XXX CIOSTA – CIGRV Congress, Turin, 2003
Management and technology applications to empower agro-food systems
ISBN 88-88854-09-6

Work organisation and safety in some dairies with different types of production and size

L. Dioguardi[1]

[1] *University of Milan, Agricultural Faculty, Institute of Agricultural Engineering, via Celoria 2, 20133, Milano (MI), Italy*

e-mail: loredana.dioguardi@unimi.it

Summary

The present study investigates 5 dairies to identify the organisational constraints that are liable to put the safety of workers at risk. The analysis is based on the Method of Organisational Congruence. The most frequently observed constraints are associated with the work environment, the process methods employed and low levels of personnel involvement. The constraints which arise from the work environment can be countered through interventions in the design stage.

Keywords: work organization, health, safety, dairies, integrated design

Introduction

With the coming into force of Delegated Law 626/94, the issue of health and safety in the workplace is now being addressed not just in terms of physically preventing accident and injury, but also with an eye to ergonomics and well-being. Taking this as a starting base we have sought to further examine the relationship between work organisation and health and safety, focusing on the dairy sector where there are still many operations of small or medium size.

Materials and Methods

We investigated 5 small to medium sized dairies in Lombardy Region, which engage in different productions (table 1). In each one we identified the factors giving rise to constraints, and which are frequently neglected despite their potentially decisive role in ameliorating the quality of work. We then sought to correct these factors through improved organisational and design solutions that can provide an integrated answer to the requirements of worker safety and the specific needs of the production process.
For each stage of the production process, we identified common risk factors and recurrent stress conditions, comparing how the organisational and technical solutions adopted in each setting impacted on the identified risk factors. A variety of processes were examined in each dairy operation, and on the whole the study took in productions of Grana Padano, Gorgonzola and Mozzarella di Bufala cheese, yoghurt, and the packaging of yoghurt and mature cheeses.
Our analysis was carried out using the Method of Organisational Congruence, developed at the "L. Devoto" Institute of Workplace Medicine of the University of Milan (Maggi B., 1991). Application of this method begins with direct observation of a workplace situation, in order to detect, disaggregate and systemise those elements pertaining to:

ISBN 88-88854-09-6

- activities (unit operations and structuring of tasks);
- work locations, methods and timing;
- technical know-how (pertaining to objects, equipment, procedures);
- personnel qualifications, skills and involvement.

Special survey sheets and check lists were prepared to enable all the researchers to collect data in an objective and consistent manner. To obtain a detailed description of the work environment, we examined the buildings and made measurements of ambient conditions with regard to noise, lighting, temperature and humidity.

The noise measurements were performed in accordance with Del. Law 277 of 27/08/1991 (Heading IV and Annex VI). The instrument used for the measurements was a Class I integrating sound-level meter manufactured by Larson Davis, mod. DSP 82. Noise levels were measured during each stage of production, at the specified work positions, noting which systems were running at the time.

Lighting levels were measured using a Minolta mod. T-10 light meter on the "fast" response setting, which is better suited for natural light and lamps, with the sensor placed on a horizontal plane at a height of 1 metre from the floor. For each work environment, both the general and local lighting levels (at the individual work positions) were measured. Some of the measurements were performed both in summer and winter, to make note of any seasonal variations. Our reference for optimal lighting levels was the UNI 10380 standard.

Microclimate measurements were performed using an Aquaria Helios microclimate monitor. The values measured were temperature, relative humidity and air flow speed. The microclimate data was acquired at one minute intervals, however only the average values of the acquired data, at 10 minute intervals, were recorded. All measured values were also date and time stamped. The acquired data was transferred to a personal computer, through a serial link using a special data transfer program. The data was graphically processed using Microsoft Excel.

We then proceeded to identify organisational constraints and evaluate alternative solutions by analysing the interdependence between the various factors, and their effects from the standpoint of health and well-being. With respect to the quantification of organisational constraints, only ambient conditions could be assessed through detailed measurements, whereas the remaining risk factors were estimated on a qualitative basis.

Results

Layout - None of the dairies had a "box within box" design, in which the processing environment is isolated from the outside world through buffer areas. Only two of the dairies had optimised layouts that physically mirrored the flow of production, without any backtracking or overlapping of the paths taken by products, equipment and personnel. It must be underlined how the use of old buildings for production activities is often liable to put the hygiene of the product at risk.

Size of work areas – The cheese-making operations are carried out within a single work environment, which is often too small for the activities and equipment that it must accommodate (figure 1). The size of the production area determines the maximum number of vats which can be installed, and hence the manner in which the production is organised to handle the total amount of milk processed each day. A clear example of this are the two dairies that make Grana Padano cheese. In both cases, production is managed by 1 master

ISBN 88-88854-09-6

cheese-maker and 2 workers. However the first dairy works a single shift, while the second works a double shift. This is because the first dairy has a larger amount of space available (1/3 more), allowing it to install twice as many vats as the second dairy, even though it processes the same amount of milk each day (24000 kg/day).

