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Designing a User Interface intended for Winemaking

Preserving meaningful activities when introducing new technology

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Abstract

When designing a monitoring system for winemaking, the user interface plays an important role in creating an effective flow of information between the monitoring device and the user. This thesis explores how a user interface for winemakers can be designed to present data effectively, while ensuring that the meaningful activities of the winemaking process are not lost. The objective is to identify which activities are considered meaningful among small to medium-sized winemakers and keep them in mind when designing a suitable user interface intended for the fermentation process. Hopefully, the interface will also improve and streamline activities performed during the fermentation process. The research is based on a case study in which a continuously measuring device serves as the platform for the interface. The main findings from this research indicate that an application, together with a small screen on the measuring device, would be an effective way of delivering data from the device to the winemaker. Meaningful activities such as tasting and smelling the wine should be preserved when implementing new monitoring techniques. The research is mostly conducted through user studies performed in Italy and Sweden.

Acknowledgement

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1 Introduction

Chapter one briefly explains the motivation and background of the thesis, along with its aim, goals, objectives and delimitations.

1.1 Motivation

The history of winemaking spans thousands of years, with activities dating back to ancient civilisations such as the Greeks and Romans. Ever since, winemaking has been considered an art form, taking its starting point from traditions, culture, and a connection to the land. The winemaking process is a balance between intuition and science, requiring attention to the interplay between chemistry, soil, grape varieties, and different winemaking techniques [Cavicchioli, 2018].

Today, measuring equipment is used to control the winemaking process from grape harvest to bottling. Despite current equipment, acquiring a consistent quality in the production is still considered a difficulty, since a great variety of parameters affects the wines taste and characteristics. Choices that are made during the process will have a great influence on the outcome. With new monitoring technologies, the outcome could potentially be more consistent and predictable, and prevent the wine from failing.

If new monitoring technologies are introduced to the market, there is a need for an effective way to deliver measured data to the user through a user interface. Inspired by the craft and traditions in winemaking, as well as the article *Slow Design for Meaningful Interactions* by Grosse-Hering et.al. 2013, this thesis research questions is introduced. The research questions is an exploration on how to maintain meaningful activities, when creating a user interface intended for the fermentation process. Preserving experienced meaningful activities may ensure that the essence of winemaking is not lost amidst advancements in technology and automation. The intention behind this is to promote the usage of monitoring devices housing interfaces in order to reduce time resources, and prevent waste of wine.

The thesis begins with a brief overview of two monitoring technologies that could be applied to the winemaking industry. Later on, user studies are performed to conduct qualitative data, used for establishing design principles for the interface. Finally, a monitoring concept incorporating one of these technologies is used as a case study for designing the user interface.

1.2 Background

This thesis is a part of a larger project, exploring the potential of two pioneering technologies funded by the EU's Horizon 2020 Research and Innovation Programme and ATTRACT EU. The technologies in question, named PIPe 4.0 and Unicorn DX, are still in development and not yet available for purchase. They are not originally intended for winemaking, but previous research has found that the techniques could be applicable within quality monitoring in beer and wine industries. PIPe 4.0 is the result of a project based in Padua, Italy. The project strives to utilise photonic- and nanotechnologies in order to construct a product containing a sensor capable of precisely measuring gas compositions inside of a pipe [Pietro Fiorentino, 2023]. Unicorn DX is a technology developed in Twente, Netherlands. The system is able to detect biomarkers via a "lab on a chip" system. The main idea is that a contaminated specimen is presented to Unicorn DX, whom in turn identifies the

biomarker and presents it to the user [ATTRACT, n.d.]. Furthermore, Unicorn DX is currently not approved for medical use, hence it would be advantageous for ATTRACT to implement it in a product while awaiting approval in order to potentially generate income during the interim period.

The larger project includes eight design and product development students from Linköping university. The primary objective of the project is to create a concept (referred to throughout this thesis as the ”project concept”) using the new techniques, applicable to the wine or beer industry, and then build a prototype using placeholder sensors. The prototype includes a physical monitoring product with a user interface. The project has been divided into three separate bachelor theses groups, those being *business viability and acceptability*, *design of the sensor containing product* and *Designing a User Interface intended for Winemaking*. The business and viability group's main focal point lays in the users perceived value of the product and to what extent it is accepted by wine makers. The group responsible for the design of the sensor are in charge of designing the physical project concept to the point where it is realisable as well as functioning. The final group, namely *Designing a User Interface intended for Winemaking*, are responsible for designing an appropriate way to transfer information from the conceptual product to the user. The project concept in question is presented in figure 1, and is a pump device operating during the fermentation process, continuously performing measurements. Furthermore the concept includes a Unicorn DX function, allowing the winemaker to take samples from the fermentation tank and present it an external Unicorn DX device, to identify different yeast species in the wine.

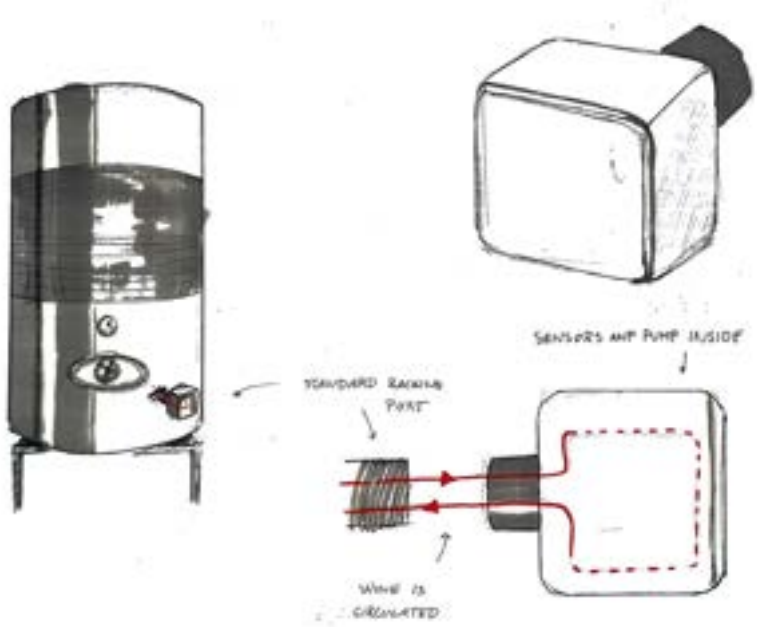

Figure 1: The project concept for which the interface should be designed. The concept is operating during the fermentation process.

1.3 Aim

Since winemaking can be considered both a craft and an art form, there might be a risk of removing activities that encourage the winemaker to make wine when implementing new technologies and streamlining processes. The aim is to promote the use of monitoring devices, so that the fermentation process in small to medium-sized vineyards can be more efficient in various ways, while preserving meaningful activities associated with winemaking. Hopefully, that will make the monitoring device and its user interface more desirable.

1.4 Objective

The objective is to establish design principles and design a user interface intended for the fermentation process, using a case study. The interface should deliver data to the user from the project concept. The user should be encouraged to use the monitoring product in the fermentation process.

The objective is reached through the exploration of the following research questions:

1. **Which activities are widely valued as meaningful in the winemaking process?**
   The purpose of research question one is to gain deeper knowledge of what the user values in the process of making wine, and understand how the activities/processes could be improved or streamlined with an interface without removing these meaningful activities. This RQ also aims to explore the winemakers attitude towards using new technologies.

2. **What might a suitable interface look like in order to maintain meaningfulness?**
   Research question two aims to determine how an interface can be designed based on the information gathered from research question one, i.e while maintaining meaningfulness.

1.5 Delimitations

Limitations are mostly related to the data collection. User data are only collected from Swedish and Italian winemakers hence the result may not reflect other users. The samples in the thesis are chosen on availability. Given that the research takes place during early spring, observing the workflows and actual process of fermentation is not possible. Consequently, the thesis is not featuring observations made during production, and lacks that point of view. The research focuses on winemaking, but the result might have capability to be used in similar industries, such as beer brewing.

2 Methodology

Chapter two introduces methodology used in the thesis.

2.1 Methodology structure

The research approach is based on both user studies and literature reviews. The first step in the process is to gather and review existing knowledge on the topic, and to meet the users, i.e. winemakers, for the initial design research. The objective is to grasp the context of use and understand the business requirements. As emphasised by B.-N. Sanders and Stappers [2020], it is crucial to explore the research area at the onset of a generative design project. In this report, this is accomplished through preliminary field observations, interviews with winemakers, and a literature review.

By collecting qualitative user data, meaningful activities and design principles for the user interface can be identified. These are then applied when designing a user interface for the project concept. Lastly, a test and verification plan is presented, but not expected to be performed due to time limitations for the project. The overall methodology is presented in Figure 2.

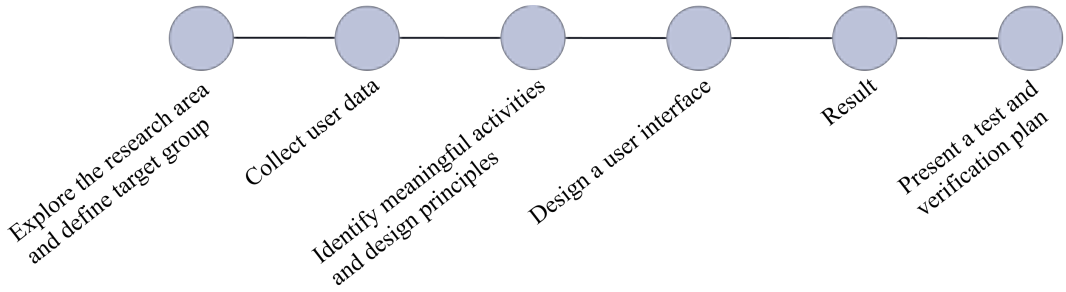

Figure 2: Flow chart of methodology.

