

Manufacturing analysis of the Serra da Estrela PDO cheese under the perspective of systemic design

Tiago E. P. CARROLA¹, Ana F. COUVINHAS² and Denis A. COELHO¹

¹ *Dept. of Electromechanical Engineering, Universidade da Beira Interior, Covilhã, Portugal;* ² *Observatory - TechnoServe Mozambique, Nampula, Mozambique*

Abstract. The authors conducted a mapping according to a systemic perspective of the processes involved in the context of manufacturing and distribution of Serra da Estrela PDO cheese. Various methods were used throughout the process, from the analysis of systemic design, through the application of techniques derived from ethnographic methods, which led to the collection of data in the field and consequently provided the immersion of the first author 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.

Keywords. Systemic design, ethnographic approach, process mapping, critical points.

1. Introduction

The Serra da Estrela PDO (protected designation of origin) cheese is not simply a cheese, its long history and the symbolism assigned to it make it a totem of a sector and a specific region of Portugal. It is one of the main results, if not one of the most important, of a way of life that is part of an ecosystem, since nature is integral and an active part of it, which was gradually developed and came to be adapted to the adversities found and eventually turning these into benefits. Presently, there are new challenges that are imposed in a changing world, and it is important not to stand still, and 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, noting strengths and weaknesses of the product concerned. An investigation was carried out to unveil the requirements needed to obtain "Serra da Estrela PDO cheese" certification, in order to try to understand what is the performance space available for the future development of benefit enabling innovations that do not clash with the current set of rules established.

2. Methods

The work reported in this paper sought to find weaknesses and opportunities for improvement at the level of the semi-artisanal manufacturing of the Serra da Estrela PDO cheese in the current context. This search aimed to boost the development of solutions to promote increased efficiency of the processes involved in the production of the Serra da Estrela PDO cheese. A holistic perspective was adopted, by means of deploying a systemic analysis based on data collected from observations (Couvinhas et al., 2012) deploying an ethnographic approach and interviews, while keeping a macroergonomics

lens in perspective (Carayon, 2006; Coelho et al., 2012).

2.1 The Systemic Approach

The most common production models that can be found generate a lot of waste and have a general tendency to focus on the product, relegating to the background the other aspects. The methodology of Systemic Design traces the path of matter during the production chain monitoring the passage from one stage to another, throughout the cycle, through continuous transformations. As a result, it creates an important economic flow progressively eliminating the pollutant parts that impact on the environment, the ecological aspect. However, the focus is not only on environmental issues, but also on the economic model that includes not only the development of the productive system but also society (Bistagnino and De Morais 2009).

The methodology of systemic design looks at making better use of material and energy flows in order to model our production and energy systems according to nature (Bistagnino, 2009). Systemic theory is the study of how complex entities interact openly with their environments and evolve continually by acquiring new, 'emergent', properties (Heylighen et al., 2000). Rather than reducing an entity to the properties of its parts or elements, systems theory focuses on the relationships between the parts that connect them into a whole. This type of reasoning leads 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, boundary conditions, external effects and potential feedback. Systemic design plans entities with inherent 'resilience' by taking advantage of fundamental properties such as diversity (existence of multiple forms and behaviors), efficiency (performance with modest resources consumption), adaptability (flexibility to change in response to new pressures) and cohesion (existence of unifying forces or linkages) (Fiksel, 2003).

2.2 Ethnographic Approach

A survey was carried out to acknowledge challenges and difficulties currently faced, in order to uncover areas or points of action in order to make the product increasingly competitive and appealing. This was done considering the product's market penetration, compared with the competition, and taking into account all the considerations and concepts covered by the methodology of systemic design. Efforts were undertaken in order to obtain relevant information about the subject of study, through analysis of resources readily available, observations at cheese making dairies, at ewe milking pavilions and places of grazing, and interviewing the various stakeholders involved in the process, while performing photographic, video and audio documentation.