Flooring - A major cause of accident in the dairy sector are floor surfaces (6 accidents out of 53 in 2001 in Lodi Province), which can cause slipping, tripping and falls. This is because during cheese-making the floors are always wet with milk, fat and water, and workers do not wear adequate PPE. Four out of five dairies were found to have unsuitable floors--i.e. smooth and without acid-resistant resin grouting to prevent grease from sticking between the tiles. The risk of tripping was exacerbated by pipes laid on the floor, and by the broken grilles of discharge channels (figure 2).

Contact constraints – Work environments that are cramped and inappropriately laid out can favour accidental contact with components at high temperature. The process forces workers into prolonged contact with hot whey and curds (40°-50°C and acidic pH) during separation of the curds or pulling of the mozzarella. This can result in irritation, dermatitis and skin burns, due to the workers' failure to wear protective gloves, which are uncomfortable.

Noise – Production operations are generally not very noisy (table 2), with the exception--in all the dairies--of the washing areas where values between 85-90 dB (A) were recorded.

In particular, an interesting case is that of the two dairies that make Grana Padano cheese, which have significantly different noise levels (table 3). This is mainly due to differences in the organisation of the work, a fact that would not have emerged so clearly without detailed measurements made in each individual production phase. The first dairy (1) initiates suction of the whey during draining of the curds, and completes its collection after about 30 minutes. The second dairy (2) instead turns on its suction pumps right after the settling of the curds in the whey, so that the pumps run for a total of about 90 minutes. Clearly, the second dairy must first of all a re-organise its production to avoid switching on the pumps before it is necessary. After which it is possible to consider solutions such as purchasing less noisy pumps, or relocating them to a confined area.

In the case of Gorgonzola cheese, noise levels are always at around 85 dB(A), even during manual operations such as placing the curds in the "fascera" mould, because the milk skimming and pasteurisation operations are carried out simultaneously in the same area. Here, too, the production should be reorganised so that these operations do not overlap, or the layout altered to locate the pasteuriser and centrifuge in a separate area. In the cheese packaging plant, the noisiest phase was the cleaning of the cheese rinds. This operation is carried out in a separate area, due to the high noise level of the equipment and of the operation itself (> 90 dB(A)). Workers spend a full 8 hours in the cleaning area, without alternating shifts in other departments, and must wear ear protection muffs all the time. This is another example of how poor work organisation can significantly compromise health and well-being, and could be easily corrected by alternating workers on shifts in less noisy stations.

Lighting – The measured lighting levels were strongly affected by the presence of windows, and therefore varied depending on the season and time of day. The average measured values are given in table 4. Although the average lighting levels were in most cases comprised between 150-500 lux--the optimal range according to the UNI 10380 standard--note that these values do not express the true lighting conditions. In fact, consider for example the production of Grana Padano cheese (table 5) which takes place from 3 to 6

ISBN 88-88854-09-6

a.m. and from 6 to 9 a.m. . Clearly, in this case the greatest problems will arise during the first processing phase, when there is no sunlight, and the artificial lighting available is often insufficient in the areas where product inspections take place. The lights are frequently placed above the vats, with the resultant risk of condensation forming, and droplets falling on and contaminating the product. In the storage areas, artificial lighting is inadequate and there is often no natural light whatsoever (there are no windows because these areas have insulated walls to maintain optimal microclimate conditions). This hampers the quality control of the product.

Microclimate – The microclimate of a dairy is by its very nature characterised by high temperatures and relative humidity, as our study confirmed (table 6). High levels of humidity may cause condensation to form. This can be countered by installing air-conditioning systems--which however may be prohibitively expensive, especially for small dairies--or through improved ventilation of the rooms designed to extract the moisture upward. Worker hardship (figure 3) can instead be minimised by improving the organisation of work with more frequent shift changes. Fortunately, the high levels of humidity last only for a short time, and the ambient temperature is not too low.

Manual handling of loads – Traditional cheese-making methods demand considerable physical exertion from workers, to an extent that varies depending on the type of operation (table 7, figure 4), the weight of the cheeses (Grana Padano 30-36 kg; Gorgonzola 8-12 kg), the repetitiveness of the movements and the posture adopted (determined by the conformation of the vats) (figure 5). The effects of the above, compounded by a hot-damp microclimate or excessive noise, serve to increase the level of worker fatigue.

Work pace – Cheese-making dairies function 7 days a week. Despite a stressful daily workload, workers are unwilling to accept reduced shifts for financial reasons. In mini-dairies production is more flexible, because it depends on how much the dairy's store is selling. Demand generally escalates at the beginning of spring-summer, forcing workers to step up the pace of production. At the same time, the small size of the operation makes it is impossible to divide the work up into shifts.

