for connecting people sharing interests and network based on affinity. It presents different job offers and recruiting options
Converve	Event matchmaking with a customized professional website. Offers integration with social media and LinkedIn and Xing profiles
Jublia	Event networking platform customized for specific meeting needs and objectives of their events
Grip	Combines interests, professional history related to the context of the event, uses algorithms and natural language processing techniques. Learns from every interaction, uses artificial intelligence algorithms.
Xing	Networking platform to find jobs, it has an option for checking events related to a certain business environment
Meeting.gs	Platform to meet people on events that provides a list of matchmaking participants and companies. Handles schedules for meetings

Most of the tools presented in Table 3 are location based matchmakers, leaving aside relevant connections that might be located outside the immediate vicinity. Another factor that those tools consider is interest, professional background and experience for suggesting people. However, it is important to add a more efficient method in order to produce relevant matches. From the presented tools Grip introduce themselves as an "event networking platform" that intends to ease the process of matchmaking in events through AI (Artificial Intelligence), suggesting relevant connections that help people use their time efficiently. The AI algorithms consists in analyzing the common aspects between people gathered from their profiles, interactions from events and groups. Then place that information in a 'container' the more similar items placed in that container produce a match and it is up to the person to decide whether they interact with the other person or not [18]. The algorithm also learns from the previous matches to improve the quality of matches.

From all the tools presented Grip is the one that has a more complex approach for generating matches which makes it stand out from the rest of the tools. The approach that is intended in this project is oriented towards the direction showed in Grip.

3.3   Context-Awareness Social-Matching Systems

It is important to understand context-awareness in the social-matching framework, thereupon, in the following paragraphs those two terms will be defined first to introduce how they interplay.

Context-awareness is a term that is constantly mentioned in ubiquitous computing topics, Guiness (2015) defines it as a "computer's ability to understand the situation or context in which it is operating". This understanding comes in terms of other humans, time and the environment where the situation takes place. Being aware of the context and act correspondingly is an inherent characteristic of human beings. For clarifying the concept let's picture a regular conversation between two people: one person suggests to go to the park, and the other mentions that is raining and does not have an umbrella. Thus, they decide to stay indoors. In this context, two main factors can be identified the weather and the action of going outside, and both will determine the course of action. Now, add that ability of understanding the context to a computational system, and it will gain awareness.

In order to understand the structure of context, Chen & Kotz (2000) categorize context into: *user context*, in terms of its characteristics, location and other people; *physical context,* referring to the characteristics of the environment; *computing context,* in terms of connectivity, technology and communication; and *time.* They insist that if these factors are analyzed the consequence will be a powerful context-aware system.

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[18] https://grip.api-docs.io/1/introduction

Moving on to the second concept, social-matching can be summarized into two words, connecting people. Social-matching systems are presented as the bridge towards that connection, they intend to establish a match in the online environment that could end up in real-life encounters. Now, the circumstances where it takes place can be of two types: a match between two complete strangers or two acquaintances that are not aware about their common interests (Terveen & McDonald 2005). In a social-matching systems contextual factors that can be considered are interests, location, activities, experiences or events. All these factors play a significant role when finding a potential partner.

Now, in the area of matching most of the algorithms try to produce pairs based on similarities, however, when talking about serendipity in social-matching this concept should be taken further. People tend to group with people who are similar (homophily) and reject people who might seem completely different to them. This can be explained by the comfort brought by being familiar with already known things, although, for unexpected happenings stepping out of the familiarity is the first step towards interesting discoveries. Also, McPherson et al. (2001) presents location as the basic principle in homophily, since it is simpler to form a group based on proximity, but highlights the importance of insignificant factors since they influence in the formation of weak ties.

An example of a social-matching system with context-awareness is presented by Lee et al. (2013) who show a tool for forming teams based on the suitability for performing a role in a team, where the roles constantly change depending on the person's ability and time availability. Therefore, the roles and the tasks are constantly adapting to the new needs and change based on the context, which is the perfect example of context awareness in matchmaking.

Mayer et al. (2010) structures the social matching process as presented in Figure 4, where affinity modeling and user interaction show to be dependent on each other. First, in the affinity modeling block, it is necessary to define the user's characteristics for developing a match; then, it presents the selected match for establishing a starting point. This model is presented in a loop where the system collects information from the user to enable a matching process, thus, the elements are dependent on each other.
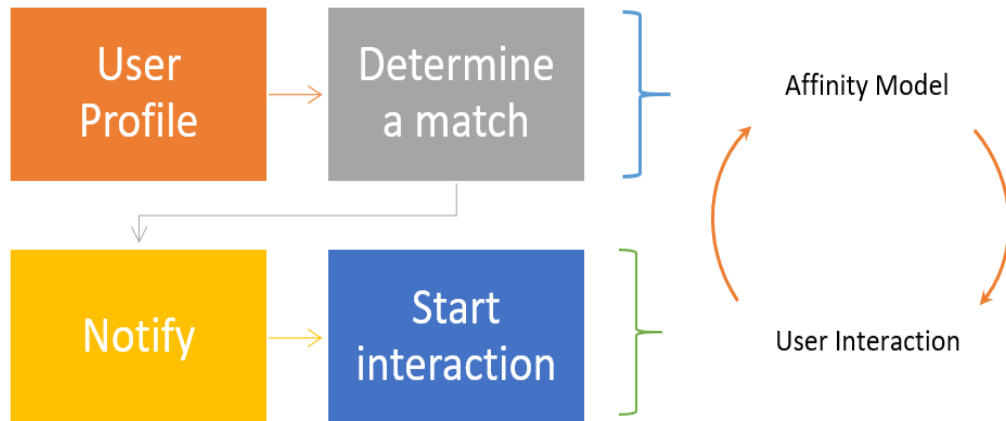
Figure 4. *Social matching process, presented as a loop between the user interaction and an affinity mode, based on Mayer's representation. When there is a notification of a match it will lead to an introduction (user interaction) and a user profile will execute a computational match (affinity model).*

Based on this model a more specific one was presented, as shown in Figure 5, that considers the shared characteristics between the match, context, and rarity to present a framework for matchmaking.

Figure 5. *Mobile social-matching framework based on Mayer's representation.*

3.4   Other Factors that Affect Matching

Terveen & McDonald (2005) present some of them as follows: demographics, a person's background, experience, or profession are factors that have a strong influence when establishing a pair; and familiarity, how close is the match to a known person might affect

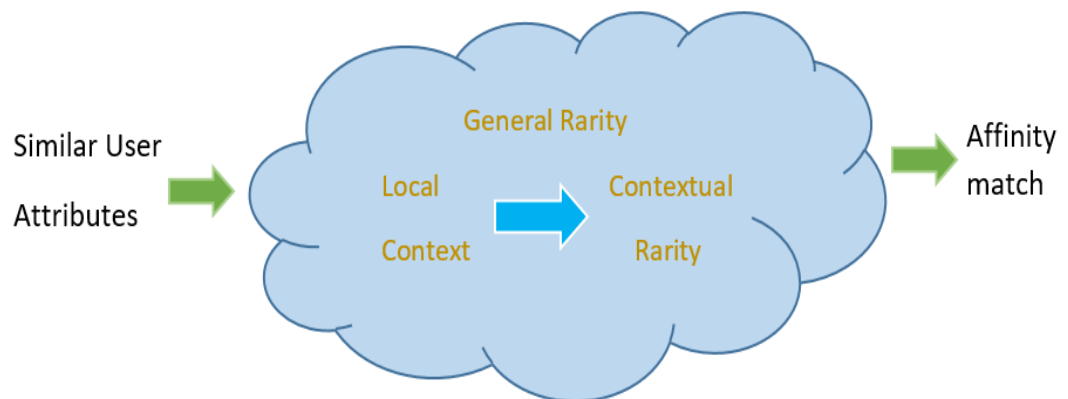the users in determining the suitability of a match. These factors, should be studied when evaluating what people consider relevant in a match.

