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HIGHLIGHTS

- We mapped the processes involved in producing a certified artisan cheese
- We used observations and an ethnographic approach to collect the data
- Systemic analysis yielded the overview on which we identified critical points
- Acting on these issues represents opportunities for process improvement
- We designed a cheese chip cutting hand tool to act on one of the critical points

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Systemic Analysis of Certified Artisan Cheese Production for Improvement—The Case of the Serra da Estrela PDO Cheese

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ABSTRACT

The research reported on this paper was aimed at improving the overall efficiency of a PDO certified artisanal cheese production process. Being a PDO certified foodstuff by the EU, it is considered to have properties and qualities determined by the geographical environment in which is made, with its production taking place in a specific and determined geographical location, in this case the Serra da Estrela region. In that sense, the authors conducted a mapping according to a systemic perspective of the processes involved in the context of manufacturing and distribution of certified Serra da Estrela cheese. Numerous methods were used throughout the process, such as a systemic design analysis, and techniques derived from ethnographic methods, which led to the collection of data in the field and consequently provided the immersion of the researcher in genuine work situations. Critical points were identified and emphasized in the systemic map with the purpose of encouraging initiatives to address and overcome the gaps and inefficiencies detected. The systemic design analysis triggered the development of design work. Observations following an ethnographic approach identified ergonomic risks in cheese making during the process of cutting excess chips, fostering the emergence of musculoskeletal disorders at the wrist. A tool that fits best to the task at hand was developed. A prototype of the new tool enabled collecting feedback from use in the work context, in order to inform product development. The domains of agricultural production and microbiology, considering the specific microorganisms developed trough the ripening process of the cheese, turned out to be aspects of high importance for the issue under focus, contributing to a broader understanding of the ripening process and its risks, simultaneously improving the efficiency and success of cheese production. If it were not for the systemic analysis, which served as a link between the boundaries of distinct domains such as the risk of microorganism contamination, ergonomics, energy efficiency, legislation and regulation policies, transportation challenges and economic viability, approached throughout the research. Simultaneously creating bridges between them, the various problems might not have been detected in the first place, as they are usually addressed in specialized disciplines, predetermined by the restrictions of each specific area of knowledge. As a consequence of the development of this research, which was based on an analysis that sought to establish possible connections between various disciplines and tried to constantly maintain a holistic perspective, making new connections and observing the issues from a new angle, apart from the already established methodologies. All this allowed to lay out the seeds for the development of a plan to tackle the critical points identified by the systemic analysis reported in this paper.

Keywords: process improvement; ewe's cheese; systemic design

INTRODUCTION

The long history and symbolism carried by the Serra da Estrela (SE) PDO (Protected Designation of Origin) cheese transforms it into a token for an industry and specific geographic region of Portugal. It might be considered the most important legacy of a way of life, part of a system that was gradually developed and adapted to the adversities found in the Serra da Estrela Mountains. With an annual output, on average, of 96.9 metric tons of cheese, and an average value of 1.46 million Euros (€), according to Table 1, it becomes clear that as a local economic activity it can be very significant for the regional development. The different processes associated with the manufacturing and distribution of Serra da Estrela PDO cheese were mapped based on a systemic approach. The process relied on systemic analysis, and on application of techniques from ethnography, which resulted on a substantial data collection and provided the immersion of the first author in real-life situations. Critical points were identified in the resulting systemic map in order to encourage initiatives to overcome detected ~~gaps and~~ inefficiencies and at the same time to develop well suited environmental and sustainable solutions.

The Serra da Estrela PDO cheese is one of the main results of a way of life that is part of an ecosystem, gradually developed and adapted to the local constraints over generations. Presently, new challenges emerge requiring to steadfastly follow the path of adaptability and flexibility. Thus, the features that make the Serra da Estrela PDO cheese an unparalleled product and so appealing to connoisseurs were investigated. An investigation was carried out to available space for future development of innovations that would not clash with the existing set of rules. This paper is the result of research carried out during the course of the second author's Masters thesis (Carrola, 2013).