Working on a methodology based on an ethnographic approach to the gathering of information (Rosenthal and Capper, 2006), a compilation was made of all the information that was regarded as relevant to the support of future research developments. When performing this type of work, it is important to note that the on-site observation is considered a mandatory requirement, enabling the 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, in the last stage, the information is processed, organized and systematized (Bartis, 2002; Fetterman, 2010).

a. Results

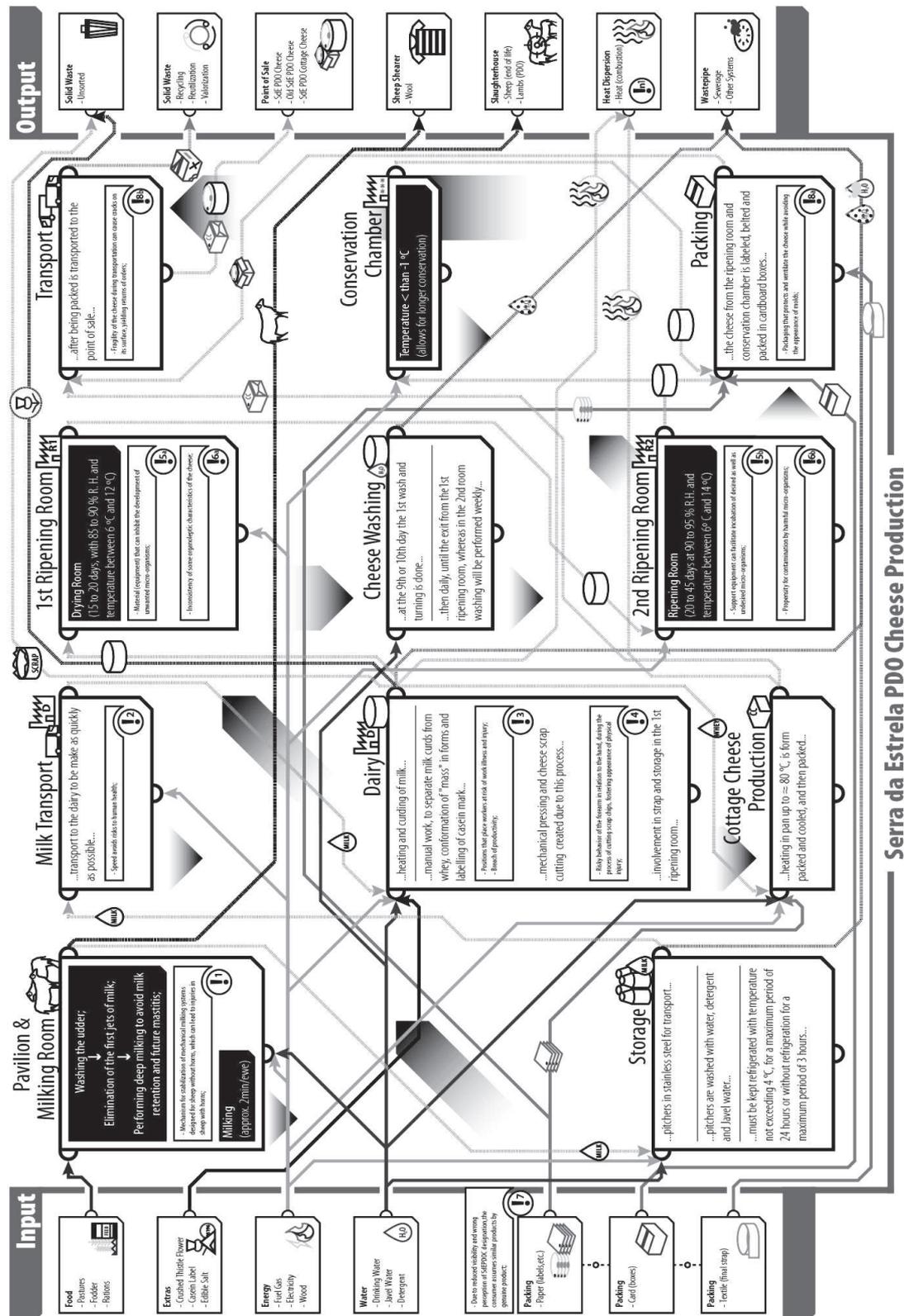


Figure 1: Systemic mapping of the Serra da Estrela PDO cheese production © T.Carrola.

A careful observation and analysis revealed the existence of relevant critical points that act as stifling factors to some system operations, and as such, it is necessary to pay attention to

them. The development of proper mitigating or improving procedures for each one of them will certainly be beneficial for the entire system, as it will result in an improvement in efficiency and in economic benefits. The systemic map developed is shown in Figure 1.

2.3 Critical Points

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, which begs for adjustments and consequently increased costs.

2 - Quickly 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 more obstacle to overcome, which translates to the cheese producer as an increase in costs. Moreover, there is the matter of ewe’s milk, which does not undertake any kind of procedure for its conservation, 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 accentuate the risk at this point.

3 - Postures that place dairy workers at risk of injuries at work and cause breaks in productivity. 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 an erosion of the task’s ergonomic qualities. This task hence places cheese makers at risk of injuries associated with repetition of the task at the level of the upper limbs and vertebral spine.