Another significant aspect is location, in some cases the physical location of a person is important when determining a pair, due to the nuances of the work that they are supposed to perform. However, there are other scenarios where the location might not be of much importance, such as in knowledge workers, because in most of the cases groups can be formed regardless of their location.

Additionally, motivation is relevant in the topic. Although, this brings multiple inquiries about the degree of motivation of an individual to work with a pair, the relevance of the attributes on the pair depending on the type of work, and the inner motivation of each individual to work together. Likewise, motivation is variable during the working process once the matching has been done. For this reason, there should be a good predisposition to get involved into a project.

Lastly, cooperation. It might come from the goal of every individual, and the purpose from participating in a specific work. The willingness for an individual to participate in a task comes from the interest and the relevance of the work for that person. Besides, expanding one's network can be another reason for cooperative work.

3.5   Challenges in Matchmaking

Coming back to the issue presented in the introduction of Chapter 3 there is a lot of space for improvement in matchmaking systems and how to make a system smart enough to determine the factors that make a match relevant for the actors. The question lays in the parameters that need to be prioritized in a specific context. The factors might vary depending on the needs of the users, the purpose of the matchmaking, the environment in terms of time and space Thus, it is vital to define specifically the purpose of the matchmaking process in terms of the user's needs.

A possible challenge could be the user's lack of trust in the results of the matchmaking process. The users could disapprove the matches that the system presents and ignore them completely. Or the users could be reluctant to use a social matchmaking system. One of the reasons for this lack of trust can be random selections or the impression of randomness might evoke mistrust and discomfort in the users. Thus, it is important to evoke trust and invite the users to test the social matchmaking system by presenting elaborate matches based on the user's characteristics.

Achieving serendipity in social matchmaking systems is an ambitious goal that intends to produce more positive encounters than negative ones. However, a large number of irrelevant matches can be considered a burden and overwhelm the user, sabotaging this type

of social facilitation. Thus, the matches that are presented should not be produced aiming for quantity but quality.

Mayer et al. (2015) highlights the importance to find not only relevant matches, but to mediate the connection that enables new opportunities. Nevertheless, they express that there is still a lack of understanding on recognizing "valuable and contextually relevant social matches". Another challenge comes in terms of the methods that are used for evaluating the contextual data (Mayer et al. 2015), which can result in very different set of matches.

3.6 Summary

Establishing matches in order to execute a specific task is something that comes natural to people, and technology can influence positively the way this matches are established. Analyzing knowledge networks and existing matchmaking systems might unfold different elements that need to be considered when aiming to design a matchmaking system. Hence, this matchmaking processes serve as the base to produce a solution that produces a certain type of matches.

The process of pairing a person to another is not as simple as thought, thus, automated systems have been developed to facilitate the process of finding a match. In particular, some factors that need to be considered can be: location, goals, motivation and cooperation. These factors can be considered when developing a solution, nevertheless, it is important to determine specifically what the users want to prioritize when looking for a partner. Therefore, a user study will help to determine the characteristics that need to be taken into account to find a partner, in the case of this thesis, a professional partner.

Establishing a match with another person through an automated system has become more popular in mobile technologies. However, most of the existing application consider proximity as their main source of information for pairing people, thus, the importance of expanding the scope of the aspects when establishing a match.

Many of the tools that were analyzed focus on the possibilities of matchmaking in events. But, they do not use a complex algorithm for matchmaking, they rely on producing a large number of matches and leaving the final decision to the user. But this adds a burden to the person who is using a tool to find matches. In consequence, the time that it might take to find a relevant match increases. Another factor is that the applications focus on the specific location of the user and find suitable matches in their vicinity, leaving aside potential candidates for a match.

Another important issue to be discussed are knowledge networks, defined as the surrounding community that enables creation and transmission of information. The type of connections established around a person can be of two main types: strong ties, referring

to the people located in our vicinity, and weak ties are the ones who are indirectly related to our social circle. When looking to create knowledge both types of ties are important in terms of what they can bring to the exploratory interplay. Most of the mobile applications and platforms that are available in the market focus on strengthening the strong ties among people and a deep analysis of weak ties as potential professional partners has been left aside.

Most matching algorithms are based on psychological and social theories like the small world phenomena, which is used to connect a person to any other person in a wide scope, since those persons might be bonded by weak ties. Machine learning techniques can be used to determine matches and increase the accuracy in them, using different type of data. The availability of information has stopped being a problem, since people willingly share a lot of information through social media, moreover, this big amount of data needs to be processed for creating profiles of users. In fact, the more information processed; the clearer the picture of the user will be and data mining algorithms can help to sort the data.

Social-matchmaking should include some form of context awareness in order to be able to produce relevant matches, and even adapt to the changes that a user might experiment. Thereby, significant results can be achieved by learning from previous matches and the environment.

Nonetheless, the way of determining what is relevant or not for every scenario in match-making remains a challenge. One of the reason is the variability of people's decisions when interacting with others. The following chapter presents a study that aims to understand the experiences of people when forming a group with strangers, and translate those experiences into characteristics that can be used in an automated system.

4. USER STUDY

There is a wide range of applications on the market that match people, however, it is debated if the presented matches are relevant and produce meaningful encounters between strangers. In general terms the existing mobile applications have two approaches: proximity and interests. These mobile applications can go from matching people with events that they are interested (e.g., Meetup), and the most explored and exploited field, matching people with romantic purposes (e.g., Tinder). Nonetheless, the focal point of these study explores a different area, professional networking applications.

Mayer, Jones, & Hiltz (2015) insist that there is potential in matchmaking that needs to be exploited, since the existing applications are rather simplistic and only consider similarity and proximity among people. They question the fact what a system considers to be an interest and its relevance for presenting a match. Therefore, a user study is considered necessary as a tool to gain a better understanding of the interactions in matchmaking and group formation, with the purpose of carrying out projects. Added to an analysis on how the unexpectedness factor takes place and influences people in this context. Analyzing people's choices and reactions when in a group can be approached using different methods, however, for this study the chosen method for collecting information about the way people are grouped is through interviews.

This chapter presents information on how and why the study was conducted. It presents the goals and methodology that was used, and the reasons behind the choices made. Then, it presents the procedure and observations gathered from the study, to conclude interpreting the obtained results.

4.1 Background

Chapter 2 discussed the structure of serendipity and it has proven that connections are important in serendipity. Connecting people to one another can be done in such a way that it looks like connecting the dots of a drawing where the vastness of the dots can lead to different results.

Gaining understanding on people's experiences and analyzing them in a defined environment might help to unveil the needs and expectations of users when finding a match. The unexpectedness factor when meeting someone new to carry out a project involves different types of reactions that might affect or not the work that is being carried out. Moreover, analyzing an environment where the process of matchmaking is executed manually can help to recognize people's attributes and perspectives in matchmaking.

4.2 Objectives

The main goal of this user study comes in terms of supporting the accomplishment of this thesis general goal. Specifically, this user study focuses on the supporting objectives of the thesis, through an analysis of the behavior and expectations from people who have been matched with unknown people. The experiences of working with strangers and being grouped in an unexpected way is what Demola brings to the table. Therefore, evaluating the experiences of participating in Demola might help to understand the expectations of people when grouped with strangers. Also, the unexpectedness of the group encounter might be an adequate environment to analyze the way it enables serendipity.

Demola projects present the necessary characteristics for evaluating matchmaking with professional purposes. They set together a group of different people and give them a certain amount of time to develop a project. Thus, a manual matchmaking is executed by the facilitators given the goals of the project. For this reason, Demola environment allows the analysis of serendipity to enhance knowledge work through innovation projects. It is important to determine the role of the unexpectedness factor when working in a group of strangers and the way it influences the results when working on a project.

Another goal of this study is to understand the way people behave when working in a group when they have not previously met the people that they are working with. Also, to analyze the way Demola matches people with each other, in terms of the aspects that are considered, the manner that matchmaking is executed, and the prioritization factors.

