HACCP in practice

Roy Kirby describes its use in small- and medium-sized enterprises (SMEs)

The hazard analysis critical control point system (HACCP) has been evolving in the food industry since it was first deliberated by the First National Food Protection Conference. Small- and medium-sized enterprises (SMEs) are companies with fewer than 500 full-time employees. This article addresses the implementation of HACCP in SMEs, highlighting some of the problems. The problems can be arranged in four groups: insufficient technical resources, concentration of functions, time and financial power. It is the conclusion of this article however, that there are no barriers to the application of HACCP in all food production operations.

INTRODUCTION

Bearing in mind that much excellent material has already been published on the hazard analysis and critical control point system (HACCP), this paper aims partly at introducing HACCP to SMEs in a form which will make the system more SME-accessible and partly at stimulating some discussion among HACCP experts regarding aspects particularly relevant to SMEs.

HACCP is a system for improving the safety of food products for consumers by reducing the risks. The system applies to all risks, that is all factors which may be prejudicial to the health of the consumer, and from production to consumption. The system is different, in that it is a non-traditional and ideally a non-destructive type of continuous monitoring. It has been evolving in the food industry since 1971, when it was first deliberated by the First National Food Protection conference (USA) (American Public Health Association, 1972). It received increased regulatory acceptance in the USA in 1973 and 1974 as a result of the threat of botulism in canned mushrooms. On three separate occasions from 1985 to 1987, it has been recommended by various National Academy of Sciences subcommittees to be employed as the inspection technique of choice (National Academy of Sciences, 1985a, 1985b, 1987).

Small- and medium-sized enterprises (SMEs) may be defined as those industries with fewer than 500 full-time employees. Until recently HACCP has been a subject for discussion by regulating bodies and international expert groups who have defined the systems objectives, laid down the structure, explained its advantages and limitations and created its vocabulary (Codex, 1989, 1991a, 1991b; International Commission for Microbiological Specifications for Foods, 1988; National Advisory Committee on Microbiological Criteria for Foods, 1989). Following the comprehensive treatment of HACCP by the International Commission for Microbiological Specifications for Foods (1988), many authors have described how the technique can be applied to food products (Buchanan, 1990; Stevenson, 1990) and some have produced reports on the system and its use in connection with industries which have a large percentage of SMEs. These include: seafoods (Garrett and Hudak-Roos, 1990; Huss, 1992); meat and poultry products (Tompkin, 1990; Adams, 1990; Anon, 1991); slaughterhouses (Roseg *et al.*, 1990); dairy industry (Shapton, 1988); and catering facilities (Bryan, 1990).

The fishing industry is typically one where a very high percentage of SMEs may be found and is extremely important to Portugal, contributing approximately 80 million ECU to the economy. Lee (1977) was one of the first to publish an article on the use of HACCP with fishery products. Following a hazard analysis, he concluded that heat-processed foods usually consumed with no additional cooking prior to consumption were the highest risk category. He went on to describe an operational process chart for specific seafood products, such as smoked fish. He pointed out that, while at least 13 individual steps are involved in the commercial process of smoking fish, only three are critical: brining, smoking and storing. Many have since followed his example, publishing

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detailed process flow diagrams and accompanying hazard analyses. Some recent publications have attempted to outline how HACCP can be implemented, one of the most well known of which is by the Campden Food and Drink Research Association (1993).

As previously intimated, the subject of HACCP has been exhaustively discussed. Despite the wealth of information published relating HACCP to small-scale production processes, one of the few remaining challenges in this area is the adoption of the system by SMEs. The aim of this article is to demonstrate that HACCP is applicable to all sectors of the food and drink industry including SMEs. This article will attempt to address the challenge of implementing HACCP in SMEs, highlighting some of the specific potential problems that may be faced and presenting proposals to overcome them. Some of these problems and solutions have been presented by Mayes (unpublished) and discussed by the FLAIR concerted action on HACCP. The findings of this group were due for publication in September 1993. In order to persuade SMEs that the HACCP system can be applied to their specific case it is necessary to avoid confusing and complicating the issue. The article also aims, therefore, to present official HACCP literature in a simplified way avoiding jargon. Many definitions and principles are presented in a way as to explain the ideas without using the official language. A new dichotomous key (decision tree) for the identification of critical control points (CCPs) is also presented.