Personnel qualifications and satisfaction - The personnel of dairies, with the exception of the master cheese-maker who is a specialised technician, often consists of unskilled immigrant labourers. These workers perform purely manual tasks which do not require specific training or qualifications. Their mental involvement is minimal, because they must only follow the orders of the cheese-maker. The cheese-maker is the only worker authorised to perform inspections and take decisions, leading to a better level of engagement and involvement on his part (tables 8-9). In addition, the cheese-maker is the only worker who cannot be replaced by other personnel, due to his specialist knowledge of the process.

Discussion

The common factors which contribute to generating hardship and constraints can be principally ascribed to the work environment, the manner in which processes are carried out and poor levels of worker involvement. The layout and the choice of building finishes, especially the floors, can pose a hazard to both worker safety and the hygiene of the product. This state of affairs is a clear consequence of poor initial choices: i.e. the decision to reconvert existing buildings, adapting them to meet the hygiene regulations in force, rather than using purpose-designed facilities for the specific needs of the process. Excessive noise, lighting levels that are frequently inadequate and a harsh microclimate all serve to

ISBN 88-88854-09-6

aggravate worker discomfort, and hence the likelihood of accident. The traditional cheese-making methods require workers to maintain strenuous postures and lift considerable loads, especially in the smaller dairies where the degree of mechanisation is minimal. The level of job satisfaction among unskilled labourers is low, both because the work does not engage them mentally, and because of the exhaustion which results from lack of rest and a harsh work environment. The constraints arising from the work environment can be prevented in the design stage, through an evaluation of all the factors which impact upon the well-being of workers. The Organisational Congruence Method is able to elicit a great deal of information, including that which is not formalised, making it a valuable analysis tool for:

- effectively predicting the effect of any given intervention based on the psycho-physical constraints which result from it;
- comparing different organisational options for a given workplace situation, to find alternative solutions with a lower impact.
- informing and educating workers, and the other actors involved in prevention, on the risks and behaviours to be adopted in specific work situations.

References

AA.VV. 1996. Formazione per la prevenzione, metodo delle congruenze organizzative e D.Lgs 626/94. Quaderni del gruppo di ricerca Organization and well-being. I edizione. Tirrenia stampatori, Torino, 86 pp.

Maggi B., 1991. Lavoro organizzato e salute. I edizione. Tirrenia stampatori, Torino, 254 pp.

Mosca F., Breviglieri M.A., 1994. Lavoro, salute e azione sindacale in un comparto agricolo. I edizione. Tirrenia stampatori, Torino, 165 pp.

Dioguardi L., Sangiorgi F., 2002. La progettazione integrata nell'industria agro-alimentare. Proceedings of the AIIA "La sicurezza delle macchine agricole e degli impianti agro-industriali", 11-15 September 2002, Alghero (SS), Italy.

Dioguardi L., Sangiorgi F., Cortellessa G., 2002. Le condizioni ambientali in caseifici lombardi: conseguenze su igiene della produzione e qualità degli ambienti di lavoro in un caseificio artigianale. Proceedings of the AIIA "La sicurezza delle macchine agricole e degli impianti agro-industriali" 11-15 September 2002, Alghero (SS), Italy.

Table

Table 1. Production data for the 5 dairies investigated.

Dairy	**Type of product**	**Milk processed** (100kg/day)	**N° workers**	**Milk processed per capita** (100kg/worker·day)	**Dairy area** (m^2)	**Area per capita** (m^2/worker)
1	Grana Padano	250	4	62.5	500	125
2	packaging	-	123	-	30,000	243
3	Grana Padano, Gorgonzola	250	6	41.7	1,700	283
4	yoghurt	2.5	1	2.5	185	185
5	Mozzarella di Bufala	2	2	1	66	33

ISBN 88-88854-09-6

Table 2. Average noise levels (dBA) in the 5 dairies studied.

Dairies		**1**	**2**	**3**	**4**	**5**
Noise	dB(A)	79.2	82.0	84.5	73.7	64.0

Table 3. Noise (dBA) measured in 2 dairies during production of Grana Padano cheese.

Production phase	**Dairy 1**	**Dairy 3**
Transfer of milk into vats	71.9	75.7
Addition of whey-starter, curds, lysozyme	83.5	n.d.
Coagulation	76.5	77.6
Breaking curds	75.3	84.6
Cooking curds	85.6	86.2
Settling in whey	75.0	81.7
Curd separation	75.8	86.0
Placing in "fascera" moulds	83.4	87.3
Collecting whey	81.4	88.9
Turning cheeses	61.7	79.5

Table 4. Average lighting levels (lux) in the 5 dairies studied.