2.2 Literature study

To gather information on usability, human-machine interaction and traditions in the wine industry, previous research is used. The keywords used in the secondary research is presented in figure 3. This literature review provides an overview of the current knowledge on interface design and user centred design, offering insights into how the user studies should be conducted in this report, and what the features on different devices should or might look like. It also provides domain knowledge and vocabulary used when talking to the users and doing the observations. The keywords in Figure 3 are used both as search strings and as individual search words. The literature review was conducted between January and April, and the search engines used are Google Scholar and Unisearch.

	Area		
	Winemaking	*User studies*	*User and computer interaction*
keywords	Winemaking, technologies in winemaking, winemaking process, wine quality, wine traditions, vitivulture, white wine, red wine	Semi structured interviews, interaction design, UX, Personas in design, Observations	Interface design, UI, cognitive science, HCI, usability, UX, Information architecture, graphic design

Figure 3: Keywords used in the literature review.

2.3 User studies

To collect qualitative data, user studies are conducted, playing an important role in describing the winemakers needs, desires and goals. This subchapter presents the methods utilised for the user studies.

2.3.1 Observations

User observations is an important part of understanding how winemakers perform their tasks. It is also used for identifying unspoken problems or areas for improvement, as well as uncovering habits and behaviour of the user that may be important to consider [Arvola, 2014]. The observations in this thesis are performed on vineyards, mainly in the winery where the wine undergo pressing, fermentation, ageing and chemical analysis. According to Mattias Arvola [2014], 5 to 10 minutes is a good time for observations if you are going to examine a specific detail in the user's behavior. Depending on how much the winemaker speaks and wants to show, the observations varies in length.

Arvola also notes that, when performing a field study, there are some important things to note and observe. Firstly, it is important to write down and note various facts and observations. Additionally, it can be helpful to note what works well or less well, as well as things that are especially important to consider. This is done continuously during the observations conducted in this research. Considering the research questions, it is particularly important to note the winemakers attitude during the observations, as the goal is to find what is important or meaningful for the winemaker.

As previously mentioned, the research is conducted off-season. Therefore, the user observations focus more on observing the types of measurement equipment currently in use and the appearance of the labs and wineries, rather than the specifics of how their tasks are performed. How the interfaces and information flows in the labs look like and works are also of importance. The users are asked to provide guided tours of the lab and winery, while encouraged to freely discuss their processes. Spontaneous questions are also asked during the tour.

In the beginning of the research, the focus is primarily on understanding the entire process of wine making, and here observations are a very useful tool. However, as more knowledge is gathered, observations increasingly focus on fermentation, and the details of how users interact with current measurement equipment during the fermentation process, since the project concept is designed for fermentation tanks.

2.3.2 Interview study

In his book, Arvola provides many tips on how to conduct interviews and gives examples of how questions can be formulated and which questions should be avoided. A poorly asked question is leading and closed, which can lead to a misleading answer. A good question is on the other hand not leading and allows the user to speak freely about what is important to them. Arvola also mentions the importance of the question ”why” in order to encourage the participant to delve deeper into their experiences. There are also some tips on how to keep a participant who tends to become quiet to keep talking. This can be done by, for example, repeating and rephrasing what has already been said and adding a clarifying question. It is also good to start an interview with some lighter and perhaps less serious questions to help the participant feel comfortable [Arvola, 2014].

A crucial part of an interview and an observation is what happens afterwards, analysing the data. This should be done as soon as possible after the study has been conducted while it is still fresh in the memory. There are various methods for this; one of them is to use post-it notes on a board and group different observations made by different individuals, then categorise them to create some structure [Arvola, 2014].

2.3.3 Workshop

With the aim of getting to know the winemaker's needs better, a workshop is planned using the results of the interviews as a base. The goal of the workshop is to acquire knowledge about how the winemaker prefers to interact with an interface, in what format measurable parameters should be displayed and how the winemaker wants to be notified in case of non satisfactory measurements.

2.4 Producing interface concepts and design solutions

To define the target group, the user research result is used to create a persona. The persona is intended to provide a common description and perception of the target group in this thesis and the larger project. The results are also utilised to generate ideas for which interface concept would be suitable for the sensor-containing product. A test and verification plan is carried out using the System Usability Scale (SUS) method, but this thesis does not cover the result from it.

2.4.1 Using personas in design thinking

According to Cooper [2014] and the Goal-Directed Design method, personas are used as a powerful tool. The persona is an archetype of the user that should represent the empirical data collected in the field. In this research, the persona is primarily based on the interviews. The persona is given a name and a face, is described through needs, tasks, and goals, and is based on the behaviors, experiences, and motivations of real users [Tidwell, 2020]. The persona aims to represent the user throughout the design process and can simplify for the design team by providing a common description of users, as a design and communication tool. Instead of referencing to the users, the design team can refer to the single persona, as if it was a real person. Incorporating personas into the design process is crucial, ensuring that the entire design team is familiar with them and understands how to effectively utilize them [Blomquist and Arvola, 2002].

2.4.2 Idea generation

Brainstorming is utilized extensively across the project to encourage the generation of interface concepts and ideas, with particular emphasis placed on its role during the concept development phase. Several different methods are used, including storyboarding and brainwriting. Storyboarding is a method where a scenario is described, and a problem is presented. Various solutions are then sought based on different requirements set by the session leader. Another type of brainstorming is brainwriting, where various problems are formulated on a whiteboard. Members are given a certain amount of time to write down all ideas that come to mind on post-it notes, which are then collected and sorted based on the most frequently mentioned.

2.4.3 The System Usability Scale method

When doing a usability test, one commonly used method is the System Usability Scale (SUS), which was first presented in 1986 by John Brooke [Jeff Sauro, 2011]. Sauro describes the SUS method as reliable even for studies on smaller groups of users, which suits this research, since the target group is relatively hard to reach. The method is a question-based test, where ten statements are presented to the user on how the system was experienced. The user can then chose on a scale of one to five how strongly they agree, with one being ”strongly disagree” and five being ”strongly agree”. As it is question based it would also be possible to do the test remote, as long as the winemaker has access to the protoype. The author of this article, Jeff Sauro, proceeds to describe how to score the results and states a good result to be over 68. Even if the test scores are on a scale of 100, it is not a percentage. As an example, a score above 80.3 would be in the top 10 percent [Jeff Sauro, 2011].

2.4.4 Honest feedback

Nikki Anderson [2022] from the user research company describes in her article how to ensure getting honest and constructive feedback from users. She points that one way to present the concept to encourage the user to express their thoughts candidly is for the presenter to distance themselves from the design and make it as impersonal as possible. This can make it easier for the winemaker to criticise the product without feeling like they are criticising the person who designed it. Presenting the interface concept as something ”quickly put together”,and emphasising that most things can still be changed without any problem also makes it easier for the user to comment on minor details they might otherwise have kept to themselves.

Another important method is to ask many follow-up questions and inquire about the user’s thoughts, reasons, preferences, or why they consider a specific feature good. This also includes asking the user to elaborate on their answers, using phrases such as ”explain what you mean by...” [Nikki Anderson, 2022] [1].

2.5 Generative AI

Generative AI has been used in the thesis to correct grammatical errors and translate Swedish to English. It has also been used to assist in generating search terms and keywords to find relevant sources.

[1] This chapter is taken and slightly modified from the larger project [Gunnar Berg et al, 2024]

3 Theoretical framework

This chapter covers the theoretical framework on which this thesis is partly based on.

3.1 Human-computer interaction

The book *Designing interfaces: Patterns for Effective Interaction Design* [2020] by Jenifer Tidwell covers interaction design and HMI, human machine interaction. In chapter one, *Designing for people* she points out the importance of understanding the user in order to do the interaction design, and also describes the interaction between a user and the software as a conversation between two parts, and claims this is the perspective a designer needs to have in order to create a good responsive design for the software.

Tidwell outlines four key points that serve as a crucial foundation for understanding and designing an interface for a specific user. These points are context, goals, research, and patterns. The first point, context, refers to understanding the environment and circumstances in which the user interacts with the product. When does the user engage with the interface? Tidwell describes a spectrum of how often and how much the user interacts with the interface, which correlates with the number of choices presented to the user and how much information is displayed on the screen. As examples, she takes Photoshop or Excel on one end, where the user is willing to invest time in understanding the software in order to then use it for a variety of purposes, such as in the workplace. Here, many choices are presented, and there are extensive possibilities. On the other end of this spectrum, she gives the example of a ticket machine for tourists. It is meant to be used only once and should be intuitive to understand. To much information displayed on the screen will only confuse the specific user [Tidwell, 2020].

When describing goals she proceeds to ask questions about why the user even begin to interact with the software, such as ”what does he or she hope to accomplish?” If the user’s purpose and ultimate goal can be identified, it becomes easier to define what the interaction should look like [Tidwell, 2020].

The author also describes how patterns can be used and what is called ”spatial memory” which means the memory of space and orientation. This should be taken in consideration when creating an interface. She presents the example of how people are used to the undo button being in one specific place, and by following this unwritten rule it is easier to avoid confusion [Tidwell, 2020].

In later chapters, Tidwell describes different navigation models and when these are best put to use. One of the describes models is called ”Multilevel or Tree”. The basic architecture is built of the home page or were multiple options are presented to reach the subpages. Each subpage has its own underpages and the user can navigate from one subpage to another without first returning to the homepage [Tidwell, 2020]. The model is visualised in Figure 4.

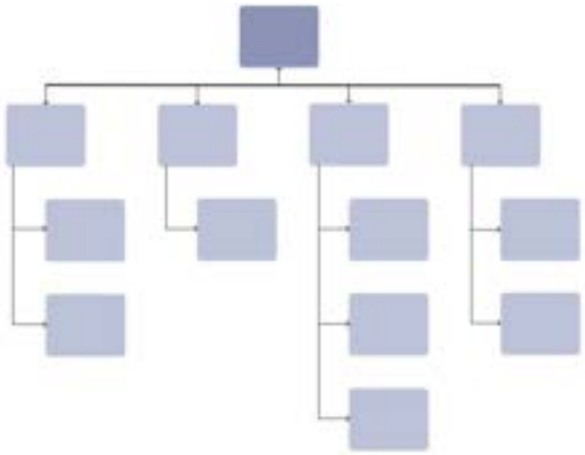

Figure 4: Multilevel or tree model redrawn from [Tidwell, 2020].