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Table 1. Serra da Estrela PDO cheese production values and respective price by year (Lamas 2014, 62–64)

Year	Cheese Production (Metric Tons)	Price (€/Kilogram)
2002	90,10	14,96
2003	98,80	15,75
2004	93,60	15,75
2005	74,80	15,75
2006	81,00	14,70
2007	98,60	14,70
2008	101,10	14,70
2009	134,70	14,70

METHOD

Throughout the duration of this project a holistic perspective was adopted in accordance with a systemic analysis based on data collected from an ethnographic approach, observations (Couvinhas et al., 2012), and interviews, all this under a macroergonomics lens (Coelho et al., 2012). The design approach employed in the second part of the development work, reported in this paper, was presented by Coelho (2010) and by Figueiredo and Coelho (2010), based on work by Lewis and Bonollo (2002) and early work by Hales (1991). The operational model of the design process embedded in this approach is comprised of five subordinate processes (task clarification, concept generation, evaluation and refinement, detailed design of preferred concept and communication of results). In this particular case ~~at hand~~, detailed design was informed by user feedback and trials, and at the time of writing this paper, is yet to be completed. Task clarification was developed during the ethnographic observations carried out by the first and second authors. Concepts were generated, evaluated, and refined, leading to

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the detailed design of the preferred concept. The concept was then prototyped and used by cheese makers in user trials, which provided feedback to serve as input for the next round of iterations of the new hand tool design.

The Systemic Approach

The logics of linearity presents itself in the industrial sector through phenomena such as the cause-effect relationship; that means that technical problems are solved and strategies are drafted on a step by step basis in order to improve the product and innovate. However, a simple change of perspective on how the various situations taking place are observed can lead to more innovation. The key is to observe production processes in a systemic way, considering waste and residue, together with scarcity of raw material, from the onset of analysis. While taking preventive measures rather than corrective action one can ~~to~~ transform shortcomings in strengths and create situations where the outputs of a system become new inputs for the same or ~~another~~ a different system (Bistagnino and De Morais 2009).

The most common production models that can be found generate a lot of waste and have a general tendency to focus on the product, keeping other aspects dimmed. The methodology of systemic design traces the path of materials and energy during production, monitoring transition from one stage to another, throughout the cycle. As a result, it creates an important economic flow, while eliminating polluting parts. However, the focus is not only on environmental issues, but also on an economic model that encompasses not only the development of the productive system but also of society (Bistagnino and De Morais 2009).

Systemic design strives to make better use of material and energy flows, shaping our production and energy systems according to Nature (Bistagnino 2009). Systemic theory

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studies how complex entities interact openly with their environments and evolve continually by acquiring new, and ‘emergent’ properties (Heylighen et al. 2000). Rather than reducing an entity to the sum of its parts, systems theory focuses on the relationships between all its parts and what connects them into a whole; a reasoning leading to the ‘Gaia hypothesis’, which claims that the world is a single giant organism (Lovelock 1988). Systemic design proceeds with constant awareness of related systems, boundaries, external effects and potential feedback; it plans entities with inherent ‘resilience’ by taking advantage of fundamental properties such as diversity (existence of multiple forms and behaviors), efficiency (performance with least consumption), adaptability (flexibility to change in response to new challenges) and cohesion (existence of unifying forces or linkages) (Fiksel 2003).

To encourage systems that explicitly incorporate sustainability thinking, systemic design offers a scientific method deriving from generative science and developments from industrial ecology, (focusing on symbiosis and ecosystems) and cluster theory. It can be summed up by its five basic principles (Bistagnino 2009):

1 - Man at the centre of the project: products have become the fulcrum of a paradigm of values and actions, as economical wellness, the quantity of monetary resources, the desire to achieve social status, negatively shape consumption choices. This approach, instead, questions the present industrial setting and proposes a new paradigm where at the centre of each productive process there are social, cultural, ethical and biological values that every person shares.

2 - Output as input: as in Nature, what is not used by a system becomes raw material for the development and survival of someone or something else; in production processes waste (output) of a system becomes an opportunity (input) for another one, creating new economic opportunities.

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3 - Relationship: considering, broadly, all the networks of components in a production system, including materials (resources) and energy, which are used, captured and stored through different stages of the product life cycle. Understanding the pattern of material and energy flow and investigating where it can be improved enables identification of entry-points for designing a more sustainable system.

4 - Towards *autopoiesis*: in Nature, self-maintaining systems sustain themselves by reproducing automatically, defining their own paths of action. The system naturally seeks balance and preserves independence. If a production system were to aim *autopoiesis*, it would be possible to efficiently allocate and distribute material and energy flows.

5 - Act locally: just as an ecosystem is deeply influenced and shaped by its habitat, the same applies to any type of system. Based on local context, new opportunities can be created by reducing the problems of adaptability inherent to 'general' solutions and increasing people's participation.