IMPLEMENTATION OF HACCP

HACCP is a system which identifies hazards, recommends methods for their control and then monitors and verifies the control. Previous authors (Codex, 1991b; National Advisory Commitee on Microbiological Criteria for Foods, 1992) have described the system as having seven principles which are steps along the road to implementation. These seven principles have recently been redrafted in the Codex publication ALINORM 93/13A (Codex, 1993) where they are described in detail. *Table 1* summarizes these principles. It is essential that the first contact with the system by SMEs should not be overly detailed or confusing, therefore the information from the Codex document is presented in a summarized form.

Table 1 The seven principles of HACCP (modified from Codex, 1993)

Principle	Subject	Action
1	Hazard analysis	Construct a flow diagram of the process stages Identify and list all of the potential hazards
2	Identification of the critical control points (CCPs)	Identify the CCPs using a decision tree (*Figure 1*) Specify the systems of control
3	Establish critical limits	Target values and critical limits must be set for each CCP
4	Monitoring	Continual or regular registering at each CCP to verify maintenance of control
5	Correction	Establish protocols for: (i) when a CCP is moving towards loss of control (ii) when a CCP is already out of control
6	Verification	Establish systems to confirm the correct functioning of HACCP
7	Documentation	Establish documentation regarding all of the procedures and records necessary for the implementation and operation of the above principles

For HACCP to be succesfully implemented in a company, the following prerequisites must be met: that the implementation has the full support and participation of the most senior management; that the implementation be driven from within the company; that the whole process from raw materials, preferably supplier accreditation, to consumption be considered; and, that all company staff are made aware of the importance of quality, the importance of safety as a component of quality and of their individual roles in achieving the company quality goals.

The implementation of HACCP requires one action before any of the principles can be addressed; namely, the formation of the HACCP team. The members of the team and their roles are shown in *Table 2*. The formation of the HACCP team is critically important to the success of the whole implementation programme.

As stated in the introduction, the process must be considered from the raw material to consumption. Production can effectively be broken down into four areas of activity. In reality there are no barriers between these areas, which

Table 2 Members of the HACCP team and their roles

Title	Role
Chairman	Must convene and chair all meetings and ensure that the technique is correctly applied
Production specialist	Usually the person most appropriate to construct the process flow chart. He may also act as a buffer against the recommendation by the team of control measures which would be impossible, impractical or inappropriate to implement within the current or future production system
Technical specialist	Should be capable of understanding the hazards and risks associated with the product. More than one technical specialist may be required to complete the study
Process engineer	Supply information regarding the mechanical/operational performance of the processing lines or the processing intentions of individual process stages
Other specialists	As the study progesses the need may arise to consult specialists in other areas such as raw material purchases, packaging, distribution and sales
Secretary	To provide an accurate written record of the team's progress

Table 3 Detailed aspects of each of the four areas of production which contribute to a HACCP study

Raw materials	Processing phases	Final product	Laboratory analysis
Delivery book	Material handling	Storage	QA policy
Certificates of analysis	GMP status	Distribution	Manual
Supplier audit	EHD status	Retail storage	Organisation
Identified risks	Monitoring	Consumer habits	Equipment
Inspection	Registers	Risk awareness	Methods
Quarantine	Risk awareness	Complaints	Results
Handling	Product codes		Records
Storage	On-line control		Audits
Traceability	Off-line control		
Conformation			

EHD, equipment hygienic design; GMP, good manufacturing practice; QA, quality assurance

are: raw materials, processing, final product and laboratory testing. It is interesting to note that testing laboratories can now be subject to a HACCP-type study as demonstrated in the recent publication from the Association of Official Analytical Chemists (Garfield, 1991) in which critical control points in the laboratory are discussed. Some of the detailed aspects of each of these areas which contribute to a HACCP study are shown in *Table 3*.

User guides on the implementation of HACCP are now available and may be consulted on the details of implementation procedures. The technical language in these different manuals is slowly being standardized and is the subject of a multitude of publications: this subject will therefore not be addressed further.

PROBLEMS FACING SMEs

HACCP is regarded by many as a tool for large-scale production and not having a relevance for small-scale production. This view is incorrect. HACCP was initially designed for small-scale production of a specialist product where a high level of safety and confidence in that safety was needed, a situation which commonly exists in many SMEs. HACCP as a system and philosophy has many factors which recommend it for use with SMEs. As many people, however, prefer to concentrate on the negative and raise objections to its implementation, this article attempts to challenge some of the preconceived negatives regarding HACCP implementation in SMEs.

Issues such as the wording of definitions, the emphasis on microbiology and the role of good manufacturing practice (GMP) in CCPs, are general problems affecting all companies associated with the implementation of HACCP and have been previously addressed by other authors (e.g. Garrett and Hudak-Roos, 1990) and will not be discussed further here. SMEs face some specific potential problems in applying HACCP. They are discussed below. Proposals made to overcome such problems are made in the following section. The problems generally linked to HACCP implementation in SMEs can be grouped together as outlined below.