3.2 Graphic design in user interfaces

In the article *Analysis of interaction function of modern graphic design based on technical-aided design* [2023], Hui Xie explains that the success of a design project primarily depends on the designer's ability to satisfy the client's demands. Once these demands are met, graphic design should be implemented in a manner that does not distract from the main objective. Instead, visual assets should be used as a tool to enrich the user experience within the system, further helping to achieve the client's needs. Furthermore, Xie mentions that implementing graphic design in interactive features has the potential to substancially enhance the user experience [Xie, 2023].

In *The impact of colour on Website appeal and users' cognitive processes* [2010], Nathalie Bonnardel, Ludovic Le Bigot, and Annie Piolat conclude that factors perceived as beautiful and contributing to wellbeing positively influence the user's willingness to engage with a website for a longer period of time. The authors found that an appropriate choice of colour can help the user navigate a website, as well as amplify important information. For example, participants in user studies were able to recall color-marked information from websites in more cases than unmarked. Furthermore, user tests judging homepage colour themes in the study showed that participants prefer blue and orange hues. In tests performed with professional website designers, blue, orange, and grey were appreciated most. Common among both groups, was the dislike for homepages dominated by green and magenta [Bonnardel et al., 2010].

3.3 Digital user interface principles

When designing an interface displayed on a screen, Nick Babich proposes a few recommended guidelines about the use of shadows and gradients in the article *Graphical User Interface as a Reflection of the Real World: Shadows and Elevation* [2016]. Babich explains that elements visually appearing raised above the background are typically viewed as clickable. On the other hand, users are inclined to view items that appear sunken into the background as fillable or editable fields. Therefore, elements with an elevated appearance are best suited for button functions, while sunken items are more appropriate for text input fields. The article concludes that the use of heavy drop shadows, excessive gradients and intense light effects should be avoided, if not connected to an interactive element [Nick Babich, 2016].

Depending on which hardware an interface is designed for, there is array of different layout patterns to choose between to display information. Alan Cooper, Robert Reimann, David Cronin and Chris Noessel discuss this in the book *About Face: The Essentials of Interaction Design* [2014]. The writers mean that functions designed for desktop use are rarely suitable for direct porting to a phone or tablet and vice versa. Stack elements and screen carousels are examples of features that fit well for tablet and mobile use but are unintuitive and awkward to manoeuvre on a desktop. Chapter 18 and 19 in the book concludes general directives to keep in mind when designing user interfaces for either desktops, tablets or phones. A summary of the directives can be found in Figure 5.

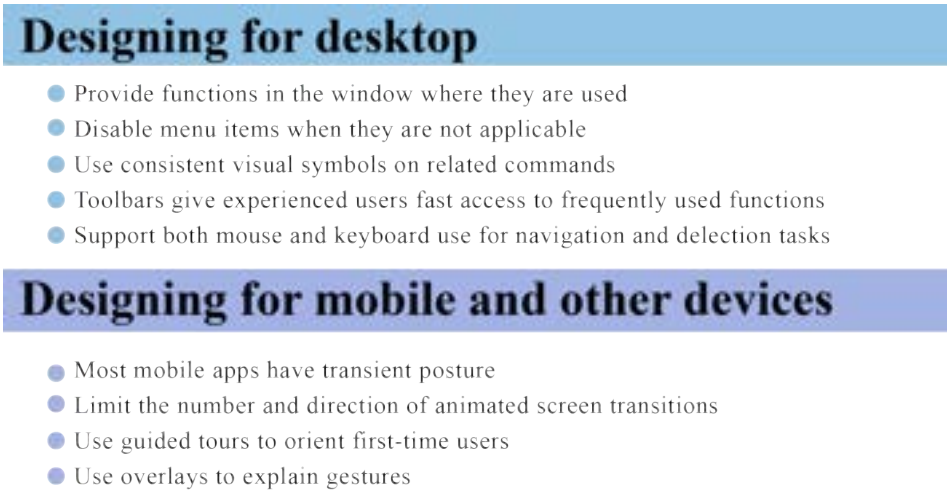

Figure 5: Key factors when designing for desktops, mobile and other devices [Alan et al., 2014]

Application designs have fundamental postures with different characteristics. Applications meant to maintain a user's attention for longer periods of time are classed as sovereign. Examples include word processing programs, spreadsheets, and email applications. Additionally, many job-specific applications tend to utilize sovereign principles. When designing an application with a sovereign posture, creating an efficient and logical workflow is key to avoiding user frustration. Transient posture, suitable for mobile and other devices, refers to applications that serve one or a few purposes. These applications are only meant to be used when the user prompts them and are closed once the task is finished. Calculators, cameras, and file libraries are examples of transient applications. Transient applications are often implemented as sub-functions within sovereign applications [Alan et al., 2014].

Daemonic-posture applications manage processes running in the background. Examples include printer drivers and network connection systems. These applications are designed to be clear and straightforward, with minimal and simple interactions between the user and the program. When designing daemonic applications, visual clutter should be avoided, meaning there should be minimal use of unnecessary graphic designs and icons [Alan et al., 2014]. Examples of daemonic, sovereign and transient postures are displayed in Figure 6.

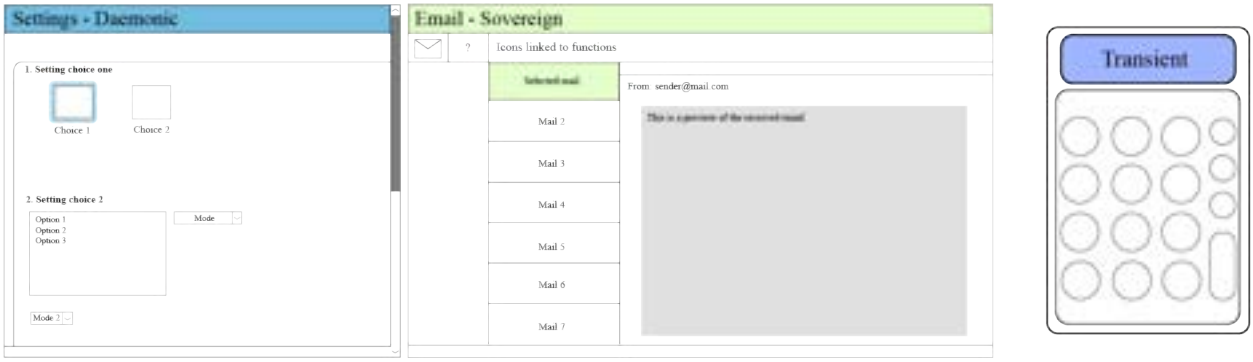

Figure 6: Examples of application postures redrawn from *About Face: The Essentials of Interaction Design* [Alan et al., 2014]

3.4 Fermentation Process

The alcoholic fermentation is the second or third step in wine making, depending on the type of wine. The basic process for both types of wine are similar, but with slight differences. Both are described in this chapter, and illustrated in Figure 7 and 8.

3.4.1 Red Wine making

After crushing, the must is fermented to convert sugars into alcohol. This can be done by adding commercial yeast or letting the native yeast that already occur on the grapes start the fermentation. Keeping the skin during the fermentation is what leads to the deep red colour. Depending on what kind of vessel that is used, different kinds of characteristics can be added to the wine. At the end of the alcoholic fermentation the wine is transferred to wine presses which separate the liquid from the skins and seeds.[2]

[2]This chapter is taken and slightly modified from the main project [Gunnar Berg et al, 2024]

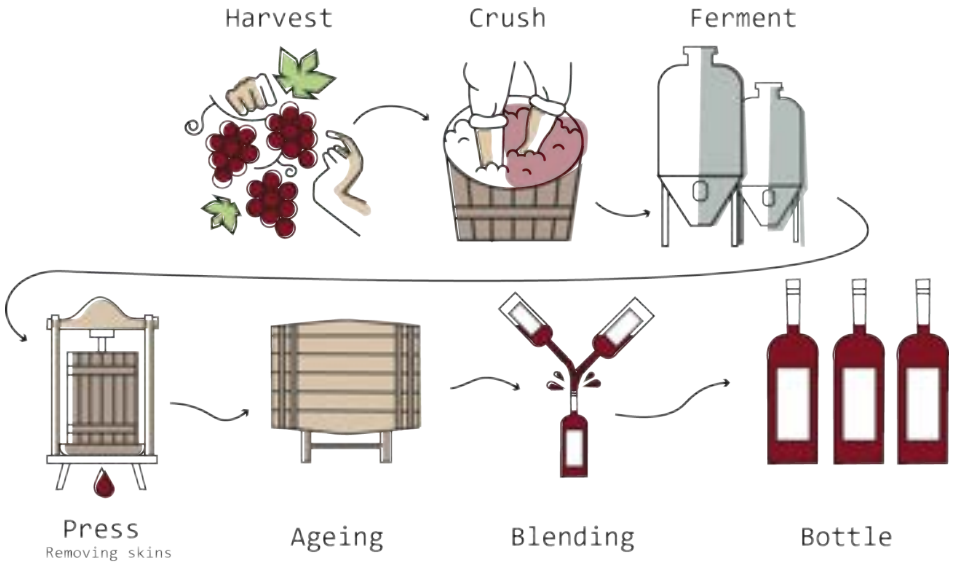

Figure 7: An illustration showing the whole red wine making process.