Scrap generated by manufacturing processes is typically viewed as a cost. In order to go through the systemic design approach, it is essential to start from the current state and make a peculiar observation of all aspects which are part of the system (input), what occurs inside it and what comes out of it (output). The analysis of these inputs and outputs should be done both quantitatively and qualitatively. The result is a vision that encompasses the whole process and enables perceiving the relationships interwoven within the analyzed system. By exploiting resources in the territory, development has a local dimension and new self-sustained realities are spawned, in terms of energy, production and supply (Couvinhas et al. 2012).

Any company that wishes to remain competitive, sustainable and meet the needs of society and the market, now or in the future, should seek skills development for

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handling large amounts of information, the introduction of new technologies and continuously adapt to an ever changing environment (Bistagnino and De Moraes 2009).

Ethnographic Approach

A method based on ethnographic data collection, yields information compiled from field observations in order to support design research. A survey was carried out to acknowledge challenges and difficulties currently faced, in order to uncover points of action to make the product more competitive and appealing. This was done considering the product's market penetration, compared with competition, and taking into account considerations and concepts within the systemic design method. Relevant information about the subject of study was collected through analysis of resources readily available, observations at cheese making dairies, at ewe milking pavilions and places of grazing, and interviewing several stakeholders involved in the process, while performing photographic, video and audio documentation.

A compilation of all relevant information was made to support subsequent research developments. When performing this type of work, on-site observation is considered a mandatory requirement, enabling gathering of raw material that will later be processed and analyzed. A project meant to gather this type of information can be split into three stages: conducting a background investigation in preparation for fieldwork; actually carrying out fieldwork; and, finally, processing, organizing and systematizing information (Bartis 2002, Fetterman 2010).

Fieldwork followed market research focused on the commercial availability, packaging and sizes available in a sample of general and specialty stores (7 stores visited). Fieldwork entailed 5 events, summarized in Table 2. Additionally, a focus group session was carried out, described in detail by Vieira (2013).

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Table 2. Fieldwork events supporting the project

Date	Fieldwork events and field observations
Feb. 2, 2013	Participation in the regional Serra da Estrela Cheese Fair in Fornos de Algodres; visit to a traditional cheese dairy owned by Joaquim Albuquerque de Sousa, in Vila Ruiva (Fornos de Algodres).
Apr. 12, 2013	First meeting with ESTRELACOOP's certifying authority chief executive officer in Celorico da Beira; visit to the museum hall of the Cheese Manor in Celorico da Beira.
Apr. 23, 2013	Visit to the agriculture society of Vale do Seia, observation and registration of the cheese manufacturing processes, interviews and contact with shepherds in Santiago, Seia; visit to the Fernandes Pessoa dairy in Carragozela (Seia); Visit to "Casa Matias" to meet the company's CEO and discuss market challenges.
May 7, 2013	Observation of manual milking in a herd owned by Joaquim Nunes in Monte do Bispo, Belmonte.
May 20, 2013	Second meeting with the CEO of ESTRELACOOP in Celorico da Beira.

As an example of outcome of fieldwork, consider the first field activities listed in Table 2. These enabled identifying relationships between pasture improvement and ewe's milk quality improvement, as well as the proposed benefits and challenges involved in mechanical milking of ewes. Further outcomes of the ethnographic observations and analysis of requirements in the specification for the product certification are shown in the remainder of this section.

Production of Serra da Estrela PDO cheese must satisfy the conditions laid down in Annex II to the Portuguese Law Decree No. 38/2002 of 27th May, in addition to the conditions set out in documents provided by the certifying authority (ESTRELACOOP). Firstly, only producers authorized by ESTRELACOOP may use the protected designation of origin on their products. For this, producers must comply with certain conditions, exercising their activity exclusively in the production territory defined in Annex I to Portuguese Law Decree No. 38/ 2002 of 27th May. Only milk from *Bordaleira Serra da Estrela* and, or, *Churra Mondegueira* sheep breeds, from farms in

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the defined geographical area can be used. These must necessarily produce cheese according to the conditions laid down in Annex II of the above Ordinance and be willing to accept the system of control and certification provided, complying with it.

Producers must consider health, hygiene and management conditions of the herds, taking into account the necessary conditions for milking, collection, transport and storage of milk. Producers must control the quality of raw materials and follow the rules and hygienic procedures for cheese manufacturing. Each producer has an obligation to keep a record, which contains information on the origin of the milk and on the production conditions and by applying casein tags provided by ESTRELACOOP. They must also hold updated records of suppliers of raw materials, of the quantity of milk received and of the quantity of cheese produced.