Insufficient technical resources

It may be claimed by many SMEs that they do not have the full range of skilled technical resource (particularly specialist resources, e.g. microbiologist, food chemist, technologist, packaging expert) available to perform the HACCP study. As a result therefore, some of the technical detail required to perform the study may be unavailable.

Concentration of functions

Within SMEs it is common for one person to have more than one area of responsibility; this phenomenon may be termed 'concentration of functions'. Concentration of functions often means that good lines of communication exist within the company. The disadvantage however, is that many responsibilities are concentrated in the hands of one or two people, giving rise to some difficulties assembling the HACCP team as a result of conflicts of interest, and in carrying out the HACCP study due to a lack of breadth of knowledge.

Time

Due to the concentration of functions it may be difficult for employees of SMEs to include the HACCP work in the daily routine and to put aside the necessary time. To perform a HACCP study both large and small companies must prepare the flow chart, analyse the hazards and follow the rest of the seven principles. As the system is production line specific, the implementation process requires roughly the same amount of work regardless of the volume of product produced. In SMEs the number of people amongst which the work of implementation may be divided is fewer, making time a problem for them. This problem is directly linked to concentration of functions.

Financial power

The smaller financial power of SMEs has three implications with regard to HACCP which make the full implementation of the system especially difficult for them. The first of the difficulties is the cost of the implementation of the system relative to a company's turnover, this relative cost being potentially higher in smaller companies compared with larger ones. The second difficulty is purchasing power; their smaller purchasing power means that they often cannot exert sufficient influence on their suppliers to move to using HACCP systems. Finally, the power that they can exert over clients is limited, making it difficult for them to ensure that the control of hazards is maintained right up to the point of sale.

PROPOSALS FOR SOLUTIONS

It could quite rightly be pointed out

by larger companies that SMEs have many advantages with regard to the implementation of the system: furthermore, many senior managers of multinational companies now state publicly that the implementation of a quality assurance system like HACCP is no longer simply a question of improved profits but is an issue fundamental to long-term company survival. The implementation of HACCP or similar systems in SMEs is therefore no longer optional, it is essential.

Allocating time

Concentration of functions may mean that to include the HACCP study in the daily timetable and to put aside the necessary time required is difficult for employees in SMEs. In this case the implementation of HACCP can be achieved either by allocating time within the current company structure or by making additional resources available. Once it has been understood that the correct implementation of the system is essential, the justification for making available the necessary resources is automatically made.

To optimize the use of time, the input of specialists both from within and from outside the company should be carefully programmed at the beginning of the study. It is important to remember that the whole company must be made aware of quality and safety. The successful implementation of HACCP depends upon the cooperation and goodwill of all company employees. The consultation of members from all departments within the company may be a great help in fulfilling these goals.

Once the HACCP system is operating it is important to remember that monitoring and auditing functions will need to be carried out. Personnel and the necessary time must be made available for these roles too.

Addressing the lack of technical/ specialist resources

Following the allocation of resources, both human and material, the next step must be the gaining of an understanding of HACCP and related subjects, e.g. GMP. Good manufacturing guides for the food industry have been published, by among others, the Institute of Food Science and Technology in the UK (Institute of Food Science and Technology, 1991, 1992). An understanding of the principles of HACCP itself can gained through HACCP user guides and specific training sessions.

When addressing HACCP for the first time many are put off by the apparent complexity of the subject. The HACCP system can be simplified for SMEs. The system as originally designed by Bauman (1974) addressed only safety issues. Attempts have been made to broaden the scope of the system to include issues other than safety (Coons, 1991). Much confusion and overelaboration can be saved if the system is used for the purpose for which it was originally intended.

The practise of risk assessment of each hazard may also be addressed here to simplify the system for