It is vital to identify the priorities of people when working with others, from the people who have experienced Demola. These might help to find the goals and expectations when working with others.

Last, it is important to evaluate the perception of multidisciplinary work and its importance for achieving new and innovative results.

4.3 Procedure

In order to gather the necessary information about the way people behave towards strangers when working in projects, the Demola environment was chosen as a suitable scenario where this type of encounters take place.

Demola presents itself as an innovation ecosystem that connects students, companies and universities to carry out projects. They match people between them to form a group to work on a specific project. Companies propose projects to Demola, Demola in turn recruits a set of students from different universities with diverse backgrounds to participate in those projects. Hence, the group selection is carried out around the project itself. Demola matches people with different skills to carry out the proposed project.

Students from different study fields apply to participate in a project and a group is formed to take care of its development. The group members might not know each other before starting to work in the project and this creates the perfect environment to study the expectations, behaviors and outcomes of working with strangers in an environment that enables serendipitous encounters.

The chosen method for to carry out this study is through interviews, since it is an exploratory research aiming to collect information from people experiences. In qualitative research, interviews are one of the most common methods used due to the richness of the information that is provided. Interviews have proven to explore opinions, experiences and drives of people, moreover, they are more suitable in exploratory research (Gill et al. 2008). In this type of study, the goal is to obtain qualitative information from a sample of people, hence, the type of interview held was semi-structured to allow the interviewees to develop on their ideas.

The first set of interviews was handled to students who have participated in Demola projects, 7 interviews were handled with participants chosen randomly from different backgrounds and projects. The interviews lasted from 18-30 minutes, depending on the participant and the type of experience. The description of the participants can be observed in Table 6.1.

Table 3.   *Characteristics of the interviewees from Demola*

Interview Id.	Study Field	Nationality	Age	Gender	Demola projects
1	Design and Multimedia	Uruguay	21	Female	1
2	Design and Multimedia	Uruguay	20	Female	1
3	Industrial Engineering	Spain	22	Male	1
4	Internet and Game Studies	Finland	32	Male	1
5	Electronics	Pakistan	25	Male	3
6	Wireless Communication	Bangladesh	30	Male	2
7	Software-Engineering	Algeria	24	Male	1

Adding to that, a final interview of 1 hour and 5 minutes with the head of Demola Tampere was conducted. The purpose of it was to gain a better insight on how does the matching among people and the projects takes place. The questions for the interviews are presented on Appendix A.

4.3.1 Limitations

It is important to mention that the chosen environment to carry out the analysis presents some limitations to the study. The main constraint that can be found is the fact that an individual does not choose willingly the people that they will be working with, therefore, this might affect the type of results that will be obtained. The members of the group might have different goals with the project that could clash in the development of it. There could be misunderstandings when communicating a message or struggles to maintain group cohesion.

Another factor considers the relations among the members of a group, which is somehow mediated by Demola, and this might not happen in the scenario proposed by this study. Demola keeps a set of activities that intend to create working bonds among the team members and increase creativity. In a real setting, these activities might not exist and it could affect the type of experience that is perceived once the matchmaking has been done.

Time plays an important role in Demola projects, since they handle short-term projects that can last from 2-4 months. The interactions between the members and with the project itself might be different due to the short time that is given to carry out a project.

4.3.2 Analysis

In order to analyze the information from the interviews, it is divided in three sections: the first one is about grouping and matching, the second one about the perception of the method used and finally about the general environment of Demola as a networking place.

- **Grouping and Matching**

The questions considered in this part are related to the surprise factor when grouped with strangers. The expectations and reactions were also approached in this part to understand how the matching process can be improved and the positive aspects of the way that it is being carried out.

"It is interesting to work with people that have different levels of experience to carry out a project" (Male, 24 years old)

"It is positive to work with people from different backgrounds" (Male, 25 years old)

"If we are all the same and we think the same the result will not be that good" (Female, 20 years old)

All the people who were interviewed expressed a positive sensation when grouped with people who had different skills and come from a different background than themselves.

Also, a relevant part of working with different people that was mentioned was about the learning factor and creating knowledge together, as well as learning from each other as.

"It is necessary to work with people from different backgrounds if we want to innovate" (Male, 22 years old)

"Ideation is far better with people who are different from us" (Male, 32 years old)

"Working with different people forces us to come out of our regular train of thoughts" (Female, 21 years old)

Moreover, some people considered it necessary and an important aspect to analyze things from different perspectives that will eventually lead to better results. Overall, all of them praised the importance of having a non-homogeneous group. This type of reaction can be explained by the lack of diversity in their regular environment. Hence, once a more diverse set of people is brought together, they consider the advantages of having different perspectives to develop a project.

"The best part is that everyone was very motivated" (Female, 21 years old)

"To carry out a project you have to believe in the success of the project" (Male, 30 years old)

"The most important asset in a group is the commitment" (Male, 25 years old)

Most of the interviewees highlighted the importance of being interested and committed to the project in order to obtain better results. One person mentioned creativity and innovation related to interest which shows the things that are considered important in projects. The importance of innovation was also mentioned and a possible way to reach it was provided.

"If you are interested in the project it will make you more creative, therefore, innovation will happen" (Male, 22 years old)

"Innovation comes from doing something you do not do all the time, it comes from changing routines" (Male, 30 years old)

The following comments are related to the unexpectedness factor of grouping with strangers and how it was perceived. Mostly, positive reactions were presented to grouping with strangers. Nonetheless, it was also perceived negatively by some participants and they expressed their interest in working with people they already know. However, the general experience of working and meeting strangers to carry out a project was positive due to the expectancy that it creates.

"It can be scary at the beginning because you do not know the people you will be working with" (Female, 20 years old)

"I worked with people that I would not normally meet" (Male, 30 years old)

"It is exciting when you meet your group for the first time" (Female, 21 years old)

"You do not know what to expect, but it is good in a way. Because anything can happen" (Male, 22 years old)

Demola can enable social serendipity. One of the interviewees expressed that participating in Demola allowed him to work with people that he would not work with in his regular environment, enabling new social discoveries outside one's social circle.

"What I learned is that even stupid ideas can be good ideas! Because they lead to other ideas, until something clicks" (Male, 25 years old)

- **Method**

The second part of the interview included questions about the method used by Demola in matching people with a specific project and how the different skills come together to carry it out.

"The most important part is that you apply for the project that you want to work in, so, you are interested from the very beginning" (Male, 24 years old)

"I like the fact that the people are matched with projects first, and then they meet each other, because in most cases first you gather people and then you choose a project" (Female, 21 years old)

Some interviewees mentioned explicitly that it is important to be interested in the project and to have it as the starting point. However, almost everyone mentioned the relevance of being interested in a project in order to achieve successful results.

"Multidisciplinarity helps to analyze things from other points of view" (Male, 30 years old)

"The fact that I am different in the group and that I do not think the same, I ask questions that might give them different perspectives about it, and this helps to find better answers" (Female, 20 years old)

Multidisciplinarity and a differential factor is always mentioned by most of the interviewees as a way to find different paths to solutions. In general terms, the method to group people first with an idea, shows content from the people who have participated in Demola projects.