Cheese that does not conform to the production rules stipulated may be sold with the designation of sheep cheese, but may not be given the Serra da Estrela PDO cheese designation. The herds of origin of the milk must be officially disease free. When it comes to milking it is advisable to milk each animal properly and the place where the milking takes place should be clean. After milking, milk should be immediately filtered into a pitcher in order to avoid possible contamination. If, by chance, milk is not used within a time window of 2 hours after milking, it must be properly cooled to a maximum of 8 °C if used up to 12 hours or less, to 6 °C if the delay is more than 24 hours and to less than 4 °C for up to 48 hours.

For the manufacture of cheese, milk is coagulated at a temperature of 27 °C to 32 °C. The amount of thistle flower (*Cynara cardunculus*) used to coagulate the milk should not exceed 0,3 grams per liter of milk and the salt content should not exceed 30 grams per liter of milk. Milk coagulation should take at most 60 minutes, followed

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immediately by cutting the curd and slow draining the whey. The weight of the cheese should be in a range of 0.5 kg up to a maximum of 1,7 kg with a diameter which can range from 9 to 20 centimeters, and a height between 4 and 6 centimeters. During the forming process of the curd, the casein mark must be applied, while the cheese remains in the "*cincho*" for up to 18 hours (Figure 1). After the curd is completely squeezed and has the appropriate diameter, it may continue subjected to pressure in order to almost completely deplete the whey (an average of 5 kg per cheese).

Figure 1. a) Mortar steeps where the thistle flower is crushed b) utensils for cheese production ; c) cheese with "cincho" d) traditional manufacturing utensils

The ripening or maturing process should be carried out in an appropriately controlled environment, particularly with respect to temperature. An acceptable interval lies between 6 and 12 °C, while required relative humidity lies between 80 and 95 %. The

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minimum ripening time is 30 days, but it may extend up to 45 days. During the ripening period the cheese must be regularly turned and cleaned, keeping the crust clean and smooth.

Once manufactured and certified, cheese must be kept in storage until its distribution. Storage temperature lies between 0 °C and 5 °C. During transportation as well as at points of sale, temperature is accepted to rest between 0°C and 10°C.

RESULTS

Careful analysis revealed the existence of relevant critical points that act as stifling factors to some system operations, and as such, requiring attention. The development of proper solutions for each one of them will certainly be beneficial for the entire system, resulting in improvements in efficiency and economic benefits. The systemic map developed is shown in Figure 2, part one and two. The systemic map that resulted from the research highlights the inputs, what enters in the system, on the left side and the outputs, the results of the system, on the right side. It shows the flows of matter and energy between the various stages of the process. Beginning in the Pavilion & Milking Room station until the final ones, the Packaging and the Transport until the point of sale. In the map there are also critical points, marked with an exclamation mark and numbered from 1 to 8, as well as a context note, that draws attention to the main weaknesses found in the system.