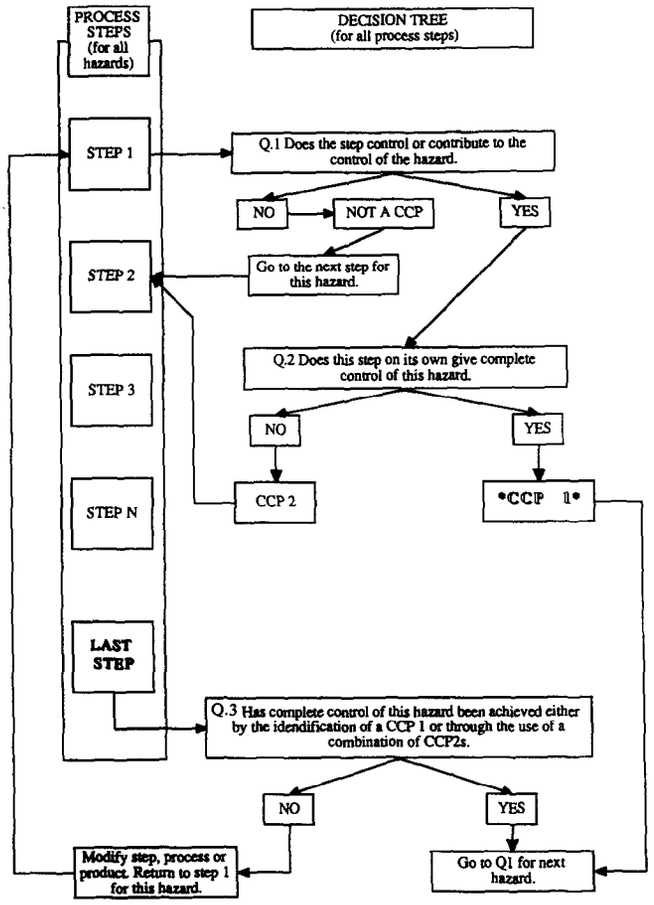

Figure 1 Proposal for a decision tree for the identification of critical control points (CCPs) in SMEs. Each hazard identified in the hazard analysis must be treated individually. The questions must then be answered in sequence for each process step. After the last process step for each hazard go to Q3.

Q1. Does the step control or contribute to the control of the hazard? If YES then the step may be a CCP: the group must then DEFINE WHAT IS CRITICAL (pH, temperature, etc.) and define monitoring and verification protocols. GO TO Q2. If NO go to NEXT STEP Q1. **Q2. Does this step give absolute control of this hazard?** If the answer is YES then the STEP UNDER CONSIDERATION is a CCP 1. A CCP 1 is defined as a step which on its own completely eliminates a hazard. Go to step 1 Q1 for the hext hazard. If the answer to THIS QUESTION is NO then the step under consideration for this hazard is a CCP 2. A CCP 2 is a step which contributes to the control of a hazard but which on its own cannot be relied upon to eliminate it. The use of two or more CCP 2s may be used to eliminate a hazard. GO TO next process step Q1. **Q3. Has complete control of this hazard been achieved?** If YES GO TO step 1 Q1 for the next hazard. If NO and preventative measures are not in place for this hazard the HACCP team must make a PROPOSAL FOR CONTROL. Return to step 1 Q1 for this hazard. After performing the analysis the HACCP team must verify that control is achieved for all hazards

SMEs. Traditionally microbiological hazards are divided into four hazard categories. The subject of hazard assessment with regard to risk and severity is addressed in detail for microbial hazards by the International Commission for Microbiological Specifications for Foods (1988) and for chemical and physical hazards by Corlett and Stier (1991). For HACCP studies in SMEs, the quantification of risks is an area needing specialist input and careful consideration when applied. Since the HACCP philosophy was developed around the principle of zero tolerance and the goal is to eliminate the risk to consumers, quantifying risks can be considered to be against the basic ideology of HACCP. Theoretically the HACCP system in SMEs should simply aim to eliminate the presence of all identified hazards in the final product. Perhaps in the cases where risks cannot be eliminated, good information for the consumer should be supplied.

The standard decision tree as presented by the Codex Alimentarius Commission (Codex, 1993) is a useful tool for the identification of CCPs. A decision tree designed specifically for use in SMEs is presented in *Figure 1* and the accompanying text. The alternative decision tree has been designed with the intention of making it as simple and accessible as possible to people with less of an understanding of HACCP. The intention is to facilitate attempts to implement the system in SMEs where a lack of technical resources may mean that previous contact with HACCP has been limited.

There are several points which are important to remember when determining the CCPs in a process: (i) no minimum or maximum number of CCPs must be identified; (ii) CCP identification is a factory and product specific process; (iii) avoid unnecessary duplication of CCPs; (iv) do not introduce control where control should not exist or is not necessary; (v) where serious doubt occurs consult an expert; (vi) above all, use common sense.

A justified criticism of the use of CCP2s (a critical control point 2 is a step which contributes to the control of a hazard but which on its own cannot be relied upon to eliminate it) is a tendency to lead to large numbers of them being identified making the HACCP system unworkable. It is important to remember points (iii), (iv) and (vi) and the example of Lee (1977). In his article on the use of HACCP with fishery products he identified many individual steps in the commercial process of smoking fish, but indicated that only three were critical.

