

# Make to stock or make to order: The decoupling point in the food processing industries

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## Abstract

Food processing industries experience growing logistical demands, growing variety in products and intense competition. As a reaction companies try to produce more on order. Often managers find it difficult to decide which products to make to order and which products to stock. This paper develops a frame that is an aid for managers in balancing the factors and characteristics of market and production process that influence such decisions. The frame is based on the general decoupling point concept by Hoekstra and Romme, which is adapted to the specific characteristics of the food processing industry. Its usefulness is illustrated in a case study. Some directions for further research are given. © 2001 Elsevier Science B.V. All rights reserved.

*Keywords:* Decoupling point; Market response; Make-to-order; Food processing

## 1. Introduction

For many years it was a common policy for food processing companies to produce in large batches to keep production costs low and limit the number of set-ups. This seemed to be a good policy. The last decade showed a number of changes, gradually growing in significance. The background and causes of these changes can be summarised under three main themes.

Firstly, consumers' wishes seem to change in an ever growing rate, causing an increase in

packaging sizes, the number of products as well as in the number of new products introduced, e.g. [1].

Secondly, many retailers are restructuring their supply chain both in a physical and information flow sense. The aims are reduction in inventories, faster replenishment and shortening of cycle times. The result for food processing industries is that logistical performance needs to be improved: faster and more dependable. There are some examples of reductions in lead-time from 120 hours in the past to 48 hours now and still further reductions are to be expected.

Thirdly, the above-mentioned changes have to be realised in a market which can be characterised by low margins in retailing and mergers and acquisitions in retail chains [1]. Both lead to a downward pressure on prices paid to producers.

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In summary, food processing industries have to deliver a greater variety of products, have to meet higher logistical demands, while keeping costs as low as possible. These demands are especially visible in those industries that produce for the consumer-market and their direct suppliers.

This article explores more flexible production as a possibility to cope with these market demands. As said above, the industry standard is to produce to stock. Producing more flexible requires that (part of the) customer orders have a direct impact on production orders. However, usually there are certain limits and not all products for all customers can be made to order. Therefore an important question is which products, product families or product–market combinations can and should be produced to stock and which can be made to order. To answer this question the general frame of Hoekstra and Romme [2] is used. Especially their concept of *decoupling point*, which is defined as “the point that indicates how deeply the customer order penetrates into the goods flow”. Hoekstra and Romme distinguish a frame in which a number of product and market characteristics, and process and stock characteristics influence the location of the decoupling point. This frame will be adapted to the specific characteristics of the food processing industry.

The main question to be answered in this article is how managers in food processing industry can be supported in deciding if some of their products can and should be produced to stock or be made to order and, if there are some, which should be selected. In investigating this, we also add to our knowledge of the usefulness of the decoupling point concept in this particular type of industry. So far, little attention has been paid to this type of questions in the literature.

The article is organised as follows. First, we will introduce the general frame of the decoupling point. Next, the specific characteristics of food processing industries are presented. Then, the findings of these two sections are combined to arrive at a concept for the decoupling point tailored to the food processing industry. Section 4 will show the usefulness of the concept in a case study. Lastly, conclusions are drawn and some remarks regarding further research are made.

## 2. The decoupling point concept

The background of the concept of decoupling point lies in the observation that within production management and logistical management attention has been paid to all kind of separate elements in a production chain, without notice for the need for an integrated framework. In developing the frame of the *decoupling point* (DP) Hoekstra and Romme [2] intend to furnish a concept for integral control. Integral control in this context means planning and management of the goods flow from purchased materials to delivery takes place, based on the characteristics of the product–market combination, within a suited organisational and control structure (also see, [3]).

An important concern in designing integral control is finding a balance in the costs of procurement, production, distribution and storage against the customer service to be offered.

The result of this balancing establishes the decoupling point for a certain product–market combination. The decoupling point separates the part of the organisation oriented towards activities for customer orders from the part of the organisation based on forecasting and planning [2, p. 6], or, in other words the decoupling point is the point that indicates how deeply the customer order penetrates into the goods flow [2, p. 66].

The decoupling point is important for a number of reasons:

- It separates the order-driven activities from the forecast-driven activities. This is not only important for the distinction of different types of activities, but also for the related information flows and the way the goods flow is planned and controlled.
- It is the main stock point from which deliveries to customers are made and the amount of stock should be sufficient to satisfy demand in a certain period.
- The upstream activities can be optimised in some way, as they are based on forecasts and are more or less independent from irregular demands in the market.