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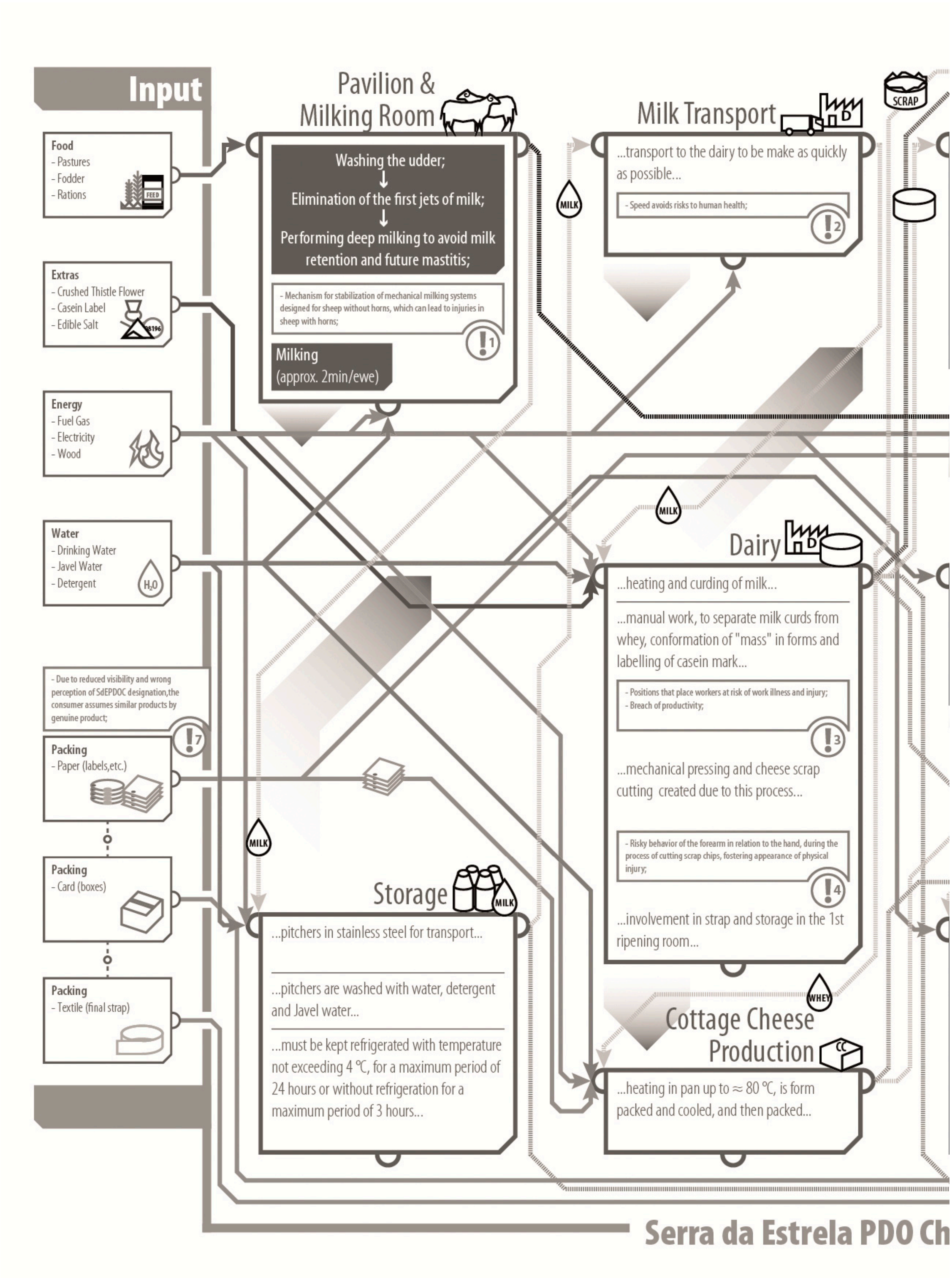

Figure 2: Overview of systemic mapping of the Serra da Estrela PDO cheese production (part one) © T.Carrola.