One question asked to order the most important factors to work in successful innovation projects considering the relevance of each one of them for the interviewees, and the results are presented in Figure 6. The interviewees considered that the most important factor when working with other people that they do not know is the interest in the project. Followed by skills, personality and finally previous experience.
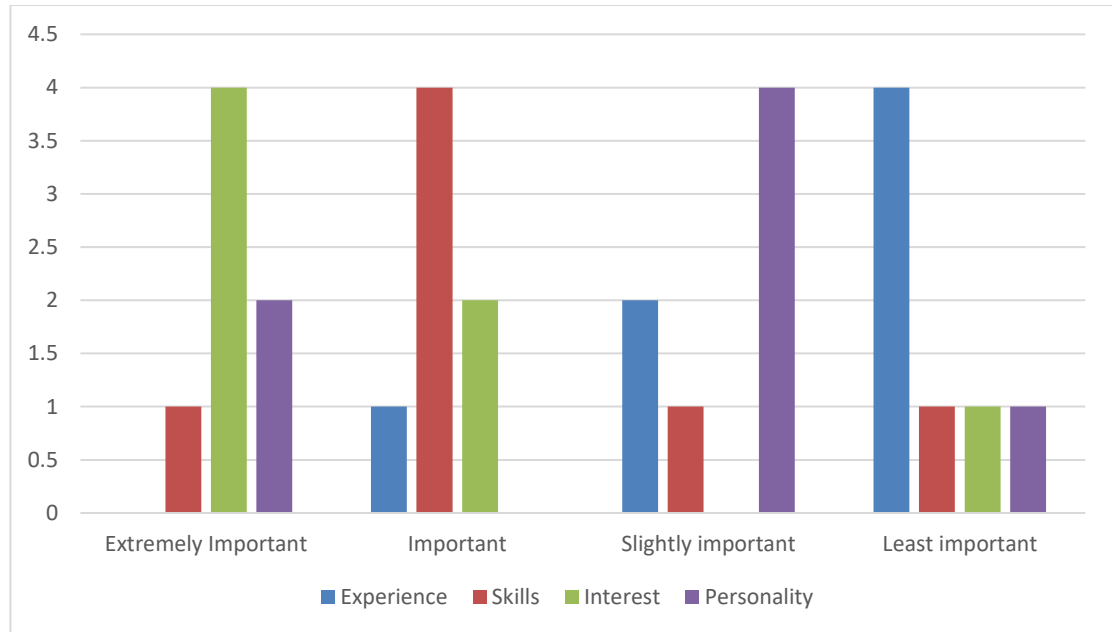

Figure 6. *Representation of the degree of importance of experience, skills, personality and interest according to the interviewees*

It is interesting to see that most of the interviewees prioritized personality over experience, and some of them considered a very important aspect to carry out a project.

"Personality is very important when working with other people" (Male, 25 years old)

- **Demola Environment**

The final questions were about the Demola environment and establishing connections between the groups. Even though, most of the participants mentioned establishing connections with the partners of the project as the most important part of Demola. They mentioned that they found people from different groups that they are interested to work with in the future. The comments some interviewees about future collaborations and connecting to other people are presented as follows:

"I like that you can meet more people from other projects and they can be a potential partner in new projects" (Male, 24 years old)

"Demola helps to create connections" (Male, 30 years old)

"I will work with some people I met in Demola again" (Male, 25 years old)

- **Expert Interview**

In order to understand the grouping and matching process, as well as, the perspective about the projects and how they are developed, the Head of Demola Tampere was interviewed.

First, he explained that projects are assigned to the different facilitators. Then, each facilitator chooses the people depending on the type of project. Therefore, they analyze the different skills required for a project and based on that, the groups are formed, considering the applicant's CV (Curriculum Vitae), any previous experience and their insight towards the project. Once the facilitator has chosen the candidates, the selected group is discussed in a meeting with the rest of the facilitators to get the most suitable combination of skills for each project. However, it was mentioned that when forming the groups motivation is prioritized over skills. The sizes of the teams go from 4 to 6 members to avoid unbalanced workload, since it is considered that some people might leave the project before finishing it.

He added that personality tests could also be considered in the process of forming a group. However, due to the time constraints of each project they do not consider the personality of the members of the group. Although, he acknowledged that maybe for bigger projects personality could be taken into account when forming a group.

It was mentioned that a surprise factor when the teams meet for the first time is necessary to create a different dynamic among the members, moreover, it was highlighted that innovation needs to have a surprise factor from the beginning.

Finally, he presented Demola as a place that facilitates networking among companies and students and students. In fact, there have been cases where some people who met in the Demola environment formed a startup.

4.4 Interpretation of Results

Once the information from the interviews has been collected and analyzed it can be summarized by highlighting some aspects of what it is considered important when looking for a professional partner.

From the interviewees perspective, the most relevant factor when looking for a partner was the self-motivation to participate, added to the skills that will make the project possible to happen. Personality was mentioned as an important aspect for the interviewees and the expert interview also mentioned it as an aspect that could be considered when forming a group.

The interviews revealed enthusiasm towards matchmaking with people from different backgrounds. Hence, a matchmaking system should have this factor of matching people with a more diverse set of skills, that can work together to achieve certain purpose. Grouping with strangers adds a new spectrum of possibilities in terms of results, from approaching to problems to different perspectives to freshen up the ideation process and combining a set of skills and here is where the importance of serendipitous encounters lies.

It is not debated that specific environments ease the process of connecting to other people who might be suitable candidates to carry out a project. Therefore, certain events are a good place for networking and cannot be left aside when looking for a relevant person to work with. Nevertheless, they are not the only way to connect with new people. Added to that, the unexpectedness factor intended to produce a relevant match is pushed aside.

Exposure to a wider spectrum of people might facilitate the process of finding potential partners, therefore, technology should be oriented towards making those connections worth in terms of time and number.

5. SOLUTION PROPOSAL

Serendipitous encounters can take place in the process of looking for collaborators in a project. However, technology can mediate the process of finding partners. The existing applications for establishing connections among people serve as an inspiration for the aspects that need to be considered when designing to influence serendipity. André et al. (2009) highlight that most systems that have been designed with the purpose of facilitating serendipity focus on producing a chance encounter, and leave aside the effectiveness of that encounter. Thus, this project focuses on ways of producing relevant matches in an intelligent manner. The objective is to produce a solution that has the characteristics of a context-aware CSCW. According to Gross et al. (2005) a context-aware CSCW use context to provide information depending on the user's task, this information influences the interaction among people and could increase the effectiveness collaboration.

To emphasize in the importance of serendipity when designing, Lian (2012) mentions that it should be conceived beyond than a consequence of interaction, but it should be placed in the center of it. Creating a space where technology mediates serendipitous encounters to enhance knowledge work should consider multiple aspects in its design. The following paragraphs present a set of approaches to it considering: context-awareness, creativity, visualization, designing to evoke emotions, behavioral predisposition, persuasive technology, the importance of strong and weak ties and multidisciplinarity.

5.1 Considerations when designing for serendipity

As time passes by, more and more elements get involved when looking for serendipity. For example, *context-awareness* is a way to understand the different contexts that encounter can take place. In terms of the user's location, people around, the place's characteristics and time. Thus, using all that information with the purpose of connecting people will help to develop more tailored solutions to a specific segment, which in this case is knowledge workers. Moreover, context-awareness can provide a match based on a specific set of needs in a specific circumstance which might result in a higher quality of matches.

The way *information* is *visualized* when browsing and presenting a match is of great importance. Providing a set of options of people with a different set of skills, might help the user to expand perspectives about their work and research. Therefore, an adequate representation of the possibilities is needed and allowing further exploration among the possible options is vital for the sake of the affordance of the solution. Concepts such as

visibility and affordance are the focal point of the design and should lead the development of the solution.

Norman mentions that a design should evoke *emotions*, and serendipity itself evokes a different set of emotions, emotions that can come from the unexpectedness of meeting people. Although, these emotions can be positive or negative since it creates expectancy, and people react in different ways towards it. That is why, the design of a solution should try to evoke positive emotions related to the expectancy, which could be achieved by presenting a set of characteristics of the other person to establish a match. In this way, the common or relevant characteristics will be highlighted creating a positive reaction towards the match. Moreover, certain terminology can evoke emotions among people.

Technology has the power to be persuasive as a medium and create experiences (Kelders et al. 2012). A *persuasive system* can be used in many different environments one of them is social support, and in this case it should be included as the focal point of it. Moreover, a persuasive system should possess certain characteristics that are considered in this solution, such as: suggestions, cooperation, social facilitation and personalization. Those characteristics are mentioned as vital when looking to develop a persuasive system (Oinas-Kukkonen & Harjumaa, 2009). Since, the goal of this thesis is to influence serendipitous encounters by making suggestions of people to work with, it aligns with the framework of a persuasive system. A way to do it is offering a personalized solution that adapts to everyone's goals, which, favors social facilitation and cooperation among knowledge workers.