3.4.2 White Wine making

Once yeast is added to grape juice, a biochemistry process unfolds, converting sugar to alcohol, releasing carbon dioxide, and generating heat. Winemakers regulate this by manipulating temperature, stirring, aerating, and feeding the yeast. Various yeast strains are available for different wine styles. While com- mercial yeast is an option, native yeast present in vineyards and wineries can initiate fermentation. The majority of white wines ferment in stainless steel tanks, with some, like Chardonnay, fermenting in oak barrels.[3]

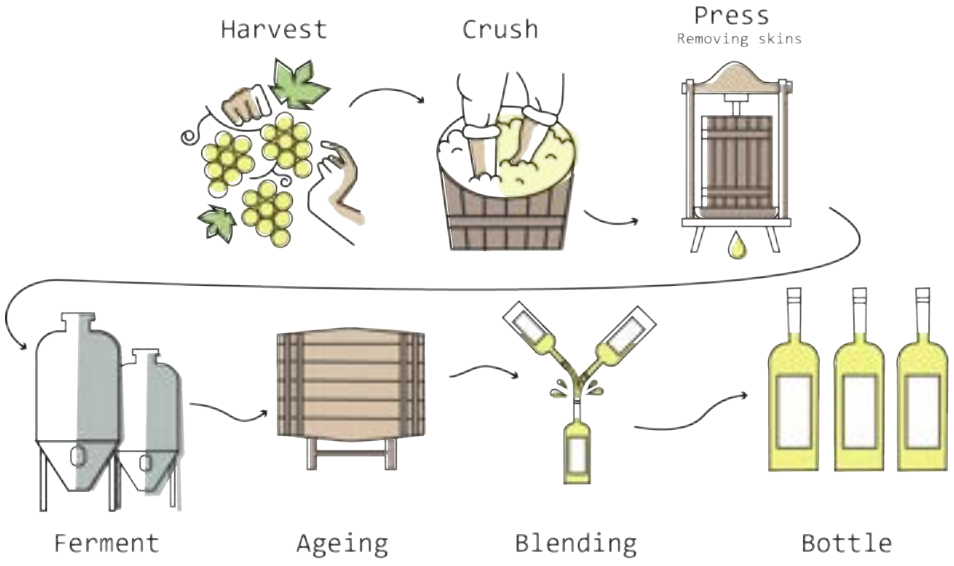

Figure 8: An illustration showing the whole white wine making process.

[3]This chapter is taken and slightly modified from the larger project [Gunnar Berg et al, 2024]

4 User Studies Results

In this section, the exact method and results of the user studies are described. The user studies consisted of observations, interviews and a workshop. The results are further discussed in section 6.

4.1 Observations

Six wineries were visited in total during this project: four in Sweden, near Linköping, and two in Veneto, Italy. The first visit, to a smaller vineyard near Linköping, aimed primarily to gain a general understanding of the winemaking process. By the field trips to Skåne a few weeks later, the research group were better prepared and had a stronger foundation in both the project and winemaking in general. The focus of the observations shifted more towards the interfaces currently used in wineries and spotting any issues the winemakers might have with these.

When the trip to Italy was conducted in April, the project concept had already been formed. The main focus of the observations was therefore to try and find more information about how the user wants to interact with the interface and what kind of information they might need at different stages of the fermentation process. A workshop was also prepared in order to try and simulate how the winemaker would interact with an interface, as the production at this time of the year is paused.

One of the main goals with the observations made both in Sweden and in Italy was also to find out more about the wine makers and what they personally value as meaningful and enjoy in the process as well as to study how they interact with technology and its interfaces in their work.

4.1.1 Observation results

When studying the currently used interfaces used in the wineries and wine-laboratories a few observations were made, one being the use of figures and symbols. As seen in Figure 9, images have in some cases been manually put next to the buttons. A lot of the wineries and their labs were located in cellars or rooms without big windows and natural lighting.

Figure 9: Observations of interfaces and instruments found in wineries.

Other recurring observations in the wineries included the multitude of hastily scribbled notes put up in different places all over the wineries. Figure 10 shows a cardboard placed next to some tanks in Italy, along with a note glued to one of the fermentation tanks. Most of the visited wineries also had some version of a whiteboard to write down and display information about the contents and test results from the tanks. Winemakers both in Sweden and in Italy seemed to store most of their information about the wine in physical folders. When asked about this it seemed both as a question of accessibility and lack of other options. These folders were sometimes found in the lab, making the place feel a bit cluttered.

Figure 10: Notes taken down on a cardboard and a note put up on a tank.

Another notable observation was the presence of wine glasses, pipettes, and other indicators of tasting in most wineries , seen in Figure 11. Most winemakers eagerly invited the group to sample their wines and passionately and proudly discussed their products.

Figure 11: Used wineglasses and wine tasting in wineries in Italy.

4.2 Interviews

In this research, the interviews aims to be conducted in such a way that the user both expresses needs and desires, as well as those that need to be read between the lines, are brought to light. The task was to identify

problems that the user may not be aware of themselves, and it was therefore important not to ask overly leading questions.

The vineyards and winemakers participating in the research were quite different, despite them having the same occupation. Some of them had on-site laboratory activities, while others sent samples to an external laboratory. Some of them were small business owners without profit motives, while others made a living from producing their wine. During tours in the Winery, questions about the fermentation and overall process were asked in an unstructured manner, depending on how many samples the winemaker took and analysed on-site, and what perspective they had on making wine. These question was unprepared, with the motivation that every winemaker interviewed was different, and it would have been difficult to prepare those questions before knowing how the winemaker worked. During the tour notes were also taken.

After completion of the tour, the winemaker was then asked to participate in a semi-structured interview, which is a mix of planned questions and spontaneous inquiries that arise during the interview [B.-N.Sanders and Stappers, 2020]. The interview questions, formulated before the interviews, and which can be seen in Appendix 1, addressed the users goals, motivations, and the process of making wine. The questions were broad, focusing, for instance, on the winemakers interests, attitudes towards using technical products, the flow of information at the vineyard and data storing methods. Each winemaker was interviewed for approximately 20 minutes. In total, 6 interviews with different winemakers, operating in both Italy and Sweden, were held.

4.2.1 Interview results

The interview answers are categorised into different subjects, covering both RQ1. and RQ2.

Motivations and meaningful activities
Almost every interviewee in this research owned their vineyard, whether it had been passed down through generations or not. They all managed the process and were responsible for production. When asked why they continue making wine, they all agreed on one thing: they enjoyed creating a final product they would personally enjoy. One winemaker said, *"I like to do what I enjoy, drink my wine, and talk about my wine at different fairs,"* which seemed to reflect the overall sentiment among the visited winemakers. Many expressed pride in producing diverse wines, and some mentioned earning awards. It's important to note that these interviewees are not large-scale winemakers. Year-to-year consistency was not a priority for them, and none of them had issues with the same wine tasting different the next year; rather, they saw it as a positive thing. Swedish winemakers talked about trying new things, exploring different areas and grape varieties, while the Italians were more rooted in tradition. An Italian interviewee compared winemaking to traditional agriculture, saying, *"As a farmer, you operate on low margins. You just have to survive."* He continued, "*But wine is special; it has high added value, which allows for considerations like establishing guidelines for winemaking and for future generations of winemakers"*.

One question addressed the interviewees personal interests. Many of them mentioned various crafts such as baking, gardening, and art. One interviewee cited a particular interest in scent as her main passion, which also led her into the wine-making industry. She expressed, *"If it hadn't been wine, it would have been perfume."* When asked about the most enjoyable part of the winemaking process, she said, *"The product itself, tasting it, and the smells."* She elaborated on the transformation of a raw product (grapes) into something complex, em-

phasizing the excitement of wine as a *"living product."* Another interviewee responded with *"the community"* when asked what was most enjoyable about making wine.

Measurements, monitoring and pain points

The interviewees were asked about their sampling process during fermentation. The most of the interviewees in this research were sending samples to an external laboratory, but they would still measure specific gravity/alchol/sugar and other simple-performed tests in-house. Most commonly, this was done twice a day during fermentation. For the middle-sized vineyards, the temperature in the tanks were controlled by tank temperature control systems integrated in the tank. All of the interviewees answered that tasting and smelling the wine during the process was the key to detect a bad wine. The interviewee who talked about wine as a living product, also expressed that the *"living product-thing"* made the tasting a bit complicated. She asked herself "*what is this taste? it's awful but you can't know what it is"*, indicating that she would like to know what component in the wine that gave the *"awful taste"*. Another interviewee said that it would be very valuable to know which parameters affect the taste of the wine.

Technical and digital interests/skills

To explore the attitudes of the target groups towards new techniques and technologies, the subject was addressed during interviews. Almost everyone expressed a positive attitude towards technology, but the frequency of its use, especially in the winemaking process, varied significantly. Some mentioned a preference for using pen and paper in the winery, describing it as 'smoother,' while others favored software like Excel for data documentation. The observation showed that many interviewees preferred to manually record information during winery tours was also notable.

Despite not having extensive in-house measuring technologies, many winemakers discussed the potential usefulness of new technologies for monitoring the process. One interviewee, who was engaged in new research and considered himself highly informed, said that *"It's challenging to find new technologies that are truly useful; we have tried many but eventually sold them."* When asked about the value of a technology capable of detecting bacteria and yeast strains, he stated that it would be worth four times the cost of any microscope he could obtain. Currently, he lacked extensive measuring technologies but discussed the possibility of acquiring a sensor system to measure various parameters from grape plantation to fermentation, with accompanying software for storing historical data and consumer feedback

Unwanted or time consuming activities

The interviewees were asked what their most boring task was. It was clear that they saw all activities as necessary for controlling of the process, but when it was further investigated, it came to the truth that the measuring activities during fermentation were considered repetitive and time consuming. The tests had to be taken, at least twice a day, on every fermentation tank. All of the interviewees did this manually, using more or less modern technology. Additionally, this resulted in tubes and other stuff who had to be cleaned and disinfected.