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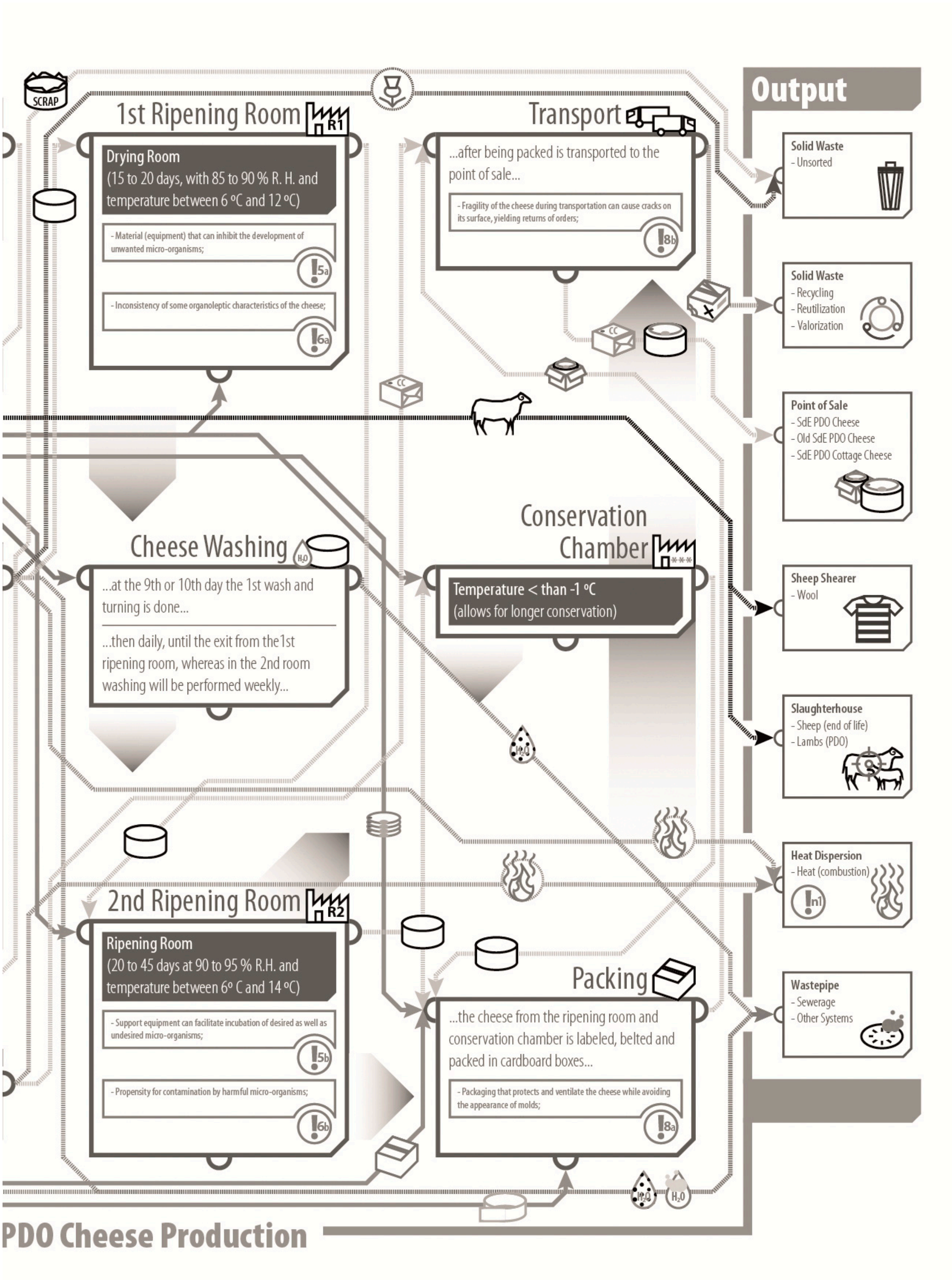

Figure 2: Overview of systemic mapping of the Serra da Estrela PDO cheese production (part two) © T.Carrola.

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Critical Points Identified

1 - Lock mechanism for milking systems designed for sheep breeds without horns, which can lead to injuries in sheep with horns. According to the description given in the Serra da Estrela PDO cheese production rules milk can only originate from two breeds: the "Bordaleira Serra da Estrela" breed with helical, elongated, strong, rough horns with a triangular section, and the "Churra Mondegueira" breed with thin horns of an open spiral shape, elongated in the horizontal plane, and with a slightly elliptical profile. Thus, this little anatomical detail turns a procedure that would otherwise be simple in something considerably difficult.

2 - Avoid any source of potential risks to human health. In cases where the same producer of cheese depends on dozens of small milk producers scattered in an area where there are several types of terrain and reliefs, gathering and transporting milk becomes one obstacle to overcome, which translates to the producer as increased cost. Moreover, there is the matter of ewe's milk, which does not undergo any kind of conservation procedure, in addition to the increased care with temperature and the time it takes from milking until production, the fact that the milk has to be transformed raw, as a requirement of the specification, further contributes to increase risk.

3 - Postures that place dairy workers at risk of injuries at work and cause productivity loss. The design of the "francela", which acts as a table to support the process of whey draining, forming the resulting mass in molds called "cinchos" and other minor tasks, has a slope in relation to the horizontal plane, which makes it useful for an uninterrupted fluid flow of the whey but at the same time contributes to erosion of the task's ergonomic qualities. This task hence places cheese makers at risk of injuries associated with task repetition at the level of the upper limbs and vertebral spine.

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4 - Development of musculoskeletal injuries of the hand and forearm during the cheese chip or barb trimming process. After removal of the cheese molds from the mechanical press, the resulting cheese cylinders present a barb, which manifests itself in the top edge, as a result of the contact area between the “cincho” and its lid. For the surface of the cylinder to coincide with the description contained in the Serra da Estrela PDO cheese specification rules, regarding the characteristics of the outer shell, it is necessary to trim excess material. Currently this activity is done manually using a cutting tool, an ordinary kitchen knife, requiring expertise for it to be done in a short time, while bearing the load of 0.5-2 kg cheeses.