Section 3.1.3 already presents and analyzes *weak and strong ties*. Thus, the importance of considering them when designing a solution that intends to connect people and expand a social circle to enable discoveries and professional connections. The purpose of including a social network analysis in the solution is a way to approach a social recommender systems for information needs. In fact, Terveen & McDonald (2005) mention them in terms of producing matches by analyzing people's social relations and specific needs.

Multidisciplinarity enables serendipity in an encounter. Allowing new people in the social circle who possess different skills is a way of diversifying perspectives. In this way, knowledge workers can discover new abilities that can be useful to carry out a certain set of projects. Presenting a different set of people with the most varied set of skills enables multidisciplinary work and harvests new ideas. That is why, new skills might enable different types of results for both parties involved in a match. Thus, this is a way to make the encounter relevant for the people in terms of the contribution to each other and the project. Moreover, it is a path towards creativity. Establishing connections with multidisciplinary people can lead to innovative ideas, since unrelated facts and persons can lead to unexpected solutions.

A ***matchmaking process based on people's expectations and needs***, the user study revealed the factors that people prioritize when looking for a professional partner. Thus, this prioritization should be translated into the way a match is produced. Taking into account people's needs and expectations the quality of matches could increase since it is based on people's perspectives. The matchmaking process should start by prioritizing the factors that people consider important and highlight them when a match is produced. In this way, the user will visualize those factors from the beginning and decide whether the presented match is interesting for them.

Personality analysis from the user study it was mentioned from the interviewees and the expert interview that personality takes an important role when presenting a match. For this reason, making a certain type of personality evaluation and showcasing the results to the users will allow them to understand the type of personality that their potential match possesses and make their own evaluation in terms of compatibility and adaptability.

5.1.1 Establishing a match

It is vital to understand human capabilities and expectations to establish a match. The results from the user study show that people show interests in finding people who have a high interest in project. Since this factor is the most valued one, the match should focus on similar or interconnected goals to produce a match.

From the related tools analysis, it can be concluded that most tools focus on proximity as its main source to produce a match. However, there is a lot of people that can be left aside when producing a match when physical location is a limit. Hence, it is important to leave that option to the user. Technology has allowed successful remote work, or maybe the type of collaboration does not require people to be located in the same area. Thus, it should depend on the user to decide whether they would like to work with someone who is not in the vicinity. On top of that a solution should consider other factors that are more relevant such as weak ties, common interests and goals.

For the previous mentioned reasons, a match should be established according that prioritization***: interest, skills, personality and experience***. Moreover, the solution should contain information about those four factors to be able to produce a match.

The most important part for establishing a match is a ***clear goal***. Goals are important for establishing a match. A shared goal can determine the success of the quality of work once the match has been established. Thus, the user should be able to specify a goal when looking for a match (specify a purpose) or the system can suggest goals based on previous scientific publications and experience in previous works. Suggestion loosely related to the purpose might can bring the serendipity factor not in finding people, but in the type of work that can be carried out.

The final purpose of matching will go further than matching people, but matching ideas and characteristics seeking innovation, when a person shares their goal maybe the idea can be modified and merged with someone else's to produce a new one. Hence, sharing their goals is vital for producing a match

As it was mentioned in the beginning of the chapter there are a series of concepts that can be included when producing a match. For instance, using machine learning techniques that collects user's preferences and previous interactions from the system to produce new and more accurate matches.

5.1.2 Matchmaking Model and Structure

Terveen & McDonald (2005) divide social matching systems in 2 types based on the needs and other based on shared interests. However, it is important to develop a solution that englobes both aspects. Context plays a vital role when establishing a match and a way of approaching the context is by analyzing people's goals.

The following model was inspired by the theoretical chapter and the user study. Establishing an adequate profile that combines the 4 factors mentioned on the interviews is the base to define a matchmaking model. Added to that, the model considers the social matchmaking process presented by Mayer. Focusing on the navigation through the user's social circle, adding emphasis on the weak ties. Figure 7 presents a matchmaking model that contains the aforementioned elements.
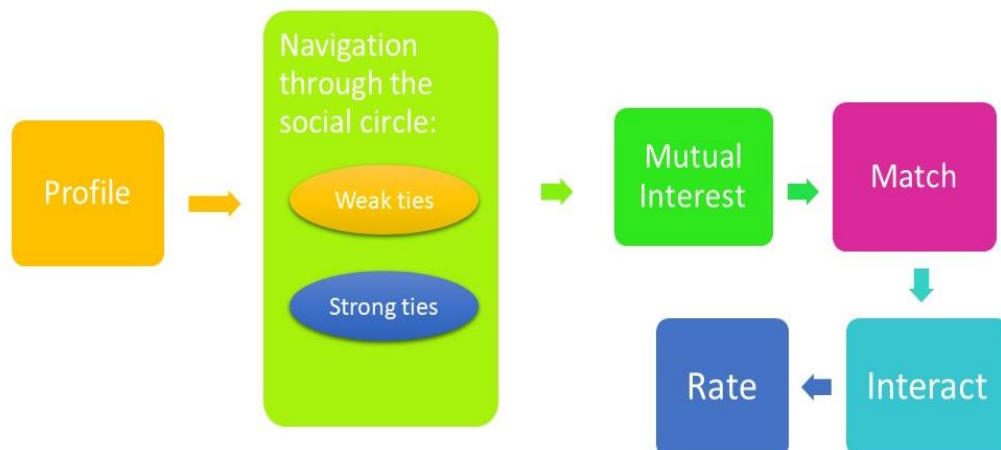

Figure 7. Matchmaking model

This model gives special emphasis to the weak ties in one's social circle as a way to achieve serendipity. Weak ties have the potential to bring a new set of people to interact with. Thus, social serendipity could be achieved through the navigation along the weak

ties. For example, a researcher in botanic can be looking to a professional nature photographer to carry out a project about endemic rainforest plants. This person might not have anyone with that profile among the strong ties. Although, a nature photographer could be found among the weak ties. And this is the intention of this model, achieving social serendipity in knowledge workers through establishing new unexpected connections.

First, it is important to establish a profile that contains information about the user. The information can be collected from LinkedIn, plus any other information that the user wants to add, this will determine the user's skills and experience. Also, the user should establish a goal in order to allow other people visualize it, and identify the interests of each user. Then, a way of analyzing an individual's personality is through a type of context awareness that can be achieved using algorithms to analyze social media behavior and determine the traits of a certain personality. The most important part of the model is the profile, since it will be the base to establish a match that suits the profile in the best way.

Second, a set of people with related goals or interests will be presented. The way these people are selected is by executing a semantic analysis on what is written on their profiles. An algorithm that analyzes the level of relatedness among the words used for each context. A match is established in terms of the goals to determine the affinity and relatedness between them. For example, a profile that contains psychology as an interest will select words that are related: behavioral analysis, health, design for the aging, cognitive engineering. The analysis will be executed among the weak ties in the user's social circle first and will be presented. Then, the strong ties with related goals will be analyzed and presented.

Third, once these people have been presented as the results of the matchmaking process. The user can choose to establish a contact with these people. When there is mutual interest in meeting each other a match is established and they can interact.

Fourth, each user should rate the relevance of the match to allow the system determine the efficacy in the presented results and state the reason why it was not a good match. This, will allow to determine more relevant matches to the user with every use.

This model intends to avoid homophily and focuses on discovering new people with a different set of skills to work together towards a similar goal. Avoiding homophily is another way to achieve social serendipity by connecting people that one would not meet in regular conditions. Creating awareness of the weak ties focusing on associating people with different characteristics might bring the unexpected factor when meeting someone. Moreover, someone with different characteristics might be the complementing match in a professional context.