Overall, it was observed that these winemakers appeared to be quite busy individuals. They both conveyed, and demonstrated through subtle actions, that they were often pressed for time. The larger vineyards employed part-time workers during peak seasons, and one vineyard had interns who were learning the process and assisting in various tasks. One winemaker mentioned making mistakes due to stress and expressed nervousness

about the wine during the fermentation process, while another acknowledged the need for additional time to implement and learn new systems and technologies.

4.3 Workshop

This section covers the design, participants and results of the workshops.

4.3.1 Design based on interviews

Based on the interview results conducted in Sweden, a UI workshop was planned and presented to a winemaker in Italy, with the aim of identifying how winemakers prefer to interact with the project concept.

Figure 12: Workshop with winemaker in Italy.

Before starting the workshop, the project concept presented in Section 1.2 is explained to the participant. This is shown in Figure 12. A physical kit containing five categories of images are then introduced in separate rounds, each round prompting the winemaker to make a choice between options. The presented categories are *form of information*, *navigation*, *screen size*, *portability* and *notifications*. Besides the options presented in each round, the winemaker is informed that if none of the options are satisfactory they are able to freely suggest ideas. After the final round, the string of choices made by the participant results in an interface concept.

The first category shown to the participant is regarding *form of information* and prompts the user to choose how measured values should be presented. This is as shown in Figure 13. During the interviews it was discovered that winemakers currently are tracking wine parameters using different methods, for example by pen and paper contra software, like excel. Category one therefor explores the potential interest for the winemaker to receive finished compilations of the measured values, instead of manually handling them. The options presented are numeric, graphs, diagrams and radar charts.

Figure 13: Informational options

Having a screen is predetermined due to the broad acceptance of modern technology ascertained during the interviews combined with its ability to display information in an effective manner. In round two, different *screen sizes* are revealed whom are roughly the size of a small display on a digital thermometer, a phone and a tablet. In order to avoid leading the user, nothing more than the sizes is mentioned about the screens. This is presented in Figure 14.

Figure 14: Screen size options

In round three the participant explores potential *navigational* methods used to manoeuvre between features within the user interface. The options in this category are buttons, mouse and keyboard, touch and a touchpen, as seen in Figure 15.

Figure 15: Navigational options

In round four further three options of the screen being stationary, portable or mounted on the fermentation tank

is asked, seen in Figure 16. The preconceived thought is that portability is an important factor since many wineries are big in size, and running back an forth between a station would not be effective. But in order to not make design choices based on the design teams own thoughts, the category is presented to the winemaker.

Figure 16: Portability variations

Finally the user chooses their preferred form of *notification*, the options being through calls, texts, emails or sounds, illustrated in 17. During this phase extra emphasis is on the winemaker to generate another option if none of the presented seem suitable.

Figure 17: Notification options

By combining the five rounds, the participant has succesfully created an interface concept based on their own preferences, experiences and wishes.

4.3.2 Workshop participant

The participant is a winemaker engaged in the wine making process from start to finish at a family owned vineyard in Italy. Annually the vineyard produces over 100 000 bottles of wine and is in possession of a large winery mostly equipped with 13 000 litres fermentation tanks. The vineyard is roughly 60 years old and the participant has embraced a larger role in the production since their parents retired. Furthermore, the participant is not educated in wine making at a faculty but has been surrounded by wine culture since young, gaining knowledge from their parents and acquaintants.

4.3.3 Workshop results

As previously described, the workshop was performed in a round format starting with focus on a suitable format of information. When presenting the different informational options the participant was instantly drawn to the graph icon, verbally expressing the helpfulness of monitoring increasing or decreasing values. When asked about examples of what these values could be, sugar levels and alcohol levels was mentioned along with the idea of being able to monitor lacteal bacteria or other yeast bacteria in a diagram or graph form.

When shown the three different screens, the smallest one was excluded due to it being tiny. The two remaining ones were inspected and the participant came to the conclusion that something in between those sized would be appropriate. The screen was also spontaneously called a tablet, indicating that it should be controlled by a touch function, which naturally became the choice of round three. In round four, when shown variations of the interface being stationary, mounted on the tank or portable the participant stressed the importance of it being portable as crucial. Since the winery is large, running back and forth would become tiresome rather quick.

In the final round the notification system was introduced. The participant quickly denied every option and explained how alerts, alarms or phone notifications would add to the already existing stress of working at the vineyard. Moreover it was mentioned that there already too many alarms and notifications in the daily life at the vineyard. Instead it was suggested that critical information should reach the user only when interacting with the interface. When asked to freely implement an idea to the interface concept, the participant suggested that a QR code system could be used in order to quickly gain access to the wine parameters. This is illustrated in Figure 20.

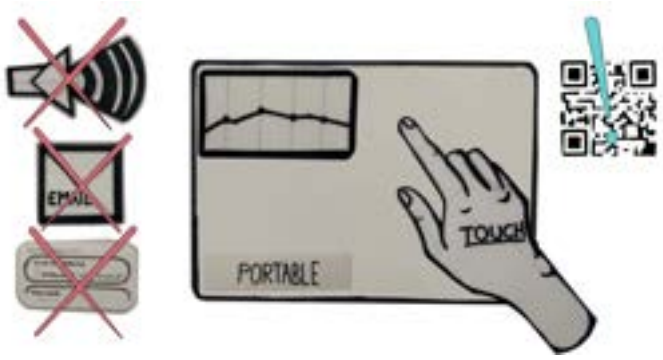

Figure 18: Concept created during the workshop

4.4 Persona

The user studies resulted in a persona, portrayed in Figure 19, that describes the target group for the user interface. Elena is a creative and curious individual who aims to infuse a personal touch into every bottle of wine produced. Unlike bigger wineries, the consistency in taste between the different vintages is not as crucial to her. She prioritises the unique characteristics of her own wine, determined by tasting and smelling.

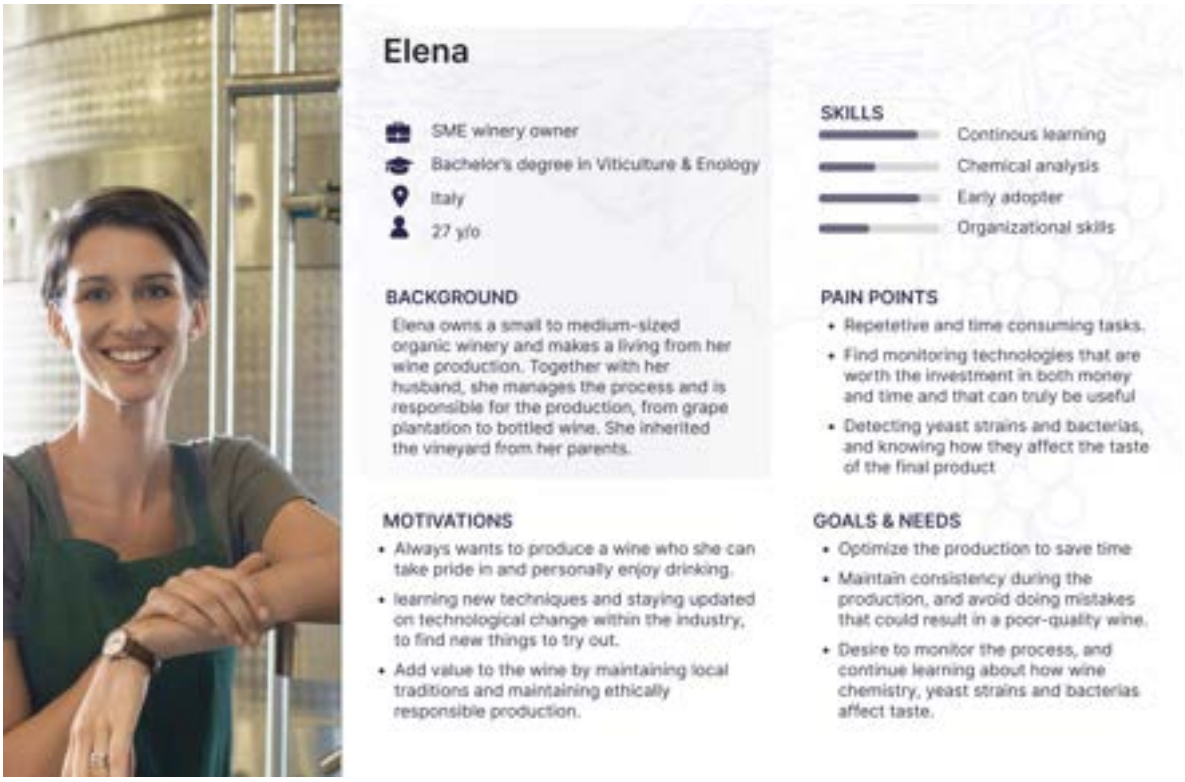

Figure 19: Persona generated from user studies

The persona has been used throughout the design process to concretely define and understand the typical user of the project and interface concept, helping to make user-centered decisions.

4.5 Identified needs and desires

The analysis of the interviews, observations, and the workshop, as well as the results from the literature study, is condensed into design principles for the user interface. These serve as an guideline when creating the interface, and are presented in table 1.

Number	Interface design principles
1.0	Display current measurements such as pH, alcohol levels, specific gravity.
2.0	Display yeast strains or bacterias detected from sampling with Unicorn DX.
3.0	Allow for remote control to obtain information about the wine and control the measuring device without being present in the winery.
4.0	The interface should display measurements over time in a graph format.
5.0	Option for viewing historical data should be available.
6.0	The sensor-containing product needs to be connected to a particular tank in a clear way so that there is no confusion about which measurements belong to which batch of wine.
7.0	A navigation model should be implemented in the interface, to make it intuitive for the user.
8.0	Place symbols and buttons on the physical interface in intuitive locations.
9.0	The interface should not require tanks to be exchanged or destroyed.
10.0	The digital interface should have a note function.
11.0	The digital interface should have a print report function.
12.0	The user must be able to see if the monitoring device is on/off
13.0	Symbols in the digital interface should be used to make the interface more understandable and intuitive

Table 1: Interface design principles.