4 - Development of musculoskeletal injuries of the hand and forearm during the cheese chip or barb trimming process. After the 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 the excess material. Currently this activity is done manually using a cutting tool, usually an ordinary kitchen knife, requiring some expertise and experience for it to be done in a relatively short time, while bearing the load of 0.5-2 kg cheeses.

5 - Equipment that can facilitate the incubation of preferred microorganisms but also unwanted ones. The equipment that is used to store and support the 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 made based on what is deemed best suited for each.

6 - Inconsistency of the organoleptic characteristics of the cheese and propensity for contamination by harmful microorganisms. During the entire time the cheese ripens, 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 such as *salmonella*, *listeria* and *staphylococcus*, 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 unknown

allows for variation in the product, taking into account variables such as the dairy where the cheese is produced, the season in which it is produced, as well as slight variations in humidity and temperature, to name a few.

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 there is no uniformity in some of the features of the label that identifies the product as a Serra da Estrela PDO cheese prevents consumers from developing a stronger recognition. The competition from similar products, which in the eyes of the consumer is considered a product of the same category and quality as the Serra da Estrela PDO cheese, even though it's not, and the fact that those alternatives can be 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). Due to the sensitive nature of the product, development of a packaging makes sense pursuant to it providing protection during transport and during waiting times endured at the point of sale. 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 some molds, which appear naturally in the cheese, because the ripening process doesn't really stop and although these can be easily removed with a simple wash or cleanse without any compromise to the quality of the product, this issue is seen as a factor that deters consumers at the time of purchase.

Context Note - When it comes to heating of the 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 the 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 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 under controlled conditions 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 hence unable to make immediate alternative use of their hands.

3. Discussion and Conclusion

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 study demonstrated the deployment of systemic design analysis within an activity centered macroergonomics 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. A couple of those critical points (numbers 4 and 7, listed in the previous section) have been tackled in Carrola et al. (2014).

References

- Bartis, P. 2002. *Folklife and fieldwork: a layman's introduction to field techniques*. 3rd ed. USA: Library of Congress. 38 p. (Publications of the American Folklife Center, n° 3).
- Bistagnino, L. & De Morais, D. (2009). *Design Sistemico: uma abordagem interdisciplinar para a inovação*. In Krucken, L. (Ed.) *Cadernos de estudos avançados em design – sustentabilidade vol. 2*. Barbacena, MG, Brasil: EdUEMG. 79 p.
- Bistagnino, L. (2009). *Design Sistemico. Progettare la sostenibilità produttiva e ambientale*, Bra, Italy: Slow Food Editore.
- Carayon P (2006) Human factors of complex sociotechnical systems. *Meeting Diversity in Ergonomics. Applied Ergonomics* 37(4): 525–535.
- Carrola, T.R.P., Vieira, F.L., Couvinhas, A. F. & Coelho, D.A. (2014). Redesign of the logo and design of a new ergonomic hand tool enabled by systemic analysis of the Serra da Estrela PDO cheese universe. *Proceedings of Human Factors in Organizational Design And Management – XI & Nordic Ergonomics Society Annual Conference – 46*; O. Broberg, N. Fallentin, P. Hasle, P.L. Jensen, A. Kabel, M.E. Larsen, T.Weller (Editors), International Ergonomics Association.
- Coelho, D.A., Ferrara, P.R., Couvinhas, A.F., Lima, T.M., & Walter, J.K. (2012). Macroergonomic aspects in the design of development programs in IDCs. *Work*, 41, 2651-2655.
- Couvinhas, A., Ferrara, P., Coelho, D., Jorge, S., & Walter, J. (2012). Ergonomic considerations for a systemic approach: the millennium maize mills project in northern Mozambique. *Work*, 41, 568-575.
- Fetterman, D.M. 2010. *Ethnography: step-by-step*. 3rd ed. United States of America: SAGE. 173 p. (Applied social research methods series; v. 17).
- Fiksel, J. (2003). Design resilient, sustainable systems, *Environmental Science and Technology*, 37(33), 5330-5339.
- Heylighen, F., Joslyn, C. & Turchin, V. (Eds.) (2000). *Principia Cybernetica Web*. Retrieved March 7, 2012, from <http://pespmc1.vub.ac.be>.
- Lovelock, J. (1988). *The Ages of Gaia: A Biography of our Living Earth*, NY: Norton.
- Rosenthal, S. R. and Capper, M. (2006). Ethnographies in the Front End: Designing for Enhanced Customer Experiences. *Journal of Product Innovation Management*, 23: 215–237.