Mayer's theories for cooperative action are supported by the model presented on Figure 7. First, identifying, by the matchmaking process it enables the user to recognize someone

to work with. Second, meeting again, this can be determined by the frequency of interaction among the match and develop a rate, which can be a way to approach the "meeting again" step. Third, information about previous interactions, by rating the efficiency of the match the system will be feeding by the information provided by the users and learning from the user on every match.

This matchmaking model focuses on finding people among the weak ties with related interests to produce a match. This manner of matchmaking avoids random picks for matchmaking. Random picks have a high chance of not leading to a fruitful professional connection, and can be a burden for the user. A profile that adapts better to each other interest is a way of reducing the probability of a connection that does not lead to a successful relation. Hence, this model intends to consider to the user's needs and interests to produce a more personalized match.

5.1.3 Social Facilitation and Interaction

The considerations and matchmaking model aim to facilitate the interaction among knowledge workers through social serendipity. For this reason, the type of connections and bonds that the design should aim is cooperative and supportive knowledge development. Thus, the design should induce cooperation among the pairs. This can be done through highlighting the goals and skills of the person that has been selected. Once the match has been set, the users are invited to start the interaction by presenting the type of projects that they have been engaged or the possible projects that they would like to participate.

The different levels of engagement need to be considered when analyzing online interaction. Ziden et al. (2009) present different levels of engagement when involved in online activities that affect the behavior of the users. Hence, it is intended to evoke highly engaged or engaged users, due to the importance of the rating once the match has been established. Since, the rate serves as input to produce better and more accurate matches on every use. Another reason to evoke engagement in the users is to expand the social circle on every use. Once a connection has been established, the information about their social circle is connected to the match. In this way, the scope of the possible connections that could be established is widened, bringing a new set of people with every use.

One way to evoke engagement is through a high level of accuracy on the first match. This will evoke trust in the results and invite the users to be more involved. It will also produce the advertisement of the solution and increase the number of users.

5.2 Exploration Prototype

To illustrate how the matchmaking model could be represented. The following figures intend to serve as a possible way of translating the theory mentioned at the beginning of the chapter.

A summary of the profile when a match is presented in Figure7, highlighting the goal of each person. First, the interests of the person are highlighted to allow a clear visualization of them to the possible match. Second, the most relevant skills that the user has selected are presented. Third, the personality is shown by the Big Five Personality Traits (OCEAN). Fourth, the experience of the user is shown.
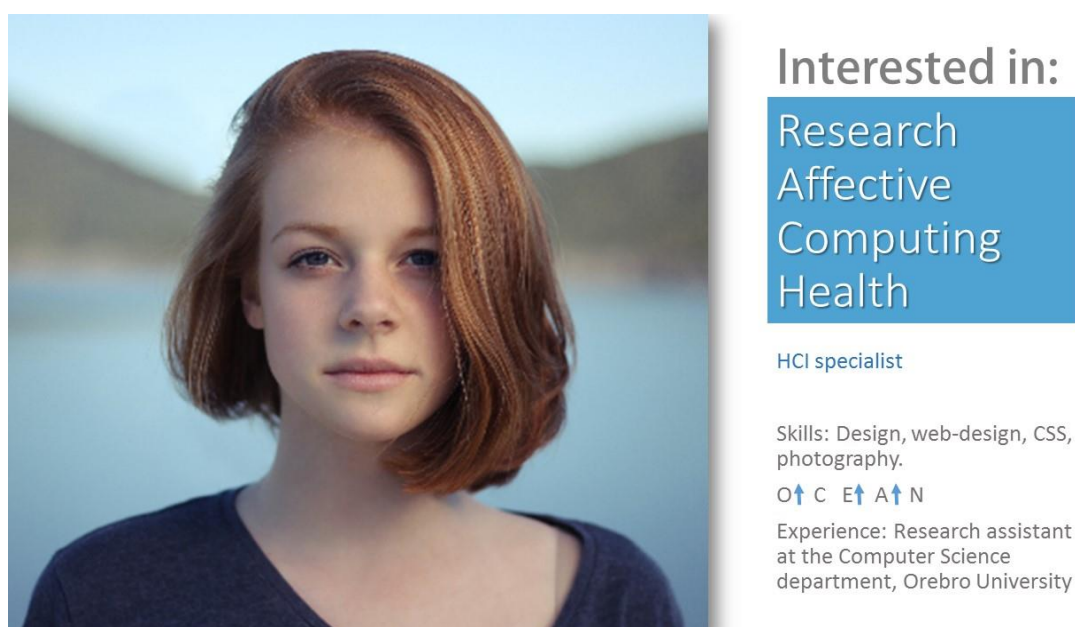

Interested in:

Research
Affective
Computing
Health

HCI specialist

Skills: Design, web-design, CSS, photography.

O↑ C E↑ A↑ N

Experience: Research assistant at the Computer Science department, Orebro University

Figure 8. Profile visualization and short summary when browsing around the social circle.

Navigation through the multiple options to establish a match is important (Figure 8). Because, the user can visualize a set of people displayed around his network, the options that will appear first, are the weak ties that have a related goal, since it is important to highlight the ties that are far from the inner and know social circle. The goals among the users should be compared using an algorithm that group and categorizes them. Then, the strong ties will be presented as well. Figure 8, presents them in a yellow color. Strong ties are important because maybe there is a potential collaborator among one's social circle, they might have skills relevant to carry out a project, that one might ignore or not be aware of.
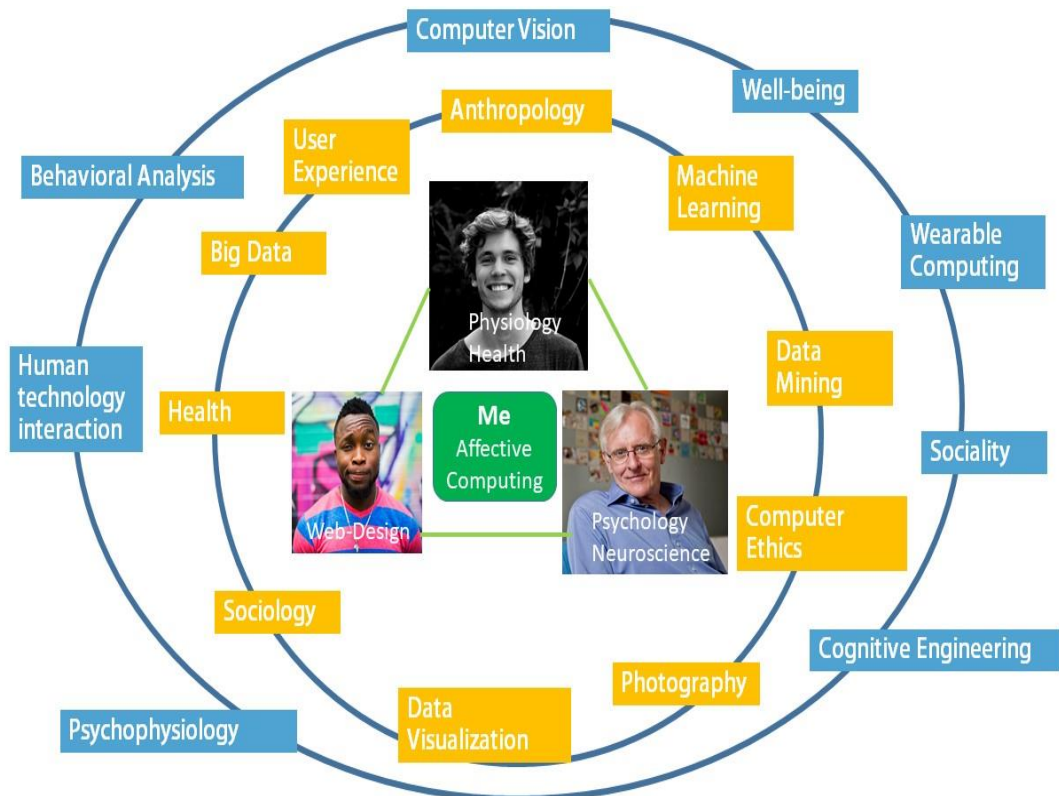
Figure 9. *Visualization of the weak and strong ties along a user's social circle. The weak ties are shown first in yellow and the strong ties in blue*

Figure 9 displays the three more relevant matches, taking into account the similarity and relatedness in goals, interests, skills, personality and experience. Then, the user accepts or not the options that the system is presenting.