The main idea of the digital interface is to deliver measured values from the measuring device to the user, without requiring the winemaker to be present in the winery. Additionally, the device should be controllable remotely, allowing the winemaker to save both time and resources, such as workforce. The winemakers expressed a desire for tracking measurements over time, which winemakers believed would give them better control over the fermentation process in the tanks, and provide information about where the process is heading. Having an option to view historical data from previous batches would provide an opportunity to track old mistakes or see what parameters affected the outcome of the wine.

It was observed that many winemakers kept documentation in physical folders or on loose papers. Sticky notes, whiteboards and even pieces of cardboard were used to note information. Therefore, another identified design principle is that the interface should contain a note function under each tank option, allowing the winemaker to keep information in a more structured and reliable way. A print report tab is also an identified requirement, enabling the winemaker to print reports and still note by hand, as this was a sought-after feature.

The navigation model ”Multilevel or Tree”, described in Section 3.1theoretical framework, can be used as inspiration for the navigation system within the interface. As mentioned, it is widely used in many web pages and, therefore, is likely easily understood by the user.

Moreover, the interface also have to indicate when the device is turned on/off, and when the pump is running and taking measurements, ensuring the user is aware of it’s operational status. The interface also has to be paired with each pump mounted on the fermentation tank, unless it is detached to the monitoring device.

5 Design of the UI

In this chapter the final concept for the design of the user interface is presented. The final concept for the user interaction includes an app protoype for tablets and phones, where the winemaker can easily view status of the wine in the different fermentation tanks. The choice to use a tablet as the main device for monitoring the wine was mainly based off the research done during the study visits. The app prototype is created in Figma, a collaborative design tool used for prototyping [Figma, 2024].

5.1 Sketches and application mockup

Based on the results of the prestudy, interviews and the workshop, basic sketches of the app UI were made. At this point in time, it was clear how the concept product was going to work. However, which measurable parameters it realistically could provide was not entirely known. This lead to a few uncertainties of what to include in the application protoype.

The sketching focused on a sovereign application posture, with transient and daemonic features available for the user when needed. Given the applications goal to make the process more efficient, the sketches explored ways to maximise workflow in the application. The sketches also explored the placement of icons and features, as well as how navigation between different functions should work. At this stage, inspiration from Tidwell's multilevel model described in Section 5 was utilised. Low emphasis laid in making good looking icons and details, the main priority was to establish a suitable workflow for the user.

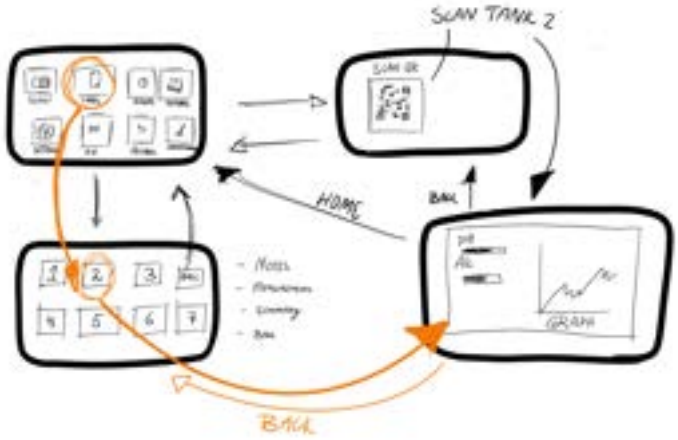

Figure 20: A basic sketch describing two ways to access measurements in a tank by either clicking or scanning a QR code

The mockup application, shown in figure 21 and 22, was made by inserting further developed sketches into PowerPoint in a slideshow format, with the goal of mimicking an application when displayed on a tablet. This is shown in Figure 20. At this phase, the choice of colours, icons and layout were not picked thoroughly, the main focus was instead on functionality and user experience. By making and exploring the mockup, inconvenient and illogical design choices could be detected and removed or tweaked, to later be implemented in the final UI. The

mockup also explored how the transient and daemonic features such as settings, reports and QR-codes should be Incorporated in the application.

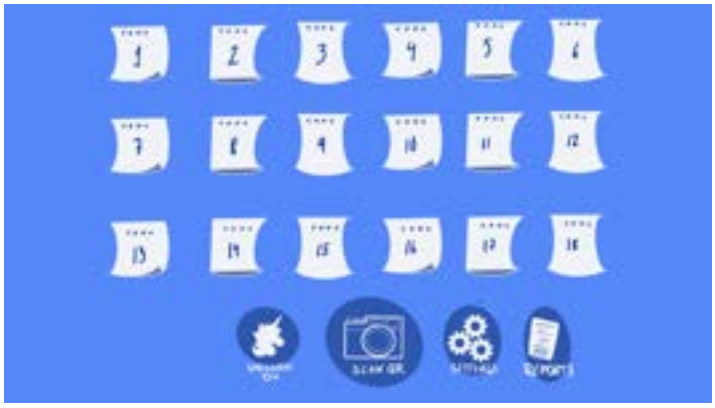

Figure 21: Sketch of potential home screen layout

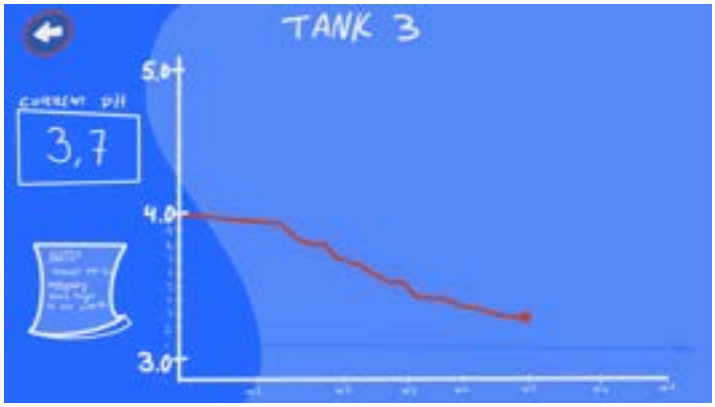

Figure 22: Sketch of how changes in pH value could be presented to the user

5.2 Final design

In this subsection, an overview of the final design of the application prototype is presented. It includes both an application UI and a physical UI on the measuring device. All of the pages in the application are not visualised in this thesis. Unlike previous mock-ups, the appearance of the app has now also been decided, as well as which measurements who are going to be displayed based on the user's needs and technical limitations. The design principles presented in Table 1 are taken into consideration when making the final design. With measurements and data from the sensor as the main focus, the application is designed to be aesthetically pleasing, while not being cluttered and confusing the user. The navigation model from the mock-ups and the overall design are also implemented, mainly using a sovereign posture with sub functions utilising daemonic and transient postures.

The colour scheme is designed with *The impact of colour on Website appeal and users' cognitive processes* [Bonnardel et al., 2010] in mind, presented in 3.2. Minimal amounts of green and magenta are used and influences of blue, orange and grey has been preferred throughout to establish a theme.

When opening the app, the winemaker enters the home page, seen in Figure 23, which serves as the top level in the multilevel tree, described in Section 3. The sub pages are the Tank tabs, Print Report and Settings. On the home page, the winemaker can choose between scanning a QR code on the fermentation tank or going directly to the desired tank. The QR option will also lead to the correct fermentation tank, providing a way to connect the interface with the right measuring device/physical fermentation tank. The scan function is seen in Figure 24 and 25. A search box is also available to navigate to features. The user can hop tabs by clicking the icons at the very bottom, when switched, the icon of the current page changes to orange to indicate the user's current location.

Figure 23: Homepage

Figure 24: Scanning QR code on prototype

Figure 25: A link leading directly to the wanted tank.

Another way to reach the tab for each tank is by clicking "Tanks" in the menu located at the bottom of the screen. The menu on the left in figure 26 presents the different tanks, and the user can quickly navigate around different measurements without being present in the winery. The tank tabs also have under pages, where the

measurements are displayed over time and as single data points. Note how the artwork becomes less opaque in the background not to distract the user and reducing clutter, while still contributing to the general aesthetics of the page.

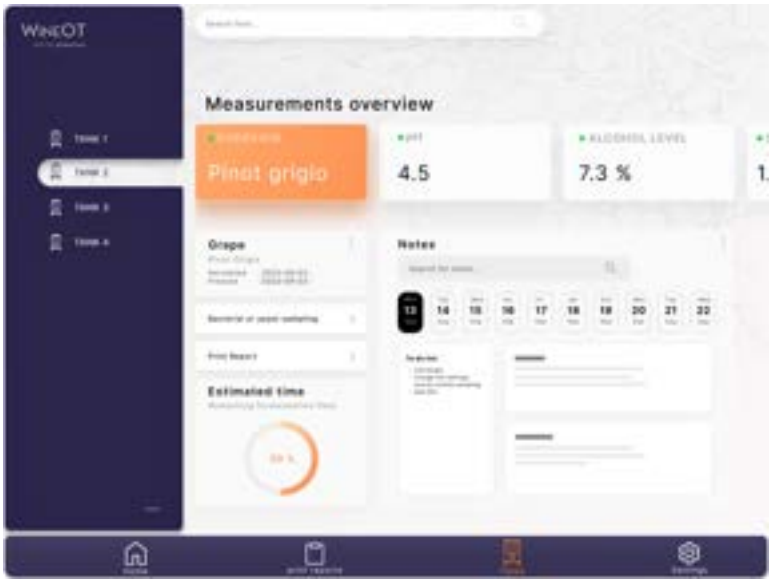

Figure 26: Overview dashboard

In the 'Measurements Overview' dashboard, shown in Figure 26, the grape content in the chosen tank is presented along with some general information, such as the date the grapes were harvested and pressed. An option to enter custom notes is also available. A search box allows the winemaker to quickly find specific wine, dates, or other data. The boxes become colourful when clicked to highlight information, and have a carousel function appropriate for tablet and phone applications [Nick Babich, 2016], when clicked, they lead to more in-depth data about the wine in the fermentation tank, as visualised in Figure 27. Here, the graphs and data points are located. The displayed values are pH, alcohol level and specific gravity.