5 - Equipment that can facilitate incubation of preferred microorganisms but also unwanted ones. The equipment that is used to store and support cheese during its entire ripening process should be composed of stainless steel or plastic suitable for food use, and may be alternatively made of unspecified wood. This being an option, each producer’s decisions are based on what is deemed best.

6 - Inconsistency of the organoleptic characteristics of the cheese and propensity for contamination by harmful microorganisms. During the entire ripening time, various microorganisms, fungi and bacteria contribute to and are also essential to the success of the process. Although tests and analysis of quality control for screening of pathogenic microorganisms are performed, the type of microorganisms responsible for the ideal characteristics that are wanted in the Serra da Estrela PDO cheese is not known with accuracy. This allows for variation in the product, taking into account variables such as the dairy where the cheese is produced, the season it is produced, as well as slight variations in humidity and temperature.

7 - Due to reduced visibility and distorted perception of the Serra da Estrela PDO cheese, the consumer accepts similar products for the genuine product. The fact that

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there is no uniformity in some of the features of the label (Figure 3) that identifies the product as a Serra da Estrela PDO cheese prevents consumers from developing stronger recognition. Competition from similar products, which in the eyes of the consumer is considered a product of the same category and quality as the SE PDO cheese, and the fact that those alternatives are more affordable, is the result of an inability to provide a communications strategy to underline and emphasize the Serra da Estrela PDO cheese as unique.

8 - Packaging that enables safety and ventilation of the cheese, preventing the appearance of molds (additionally, while it is transported some cracks may appear in its surface due to its fragility, resulting in retailer returns). One of the problems felt by producers focuses exactly on the number of orders that are returned from retailers due to issues in which the structural integrity of the product is called into question, as well as the manifestation of molds, which appear naturally in the cheese, an issue seen as a consumer deterrent at sales points.

Context Note - When it comes to heating of milk during the coagulation process and later during production of cottage cheese, heat is generated which is dispersed into the atmosphere of the dairy. This heat is considered a waste product, and as such, an output of the system. This waste is currently not used; however, the possibility for development of solutions and processes in order to make good use of it should be pursued. The production of this heat has its source in the combustion of gases (butane) that occur during heating of the milk. The fact that the combustion takes place in spaces with limited ventilation in which the workers perform the various functions required raises the question of the existence of a health risk, with respect to them, since it creates uncontrolled oscillation of carbon dioxide levels and oxygen concentration present in the working space atmosphere. There is also a situation where the production room is

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located adjacent to the cold room where the ripening process of the cheese is developed. These chambers are required to have controlled temperature and humidity. Direct contact with the work room in which the temperature varies in a random manner during the time in which the production takes place interferes with the ripening chambers. Due to practical reasons of ease of work, the latter are kept with the doors open so that a fluid traffic of workers may accrue, as they transport various cheeses simultaneously and are unable to make immediate alternative use of their upper limbs.

Figure 3 – a) Label Casa Matias; b) label Casa Matias premium; label Casa Matias selection.

The mapping of process and critical points developed can serve as a starting point for the development of future design work. The critical points unveiled represent challenges for improvement that reverberate in several domains, including the organoleptic qualities of the cheese, the cheese making process and respective tools, the well-being and safety of workers, as well as food safety, and visibility of the Protected Denomination of Origin certification. Systemic analysis has started to come to the forefront of production process analysis, given the pressures for sustainability. In the region of Beira Interior, where the study was developed, and particularly Serra da Estrela, traditional cheese making is undergoing many challenges. There is a need for innovation while respecting the requirements brought by the certification granted as part of the Protected Denomination of Origin label. The results of this study represent opportunities for efficiency gains, keeping in strict respect to the certification requirements and at the same time looking to satisfy the interests of all stakeholders of the Serra da Estrela PDO cheese sector.

The domains of agricultural production and microbiology turned out to be aspects of high importance for the issue under focus. If it were not for the systemic analysis, which served as a link between the boundaries of the various domains, new bridges between these various problems might not have opened, as these are usually tackled in specialized disciplines and predetermined by the restrictions of each specific area of knowledge.

This case study demonstrates the deployment of systemic design analysis within an activity centered and ethnographic approach. As a consequence of the development of this research, based on an analysis that sought possible connections between various disciplines and trying to constantly maintain a holistic perspective, design seeds have been laid out for the development of a plan to tackle the critical points identified by the systemic analysis reported in this paper. One of these critical points (number 4, listed in the previous section) is tackled in the following sections.