The weak ties are shown first, because the intention is to increase the awareness of this people who are normally located further away in a social circle. Thus, a closer representation of them, added to a yellow color intends to catch the attention of the users and invite them to explore the weak ties first. The strong ties which are normally closer are presented further from the user, since the probability of the user to be aware of the them is higher. The strong ties are not eliminated from the social circle because it is not intended to remove them completely from the user's visualization of possible collaborators.
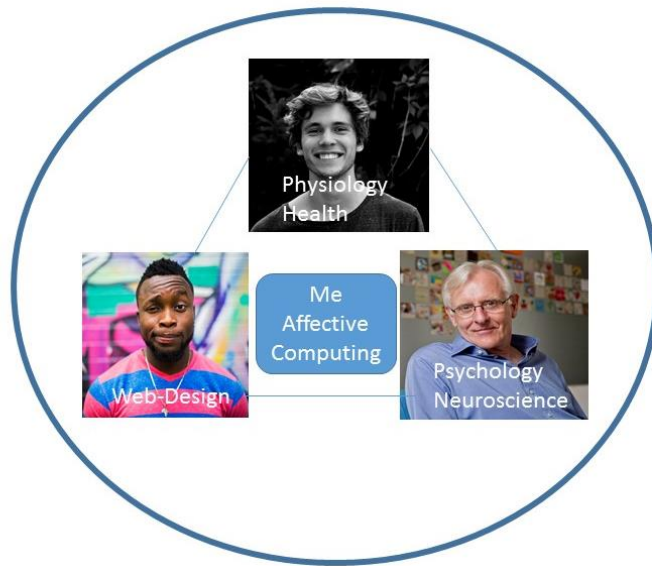
Figure 10. *Top matches for the user*

The user can choose inside the top matches or browse along the circles that were presented. In order to see a more extended profile of the person, the user must click on the person and a larger profile is displayed (Figure 11). To establish contact with another person the user needs to select it. If the other person shows interest, then, they will be allowed to start a discussion between them. Therefore, a match is established, when a match is established it is called *"A handshake",* emulating the action that you do when you meet someone. The handshake highlights the characteristics that make the match good for each other, providing a starting point for interaction.

Once they have established contact and discussed about possible projects; they must rate the quality of the match according to the goals that each one has presented on the profile. This will allow the system to learn about the user and its interactions and produce better matches in the future. The rate is done through a Likert scale system and a feedback about the characteristics that make a good match for each user. This rating process evaluates the user's perception on the match in terms of compatibility to have a fruitful collaboration depending on their individual interests. The system should use machine learning algorithms to browse through the data and provide better matches on each use.
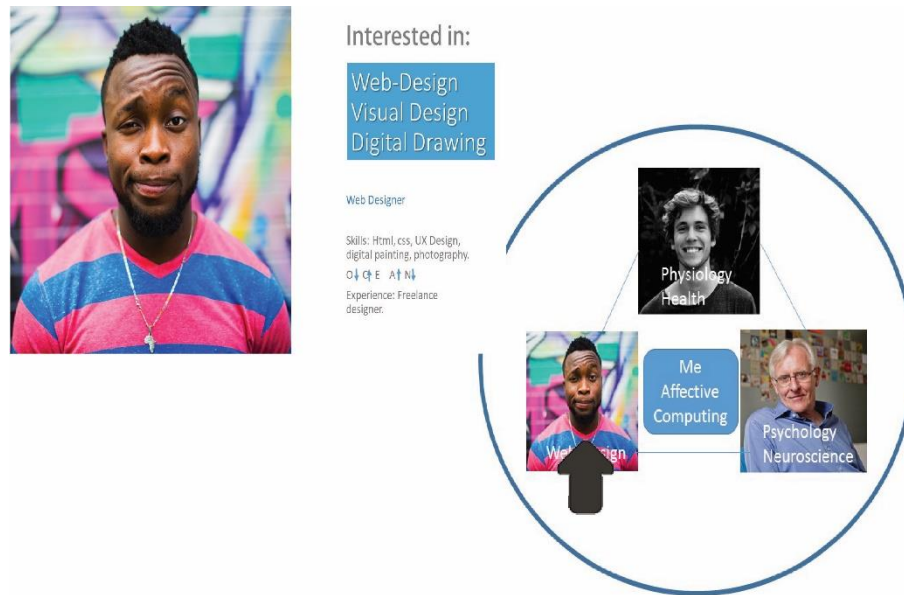
Figure 11. *Visualization of a more detailed profile when one of the selections is presented*

The matchmaking engine will keep track of connections made and will expand the social circle based on it, while analyzing weak ties among the new people added on LinkedIn. This will allow the system to update the people that can be presented as potential matches.

Previously, it was mentioned that it is important to make the encounter significant for both parts. A way to make an encounter significant is through the goals that were established on the profile, people with related goals can complement each other and set a direction for both parties. Effective introduction and profiles are the key to establish a match. Not only because the engine analyzes the type of words used to establish a match, but because it is a way to create interest in a potential match. First impression matters in a computer mediated interaction environment. Selecting effectively the words on the person's profile will determine if the other person is interested or not, and it will define the beginning of a connection. The semantic analysis will highlight different characteristics on a person's profile for different people. The system will select and highlight the relevant aspect for a match according the relatedness among the profiles.

The focal points of the design presented is the visualization of weak ties. This is because, it is within the weak ties that unknown people are located and one is less likely to establish contact with them. Creating awareness of related interests among the weak ties can help the users to identify collaborators and possible partners in future projects. The strong ties are also important, but they are presented after the weak ties, since the focus is on the weak ties to expand the options of new people to work with.

In section 5.1.2 avoiding homophily was already mentioned as a way to achieve social serendipity. Now, multidisciplinarity is a way of avoiding homophily people with different skills from different backgrounds increase the possibilities of achieving innovative

results. This model emphasizes of multidisciplinarity on a match, the model selects people based on the interest they have. Hence, people with different characteristics can have a related goal. The matches are not produced based on the similarity of their profile, but the relatedness of their goal. For example, Ann is interested in cryptography systems and the match that is selected for her has an interest in Game theory. Those two interests can be related in terms of the mathematical algorithms, which can be produced when using game theory for cryptography systems.

Different disciplines can take the development of a project to a possible new direction and bring different perspectives about an idea. The matchmaking engine should take the interests of the user and use an algorithm to identify and categorize terms and application fields that could be related. Thereby, the engine will possess context-awareness characteristics that fit that will improve the user interaction by being highly personalized and adaptable.

6. DISCUSSION

This section presents a set of lessons learned along the way of the development of this thesis. The first theoretical chapter are the pillars to construct this research work. It is important to set the building ground through concepts and previous work in the area, which brings a better understanding of the intention of this project.

The user study was carried out in order to collect information about the needs and expectations of people when working with complete strangers. The purpose of it is to develop some design implications that can be used to enhance knowledge work through unexpected encounters. This study allowed to determine and prioritize four factors: interest, skills, personality and experience as the presentation

The theoretical framework and the user study analysis served as sources to develop a set of guidelines to influence serendipity among knowledge workers. These guidelines were translated into a prototype presented on Chapter 5. The first part of the chapter describes the guidelines, a model for matchmaking and finally presents a possible design.

6.1 Reflections

At the beginning of this project a main goal was set along with two supporting objectives, which were established as an inspiration and leading parameters for this research project. This section will explain how they were approached and to which extent they were fulfilled.