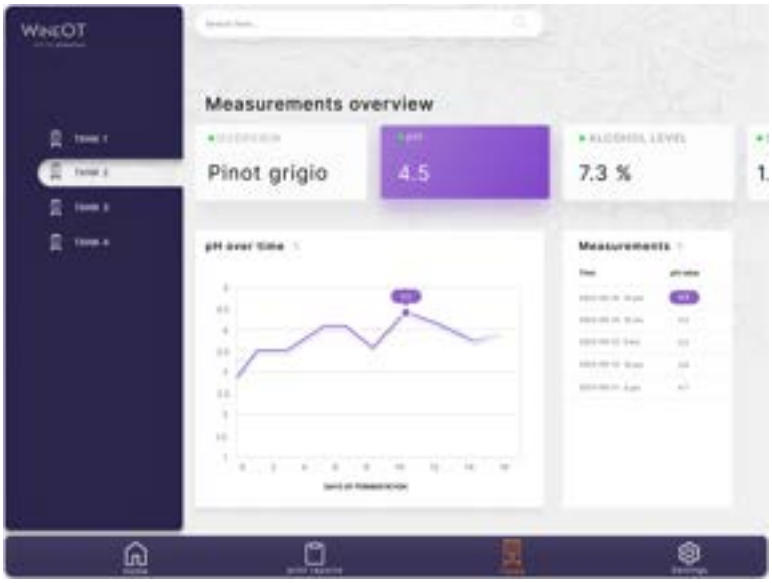

Figure 27: An example where measurements (in this case pH) are displayed over time, along with data points.

The ”Bacterial or yeast sampling” option in the overview dashboard in Figure 26 refers to the use of the separate Unicorn DX unit, which is a ship capable of detecting yeast and bacteria in the wine. In order to do this, a sample needs to be extracted from the tank through a specific outlet on the measuring device. This is also controlled in the app, as seen in Figure 28. This attribute is a transient feature and the page is only expected to be visited when the user needs to analyse the yeast and bacteria.

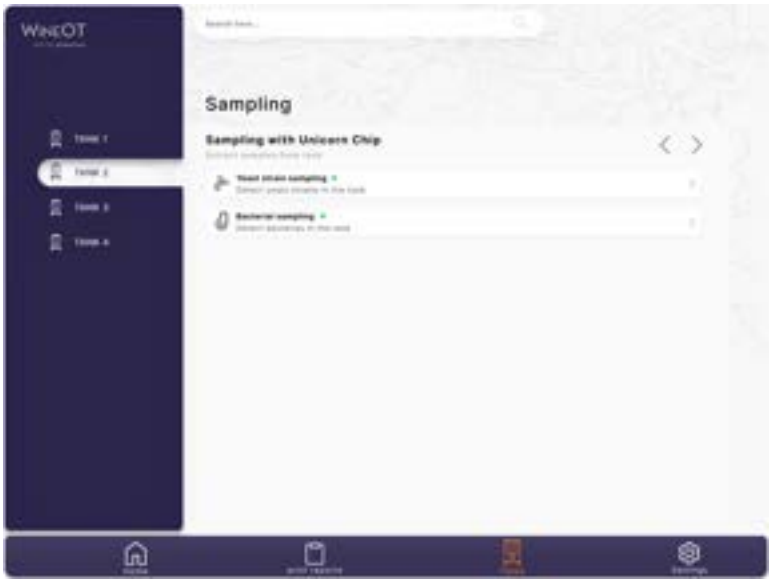

Figure 28: Overview dashboard

Another transient feature is the option to ”print report”, shown in Figure 29. This is an easy way for the

winemaker to export the information from the app to a document which could be stored on a computer or printed out.

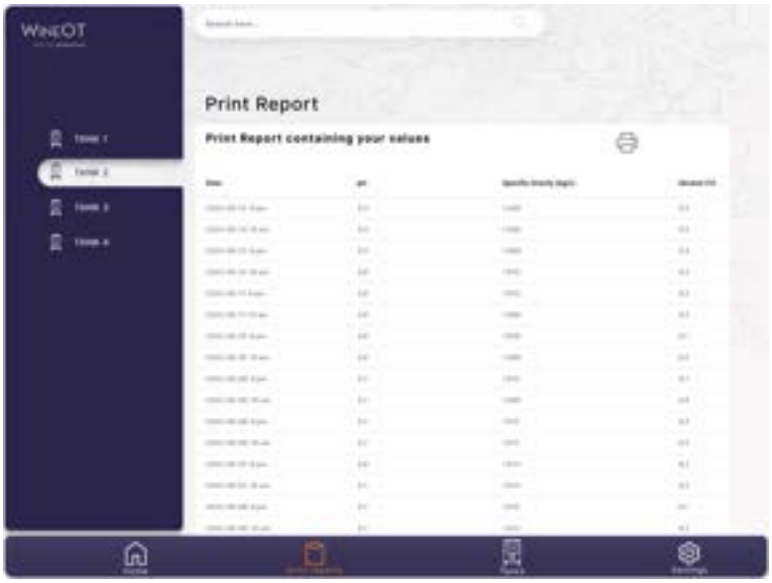

Figure 29: Print report dashboard.

In the settings page, the user can besides selecting language and internet connection also choose how often measurements should be done, pair the correct tank with the right QR code and select notification settings. This is visualised in Figure 30-33. This page is only expected to be used when adjusting background activities and is therefor designed in a clear daemonic fashion.

Figure 30: General settings

Figure 31: Manage tanks

5.3 Measuring device

The result of this thesis is a part of the larger project, described in the backgrond chapter (1.2). The project resulted in a device that is mounted on the racking unit, seen in figure 34. In addition to the application,

Figure 32: Measuring settings

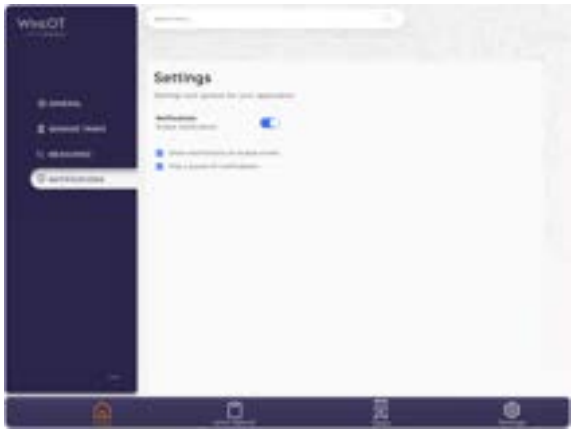

Figure 33: Notification settings

a choice is also made to include a small screen on the measuring device. The screen displays the most recent measured values and when clicking the grey mode button the measured value changes between pH, sugar levels, alcohol levels and specific gravity. The green light indicates that the device is on, when clicked the device and green light turns off.

Figure 34: Screen on measuring device

6 Discussion

6.1 Results

This section discuss the results produced in relation to the research questions introduced in section 1.4. The results from section 4 and section 5 are also discussed.

6.1.1 Identified meaningful activities

From the user studies it was identified that the winemaking industry might not be as steeped in traditions as initially thought. The user studies revealed that craftsmanship was not necessarily equivalent to preserving old traditions and production methods. The winemakers showed a positive attitude towards change, such as implementation of new technologies and winemaking techniques. The main point was that the outcome of the production turns out the way the winemaker wants and can take pride in, which was evident when the winemakers talked about their products and their interests in making wine. This might mean that introducing new interfaces can be done without scepticism, as long as the winemakers trusts that the implementation will improve the final product. The work process alone, includning activities such as taking samples twice a day and analyse the tests during fermentation, is not considered a meaningful based on the interviews. Automation of the sampling process through continuous monitoring would probably not remove meaningful activities, which is an important outcome drawn from this research. It was discovered that it would rather decrease stress and give the winemaker greater confidence in their final product.

One identified meaningful activity was the testing and smelling of the wine during the fermentation process and other steps in the procedure, which was apparent at all of the vineyards visited. As presented in the Section 4, the winemakers usually had glasses and with taste samples in the wineries, always allowing themselves and visitors to taste and smell the wine. They also talked about the importance of always tasting the juice. This may not just be related to ensuring that everything goes well during the process, but also to the pride in creating one's own unique product. Removing this step when creating a monitoring product might pose a risk of making the winemaker less motivated to use device.

6.1.2 Design of the interface

The first concept generation of the app interface design started out as simple hand draw sketches of the navigation and basic lists of desired features. In order to find the answer to the research questions asked in Section 1.3, a lot of the results and design choices were made based of interactions and observations with the winemakers.

When assembling the workshop, the answer choices were based on what the most common ways to interact with an interface, as well as some thought to what were seen in Swedish vineyards. As observations and interviews were performed, many new ideas about features in the app were created. As described in Section 4.3.3 the idea of having a QR code on the tank was first mentioned by one of the winemakers in Italy.

Another thing noticed when visiting vinyeards were as described the amount of hand written notes placed all over the wineries. This was the inspiration for the "notes" feature in the app, as there was an obvious need for the winemaker to write things down while working. The observations in the wineries was also a big inspiration for the overview dashboard, seen in figure 26. The information presented here is the same information as what

is currently written on notes taped to the tanks, as seen in figure 10. As described in Section 4.1.1, the use of physical notes and folders seemed to be something the winemakers were used to and even prefered. This led to the decision to include an option to ”print report” in the app. This means a report can be exported in PDF format, which can be useful for printing and storing physically if the winemaker would like to.

The aesthetic design choices for the app were also made with reference to the research questions. Something that was discovered through the study visits and interviews was that winemakers are often creative individuals, as described in Section 4.2.1. The app is designed to maintain the creative and artistic feel, while still presenting information in a effective way. In Section 4.2.1, the wine is also described as a living product by one of the winemakers. Inspired by this statement, a drawing of some grapevines has been used as the background in order to make the appearance more lively.