Dairy		**1**	**2**	**3**	**4**	**5**
Lighting	lux	177[1]-320[2]	344	129[1]-354[2]	507	372

[1] measured in the absence of natural light (h 3.00 am)
[2] measured in the presence of both natural and artificial light (h 9.00 am)

Table 5. Lighting levels (lux) measured in December during production of Grana Padano.

Work position	**3:00 a.m.**	**9:00 a.m.**
Chemical analysis lab	187	450
Milk holding tanks	114	220
Copper vats	160	170
Tables for placing in moulds	140	160
Salting	130	130
Heating warehouse	30	30
Maturing cellar	30	30

Table 6. Average values of temperature (°C) and relative humidity (%) in the 5 dairies studied.

Dairy		**1**	**2**	**3**		**4**	**5**
Temperature	°C	25	18	21.5[1]	24.5[2]	18.6	21.5
Relative humidity	%	85	n.d.	57.6[1]	75.8[2]	62.7	63.8

[1]Gorgonzola production area
[2]Grana Padano production area

ISBN 88-88854-09-6

Table 7. Manual handling of loads during production.

Production phase	**1 –3 (Grana Padano)**	**2**	**3 (Gorgonzola)**	**4**	**5**
Cheese-making	whey expulsion, turning	no	turning	transp. milk drums	no
Salting	loading-unloading cheeses	no	salting	-	transp. to refrig. cell
Maturation	turning	no	no	no	no

Table 8. Qualification level of workers.

Dairy	**1**	**2**	**3**	**4**	**5**
Cheese-maker	adequate	-	adequate	not always adequate[1]	adequate
Workers	adequate	adequate	adequate	-	adequate

[1]during packing of yoghurt

Table 9. Level of worker satisfaction.

Dairy	**1**	**2**	**3**	**4**	**5**
Cheese-maker	high	-	high	high/low[1]	high
Workers	medium	medium	low[2]	-	high

[1]during packaging of yoghurt
[2]due to excessive noise

Figures

Figure 1: Constraints arising from limited space for the activities.

ISBN 88-88854-09-6

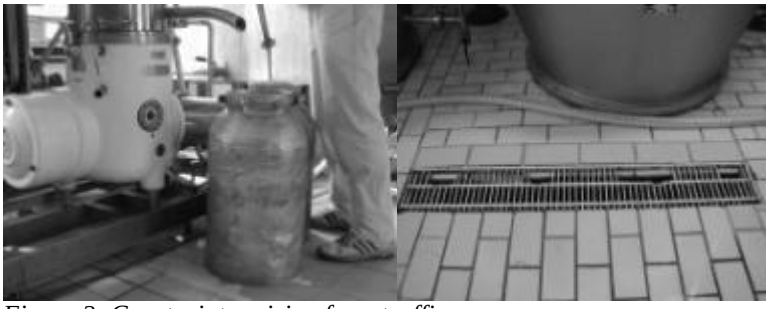

Figure 2: Constraints arising from traffic areas.

Figure 3: Constraints arising from excess humidity.

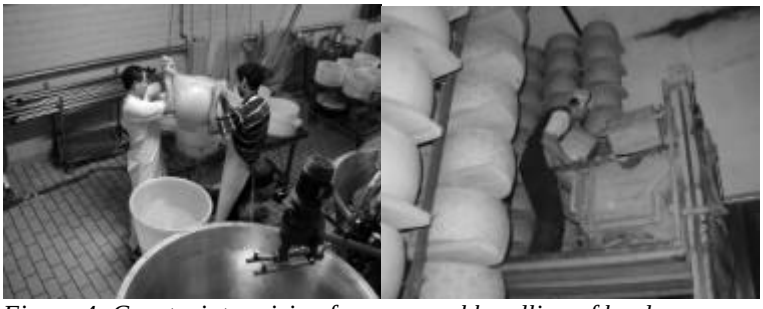

Figure 4: Constraints arising from manual handling of loads.

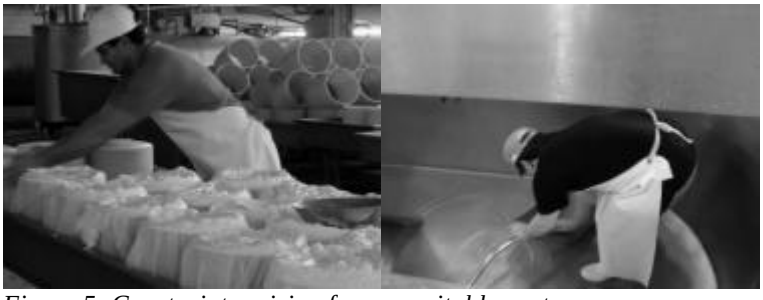

Figure 5: Constraints arising from unsuitable postures.