First, *"Discover a way to enable serendipitous encounters among knowledge workers"*. Chapters 2 and 3 explain serendipity from different perspectives, they analyze the term and decode it into instances to make the term more understandable, despite the abstract concept. This understanding is necessary as the basis to understand serendipity among people. Conceptualizing it as a common term in information technology enables innovation and new discoveries, which can help to prompt encounters among people who work with information. Chapter 3, focuses on bringing people together and how to structure the process of matchmaking people with a specific purpose. It decodes the structure of a knowledge network and its elements to illustrate what needs to be considered. All in all, these chapters set the starting point of the research and achieve the first supporting objective by providing the first source of information to develop a solution.

Second, *"Understand the circumstances that will enable an encounter to be successful from the user's perspective"*. The user study intends to provide an answer to this objective by a set of interviews to people who have been involved in innovation projects with strangers. Their expectations and needs from their experience in developing projects help

to identify the factors of a successful encounter that lead to future collaboration. It provided good insight about the openness to multidiscilinarity and set the prioritization factors that should be considered in matchmaking. However, the user study can only serve as an example of a possible way to enable better encounters, but the true circumstances in the real world still need to be proven. Specifically, the user study did not provide definitive answers about the circumstances that make an encounter successful. The reason of that could be the environment where the user study was carried out, and even the qualitative study could be changed to a quantitative one. Expanding the research to a more opened environment where the interviews are held to a wider audience could provide a better understanding of the conditions that enable encounters to be successful. In general terms, the type of answers that the study provided were related to the expectations when matched with other people, more than about the circumstances. Thus, the user study was still relevant for the main goal of this thesis.

The two supporting objectives intended to approach the main goal. *"Propose design implications based on the understanding of the phenomenon of social serendipity, through a study of people's expectations in matchmaking for professional purposes".* Chapter 5, presents the interpretation of previous chapters through a set of aspects that should be considered when designing a solution, along with a certain structure. Also, it presents those elements translated into a prototype of a possible solution. The main goal of this project was achieved with the help of the supporting objectives and this thesis is the result of them.

It can be concluded that the main goal was achieved. Even though, the second supporting objective was not achieved in the way I would have expected. Nevertheless, it provided a different type of information that served to understand people's expectations. It did not help understand the circumstances to make an encounter successful, but it provided an insight about the expectations and reactions of the users towards grouping with strangers. The objectives served as the pillars of the thesis and the development of it is a way of approaching the main goal. However, it is important to mention that there can be different ways to approach them. This thesis is a personal vision on how to approach the main goal.

The contribution of this thesis to field of Human-Technology Interaction and User-Design is through a set of implications that can be used as the base for a design using an abstract concept such as serendipity. The focal point was always understanding the user's needs and expectations as the base for the design.

6.2   Conclusions

Serendipity is not a common or specific term. A lot of authors conceive it from the most varied perspectives, and it seems to be present in different areas. It has been widely debated about a sort of "controlled serendipity" environment, since it destroys one of the conceptions of it. Therefore, maybe the term "controlled serendipity" can be changed and

converted into some factors and conditions that will enable the occurrence of serendipity. That is why this thesis presents a research and a set of actions that can be consider to influence serendipity.

Serendipity can happen when an unexpected connection is established. This thesis considers weak ties as a manner of evoking unexpectedness in an encounter. And weak ties analysis in matchmaking can produce these unexpected connections. Knowledge workers need to freshen up their perspectives and ideas for the sake of innovation. Thus, weak ties and unexpected encounters can enhance knowledge work by diversifying the group of collaborators when carrying out a project.

Moreover, trying to connect people with professional purposes among a group of strangers who in regular conditions would be ignored, can support the quest for collaborators. Most of the existing tools are based in connecting people in terms of physical proximity, however, there is still a wider spectrum to be considered for establishing a connection. This thesis does not consider physical proximity as the base for establishing a match. In fact, it ignores the location and focuses on related interests. Information communication technologies have allowed to overcome the distance difficulties and they allow to have remote work and collaboration.

The matchmaking model intends to produce personalized matches and avoid random picks. Hereby, there is a better chance to have a fruitful professional relation. Most systems intend to produce a large number of matches leaving aside the quality of it. In professional matchmaking, it is better to produce a personalized match, since the goal is to enhance knowledge work.

A revelation in this project is the importance of personality not only for serendipity itself, but for establishing a professional relation. In the theoretical chapters, personality was mentioned as an important component to enable serendipity. Individuals with a higher score in the Openness to Experience element are prompted to experience serendipity more often than other individuals. Now, the user study revealed that the people who experienced grouping with strangers prioritize personality over experience. Maybe this fact cannot be generalized, but it implies that there is a segment that prioritizes personality when carrying out innovation projects. In fact, they highlight the importance of personality when selecting a professional partner.

There are several methods for assessing personality and combining them in a professional environment. One way to analyze this topic is through P-J (person-job) fit theory which evaluates the compatibility of person's personality for a certain job characteristics (Edwards 1991). P-J could be combined with the trait activation theory which mentions the influence of certain personalities in the behavior of others (Tett & Burnett 2003). Both theories can be the base to fathom on a personality study to establish professional connections.

The nature of the projects in Demola are proposed by external parties and this is a very common project scenario. Therefore, choosing Demola as the place to carry out the study represents a sample of the conditions in which a project is held. This can be considered as a way of validating the obtained results as a representation of the public and potential users.

6.3   Future Work

Since this research project focuses on analyzing the factors and developing a prototype it should continue the UCD cycle, testing and evaluating the prototype and continue an iterative process. Thus, user testing should be the next phase of this research.

The user study could be expanded with the obtained results. Especially, the personality relevance in professional matchmaking. A compatibility analysis among the different personalities can be used to evaluate the success rate of a professional connection. Moreover, it can be combined with a trait activation theory investigation to increase the success rate in the matches.

Moreover, optimizing the matching algorithm once the prototype has been tested and used, could be the immediate step for this thesis. Redefining the matches in terms of complementing the skills and expertise of the users can lead to better connections. The algorithm can be optimized adapting for specific needs by establishing a specific purpose when searching for a partner.

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APPENDIX A: QUESTIONS FOR THE INTERVIEWS

This appendix includes material used in the user study. The interviews were semi structured interviews, thus, some questions were improvised depending on the answers of the participants.

A.1 Interview to Demola Participants

The following questions regard your experience from participating in Demola's project. The questions are about your experience in the group formation and the team work.

- How do you feel about grouping with people from different backgrounds?
- What was the best part of working in a multidisciplinary team?
- Would you prefer to connect with people from a similar professional background or with people from a different background but with skills relevant for a specific project? Why? (Explain your answer)
- How important is a multidisciplinary team for an innovation project?
- From your experience which other factors need to be considered when forming a group? (personality, skills, interest, experience)
- Is there something that will make you remember the experience a specific factor?
- Do you think that different points of view could lead to better results?
- Will you work with these people again? What will make you work with them again?
- Do you think the demola environment suits the purpose creating connections? And how?
- What is the most important factor when trying to innovate?
- What do you think about matching people with a project?

A.2 Experts Questions

The following questions intend to gain a better understanding about the group formation, member selection and the group work:

- How do you form groups, is there a particular way of forming them? Do you have any specific guidelines to follow? What are those?
- What is a good team?
- What makes a strong application to participate in Demola?
- Why is it done in that way?
- How efficient has that method proven to be?

- Does the way of grouping influence success?
- Is interdisciplinary work taken into account?
- Working with people from different backgrounds can lead to challenges what are those?
- What factors influence for the group to cooperate?
- What might lead to people leaving the group?
- What strategies do you use to make the group bond together?
- What are the most common problems that groups have?
- When the groups meet it is a surprise to them all, do you think it is a good thing that they do not know each other?
- Does the unexpectedness factor in groups influence success or failure in the groups?
- Have you seen the likelihood of people to work together after demola? How often does it happen?
- How do you choose the best project? What factors do you consider in it?
- Innovation is important in demola projects how do you try to guide or lead to innovation?
- Is it common from people from other groups to spot each other and form future projects together?
- Do you consider demola as a place that enables networking? How does it enable networking?