Design Requirements of a New Chip Cutting Hand Tool

As a consequence of the fieldwork carried out in the form of observations and interviews to a myriad of actors in the SE PDO cheese universe, as well as visits to several cheese making facilities, systemic analysis was performed and the critical points emphasized. This led to the consideration of the need for a device or utensil that is better suited to the task at hand was to be designed, to better support the cheese chip cutting process shown in photographs in Figure 4, for this was adopted an operational model of the design process described before. The need to trim the cheese barb that is formed as a consequence of the cheese pressing, to remove excess whey, has not only aesthetic grounds, but also functional ones. During the cheese ripening process, molds form on the outer surface of the cheese. As part of this process, washing of the cheeses is done regularly. This process is more efficient once the trimming is made. Task clarification yielded the following goals for the new hand tool: Cutting cheese chips in the upper face of the cheese in a hygienic manner; enabling easy repair, maintenance and cleaning of the hand tool; preventing the development of musculoskeletal disorders in the upper limbs of the cheese makers.

Figure 4: Cheese chip cutting process using a regular knife and supporting the full weight of the cheese.

Alternative Concepts and User trials of Prototype

Several design concepts were generated (Figure 5) and these were rated against evaluation criteria derived from the initial goals set for the project. Upon the first iteration of evaluation, the alternative concepts were crossed with one another, producing a new design that combined the best features of each of the original concepts generated by the first author. This concept was then designed in detail and prototyped in order to undergo user trials (Figure 6). The trials showed the need for an improvement in the prototype, in order to make the cheese cutting blades more versatile by angling them in relation to the disc shaped part of the design. Alternative handle designs are also to be developed in order to enable a more neutral posture of the wrist, when using the tool for cheese chip cutting. At the time of writing the project is awaiting funding to proceed to the next iteration of redesign of the hand tool and user trials.

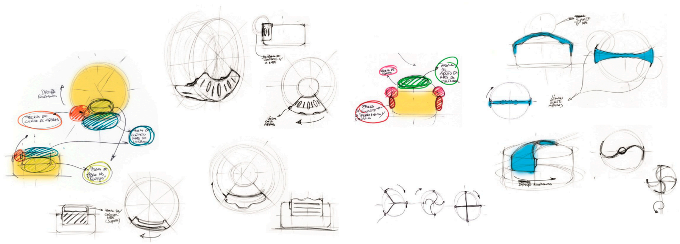

Figure 5: Alternative conceptual sketches. © Tiago Carrola.

Figure 6: Detailed design and user trials of the new hand tool. © Tiago Carrola.

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CONCLUSION

The mapping of process and critical points developed can and must serve as a starting point for the development of future related work. The critical points unveiled represent challenges for improvement that reverberate in several domains, including the organoleptic qualities of the cheese, the cheese making process and respective tools, the well-being and safety of workers, as well as food safety, and visibility of the Protected Designation of Origin certification. In the region of Beira Interior, where the study was developed, and particularly Serra da Estrela, traditional cheese making is undergoing many challenges, therefore there is a need for innovation while respecting the requirements brought by the certification granted as part of the Protected Designation of Origin label. The results and findings of this study suggest ~~represent~~ opportunities for gains in the overall efficiency of the system ~~gains~~, keeping in strict respect to the certification requirements and at the same time looking to satisfy the interests of all the Serra da Estrela PDO cheese sector stakeholders.

The domains of agricultural production and microbiology turned out to be aspects of high importance for the issue under focus.

As a consequence of the development of this research, based on an analysis that sought possible connections between various disciplines and trying to constantly maintain a comprehensive approach, a first step was given towards the development of a plan to tackle the critical points identified by the systemic analysis reported in this paper. The sustained and informed development of the proposals carried out, as well as the possibility of highlighting other opportunities for action, was in good part only possible due to the intersection points that arose during the process of observation, research and project-development. Although only one of the identified critical points was developed, and unfortunately due to time constrictions could not be further refined, we may affirm that the results achieved allow us to conclude that a broader and profound approach could only be beneficial to the whole system. It was clearly visible that there is space in the sector for this kind of innovation and thinking. Also, the utilization of other methods and tools to assist in the resolution of said critical points was never out of the table, tools such as life cycle assessment and other methodologies can only contribute to better final results, solutions and conclusions.

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