Whether or not the HACCP study is carried out by SME staff alone or with outside help, all of the information relevant to the study (e.g. raw materials list, flow diagram, product formulation, times/temperatures of processing) must be prepared before the study starts. An indication of some of the areas which must be covered in a HACCP study are shown in Table 3. A more complete list is given by the International Commission for Microbiological Specifications for Food (1988). Due to the large variety of processes that may exist in the case of the catering industry, flow diagrams for catering companies should refer only to process steps; details of the activities at each step should be obtained but used later in the study.

Due to the fact that in extreme cases loss of control may only be recognized long after production and release of the product, the HACCP analysis must also address the problem of product recall from distribution centres, retail outlets and, in extreme cases, the consumer. While HACCP minimizes the risk of loss of control, the potential for its occurring must be recognized. An acceptable and workable recall procedure is therefore required as a part of responsible management; ideally, this plan should be tested to train staff in its use and to ensure its effectiveness and efficency.

Concentration of functions

A full HACCP study requires a multi-disciplinary team made up by a number of individuals with specific skills, however, in a SME it is quite possible that the range of skills will be covered by fewer people; it may be necessary therefore, for one person to fulfil several roles. Provided that all relevant information is available and that the team is capable of using such information to ensure the correct identification and control of hazards, this situation is acceptable.

Where expertise is lacking within a company, expert advice should be obtained from other sources; such sources may include published data, codes of practice, industry guidelines, GMP guidelines or consultancy services. It is important that all of the information gained from the above sources be critically evaluated and applied to each company's specific situation; a function in itself which requires a good understanding of HACCP, GMP and unit operations.

Financial power

The problem of the cost of the implementation of the system relative to the company's turnover is a problem faced with the purchase of any new resource and is not specific to HACCP. Experience shows however, that initial costs are quickly recovered by improved productivity, quality and fewer customer complaints (Baird-Parker, 1990).

With the advancement of modern technology, new on-line control methods are constantly becoming available, examples of which include near infra-red spectroscopy which can be used for on-line moni toring with products such as beer, wine and flour (Scotter, 1990) and ultrasonics which can be used to measure the status of cleanliness of processing lines (Richardson *et al.*, 1993). The control options implemented in SMEs provide one example of where careful consideration of the financial costs is important. Once control options and monitoring systems have been proposed, systems for the rapid and effective signalling of loss of control should be considered. Such warning

systems include visual (lights), audible (bells or sirens) or both combined. This will avoid the unnecessary use of valuable staff for monitoring operations.

In relation to difficulties with the implementation of HACCP in areas of the process outside the company's own direct control, it should be remembered that the most powerful argument should not be the company's own financial power but proven facts based upon scientific arguments. The shortcomings of inspection and the advantages of quality assurance techniques have previously been published by many of the authors referenced in this article. Reason not force should be used to persuade other companies to implement the system: companies are more likely to correctly implement and operate the system when they are convinced of its benefits.

CONCLUSIONS

Current knowledge regarding the behaviour of known pathogenic organisms and the toxicity of chemicals is always expanding. This combined with the fact that new hazards are forever being identified means that HACCP is a continuous and evolving system (Stevenson, 1990). The system, however, must be simultaneously flexible, to allow for evolution, and rigid, to prevent operator error.

HACCP is, without doubt, a powerful and useful tool for improving the safety of food products. Its implementation throughout the food industry is becoming ever more important for companies' long term survival and pofitability. The world-wide trend is for inspection to be replaced as a means of assessing a company's ability to supply high quality products, both at a commercial and national level. Among others, Adams (1990), for meat products, and Garrett and Hudak-Roos (1990), for seafood products, have called for the introduction of HACCP into national regulatory agency programmes in the USA.

The responsibility for survival and profitability lies with each individual company. Therefore, the responsibility for dealing with the challenges of the modern world also lies with the company. These are the main reasons why HACCP programmes must be driven from inside the company.

Stevenson (1990) concluded that many smaller companies may lack the appropriate resources to put a HACCP programme into place, stating that they lacked the will to commit the necessary resources. The benefits of HACCP is a subject that has been addressed in this article and by many authors including Baird-Parker (1990) and they need not be reiterated here.

It is the conclusion of this article that there appear to be no barriers to HACCP being applied to all food production operations and incorporated into quality assurance plans. In companies where the lack of will exists, perhaps it is due to a lack of understanding of the importance of the issue.

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