6.1.3 Screen on measuring device

The screen on the measuring device shown in Figure 34 ensures that the winemaker can quickly glance at it to see the current status of each tank. It also provides security that the device is on and functioning correctly. Presented in Section 4.1.1, observations revealed that most existing devices feature a small screen displaying the most essential information. To align with what winemakers are used to and prefer, a screen was incorporated into the interface design.

6.2 Methods

This section will discuss and problematise the methods used to establish the design principles and produce a interface to the studied case.

6.2.1 Literature study

Because of the time it took to reach the users and the thorough preparation needed, the literature was helpful in preparing for the interview and workshop. By thoroughly reading up beforehand and being well-prepared for the site visits, the time could be utilised in the best possible way.

6.2.2 User studies

As previously mentioned, the site visits were conducted during the off-season, which meant that no active fermentation was taking place that could be observed. Therefore, the observations did not provide much insight into how winemakers work on a daily basis. However, what could be observed was the environment in which the interface needs to fit. The visits also provided an opportunity to inspect the interfaces that are already in use in the vineyards. Through observation, several of the users' behaviours and habits could be noted, providing insight into what might be seen as meaningful activities. One example which ended up being used in the interface design is the "notes" feature, based on the observation of the need to take notes. The meaningfulness of tasting and smelling the wine was further understood by the enthusiasm of nearly all winemakers to offer the visitors to try their wine.

It turned out to be more difficult than planned to conduct structured interviews with the winemakers for several reasons. Each visit to the vineyards was unique, and the people and environments varied, making it challenging to find opportunities to sit down and conduct an interview. Additionally, a few of the winemakers had limited time available, which led to the interviews being conducted while doing the observations in the winery. The interviews where therefore done in a more relaxed and partly improvised way. However, it might have been beneficial to have the interviews be more tailored to each interviewee, as this resulted in many useful answers and insights that could answer the research questions.

The workshop was conducted with only one winemaker, making it difficult to establish the result as fact. The workshop appeared to be appreciated by the participant and provided a more relaxed setting for the winemaker to express their thoughts and ideas compared to a formal interview. The goal was mainly to try and answer the research question two, *What might a suitable interface look like in order to maintain meaningfulness? (1.3)*. The workshop also sucsseeded in being a good way to overcome the language barrier, as neither the participant or the conductor uses English as their first language.

7 Test and verification plan

The plan is to allow the winemakers in Sweden who previously involved in the project to test the app prototype. This is primarily due to the fact that they are close and accessible, as opposed to the generally rather inaccessible user group winemakers tend to be. Several of the winemakers interviewed in the project showed great interest and commitment to the project and also expressed a desire to see the result. On one hand, it is a good thing that there are willing users who can test and verify the product, but on the other hand, it may be that they are biased and perhaps not completely honest with their opinions about the prototype. It then becomes even more important to apply the methods described above.

When testing the user interface with the SUS method, described in Section 2.4, it is possible to do it remote, as the plan is to make the app prototype interactive. This means that the only thing the winemaker would need to test the product is the app prototype, which could be sent to the winemakers in Italy as well. This app is created to be used consistently over time, and therefore have a learning curve. In order to get a good indication of how the user actually interacts with the product, the winemaker would have to use the app for a couple of days. One way to do this is to give an assignment or a problem to solve. A form would then be sent out with the questions used in the SUS method, where the winemaker can rate their experience. The plan includes both a qualitative and a quantitative part. When performing tests, a sample size must be chosen for both parts, and this is described in the following section.

7.1 Sample sizes

7.1.1 Qualitative research

During the project, four vineyards were visited in Sweden, yielding four qualitative interviews. When conducting the field trip to Italy, further two study visits to vineyards were made along with two interviews and a workshop. In most cases, one employee at each location participated in the interview. In total seven individual winemakers participated in the qualitative research.

Unlike when doing quantitative research, there are no strict rules or mathematical equations to determine the sample size. Instead, several factors give an indication of what amount of samples a project should aim to include. These factors are for example the availability of the target group, data saturation, time frame and budget [Khim Raj Subedi, 2021]. Given the time frame of this project, the amount of winemakers in Sweden and the budget allowing for field trips, seven winemakers participating in the qualitative research phase is a reasonable amount.

If further qualitative research were to be made, visits to other countries with a large amount of vineyards would be favourable. Currently the qualitative research is not proportionate to the vineyard population in each country, meaning that common opinions at vineyards in e.g. France and Germany are disregarded. Therefor, it is not recommended to prioritise visits to Swedish vineyards, but instead explore other parts of Europe.

7.1.2 Quantitative research

To further develop the UI concept in the future, quantitative research among winemakers in addition to the qualitative research would be beneficial. Before reaching out to the target group, a suitable number of participants

needs to be determined. There are several different methods that can be used to choose the sample size, two models deemed fitting in this scenario are Cochran's and Yamane's equations. In *Determining Sample Size* [Glenn D. Israel, 1992], it is stated that Cochran's equation is suitable for determining sample sizes in cases where the total population is large. Additionally, Israel describes Yamane's equation as a simplified formula able to calculate sample sizes of any size. However, in situations where the total population of the target group is small, nearly the entire population would have to be be included in the research depending on which confidence level is to be achieved.

$$n_0 = \frac{Z^2 pq}{e^2}$$

Figure 35: Cochran's equation

$$n = \frac{N}{1 + N(e)^2}$$

Figure 36: Yamane's equation

n = sample size
Z = critical value corresponding to confidence level
p = proportion of an attribute that is present in the population
q = 1 - p
e = desired level of precision (margin of error)
N = total population

Figure 37: Explanation of denotations

Because of cultural differences, winemakers individual preferences in Sweden are expected to differ in comparison to the Italians. Thus, it is reasonable to divide them into two separate sample groups instead of combining them. The Italian sample group could to be determined by using Cochran's equation, since the total population is classed as large, Italy being home to roughly 300.000 vineyards [Eurostat, 2022]. The Swedish vineyard population is remarkably smaller with a total of 169 vineyards existing as of 2021, only 43 of them being commercial [Föreningen Svenskt Vin, 2021]. Before calculating appropriate sample sizes for the two groups, an approximation of total winemakers in each country needs to be made, as well as a scope of what defines a winemaker.

An approximate sample size for Italian winemakers using Cochran's equation, a confidence level of 95%, p assumed to be 0.5, margin of error being 5% and counting each vineyard as a winemaker, results in a needed sample size of 385 winemakers. Before deciding on this sample size, the value of p as well as the amount of individual winemakers needs to be further explored.

An approximate sample size for Swedish winemakers using Yamane's equation, a margin of error of 5% and counting each vineyard as a winemaker, a sample size of 119 winemakers is needed. Note that hobby winemakers, whom are not working commercially with wine are included in this approximation. When excluding

hobby winemakers, a total of 39 commercial winemakers would need to take part, which is essentially 90% of the total population [Föreningen Svenskt Vin, 2021], which could prove to be a challenge. Therefor, it would be reasonable to use a finite population correction, explained on page 4 in *Determining Sample Size* [Glenn D. Israel, 1992]. Just as in the previous case, the value of p and the amount of individual winemakers needs to be further explored before committing to the sample size.

8 Conclusions and further studies

In this section, answers to the research questions *"Which activities are widely valued as meaningful in the winemaking process?"* and *"What might a suitable interface look like in order to maintain meaningfulness?"* is proposed. Suggestions for further studies on this subject is also discussed.

8.1 Conclusion

From this work we can conclude that the activities valued as meaningful in the winemaking process are primarily the activities of smelling and tasting the wine, and the sense of creating a product to be proud of. Field studies suggests that streamlining the fermentation process by implementing new monitoring technologies could be accepted by winemakers, since only a few participants expressed scepticism towards altering their current process. An application interface designed to preserve meaningfulness considers the activities that are time-consuming and tiresome, while ensuring that the winemaker can still perform their craft in their own way, allowing them to to make a unique wine. Given that the winemaking process is viewed as a craft and that winemakers in our target group are not lab workers, the aesthetics of the application interface should likely differ from traditional lab equipment. It would be beneficial to incorporate more colorful and artistic elements into the design to an extent that is not distracting. This would probably make the whole product more desirable.

8.2 Further Studies

Further studies should focus on collecting more user data during the ongoing fermentation process, as this is not included in this thesis. This could make the design principles more precise and accurate, as well as allow for testing both the physical prototype and the application prototype. The data in this report is only collected from Italian and Swedish vineyards, which opens up the possibility for further studies in other wine-producing countries. Additionally, another area of research is the testing and verification of the interface to develop a more user-friendly concept. In the introduction, the idea of implementing this technology in beer making is mentioned and ultimately deemed reasonable, allowing for further studies on how a similar application prototype and physical prototype for beer fermentation could be designed.

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9 Appendix

Appendix 1: Interview questions

Introducing questions

- What's your name?
- What's your role at the vineyard?
- How come you work here? (follow up: education, self taught, generations...)
- Why do you keep making wine?
- What do you do in your spare time?
- Are you interested in technique in general?
- Whats most demanding part of making wine after the harvest is done?
- What is the most fun while making wine?

Quality and measuring questions

- What are you required to measure by law? And how do you measure it?
- What do you measure even though you are not legally required to?
- How do you ensure that your wine is of high quality?
- What's the most difficult task in the fermentation process?
- What is the most time consuming task?
- What is the worst mistake you have made?
- What mistakes are commonly made?
- How do you know if something has gone wrong in the fermentation process?

UI questions

- How do you handle the data you get by measuring?
- Is it important for you to store the data?
- How many softwares/apps do you use to monitor your wine? information flow?
- Which of your current measuring equipment is your favorite? Least favorite?
- Do you like the way they work?
- Are you able to measure parametres remotely?