According to [2] five possible DP positions correspond to five basic logistical structures: make and

Table 1  
Determinants of the decoupling point

Product and market characteristics	Process and stock characteristics
Required delivery reliability	Lead times and costs of steps in the (primary) process
Required delivery time	Controllability of manufacturing and procurement
Predictability of demand	Costs of stock-holding and value added between stock points
Specificity of demand	Risk of obsolescence

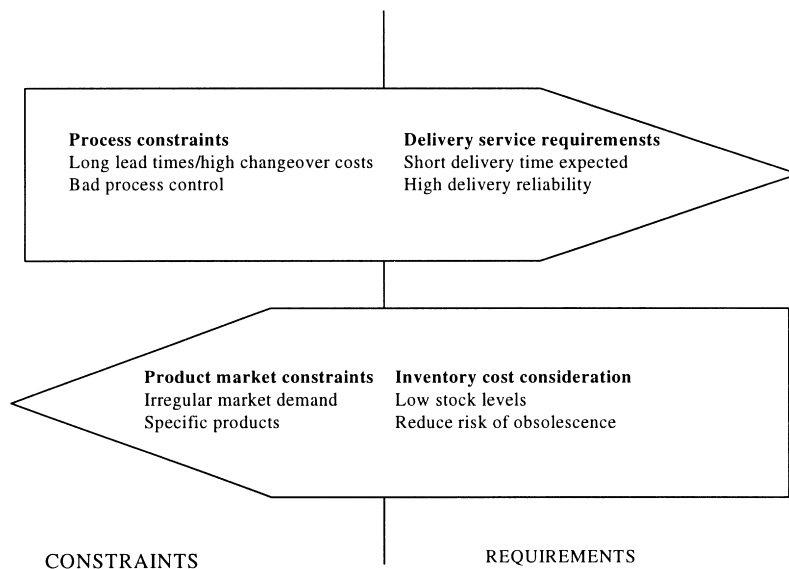


Fig. 1. Business characteristics classified according to their nature and influence on the DP [[2], p. 71].

ship to (local) stock; make to (central) stock; assemble to order; make to order; purchase and make to order. As stated the determination of the position of the DP depends, in general on two sets of characteristics: product and market characteristics, and process and stock characteristics, which are summarised in Table 1.

Their respective influence is depicted in Fig. 1 [2, p. 71]. Fig. 1 should be interpreted as follows. For each of the terms mentioned the influence on the location of the DP is shown. e.g. irregular market demand will (if all other things remain stable) have an upstream effect on the location of the DP, while short delivery times will force the DP more downwards, towards the make-to-stock position.

The DP concept is a valuable tool in describing and analysing production processes and the goods flow of organisations. However, from the existing literature it is hard to derive rules for locating or changing the position of the DP or procedures for balancing the relevant characteristics. Also, the effects of having more DP's (for different product-market combinations) in one factory and the consequences for planning have been largely neglected. Recently, [4] combines the location of the DP and the location of the capacity constraint into one matrix to derive the characteristics of an integrated material and capacity-based master schedule. Further work into this direction seems a good addition to the DP concept.

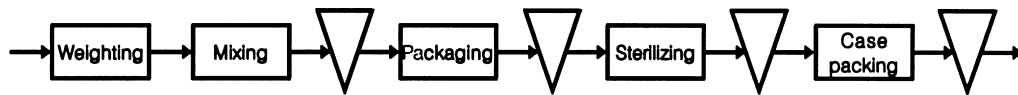


Fig. 2. An example of a production process in food processing.

### 3. Characteristics of food processing industries

This section introduces the food processing industries from a production management point of view. For the purpose of this paper it is useful to distinguish between companies that produce intermediate products from natural materials and companies that process these intermediate products further into consumer or industrial products. The first category involves mills, abattoirs, sugar refineries, etc. while the second category entails producers of canned meat, bakeries, producers of chocolates, etc. Of course, this distinction is rough and some of the producers of intermediate products, produce some consumer products as well (e.g. a sugar refinery producing sugar cubes). We will pay attention to the second category. An example of a food processing process can be depicted as in Fig. 2.

Instead of packaging, other processes might occur and sometimes products are pasteurised or sterilised before packaging. In many cases, stock points as depicted can only store temporarily, due to the perishability of intermediate products or because the capacity for storage on the shopfloor is limited.

From the literature [5–9] the following enumeration of characteristics of food processing industry can be compiled [10].

#### (1) Plant characteristics

- (a) Expensive and single-purpose capacity coupled with small product variety and high volumes. Usually, the factory shows a flow shop oriented design.
- (b) There are long (sequence-dependent) set-up times between different product types.

#### (2) Product characteristics

- (a) The nature and source of raw material in food processing industry often implies a variable supply, quality, and price due to unstable yield of farmers.

- (b) In contrast with discrete manufacturing, volume or weights are used.
  - (c) Raw material, semi-manufactured products, and end products are perishable.
- (3) Production process characteristics
- (a) Processes have a variable yield and processing time.
  - (b) At least one of the processes deals with homogeneous products.
  - (c) The processing stages are not labor intensive.
  - (d) Production rate is mainly determined by capacity.
  - (e) Food industries have a divergent product structure, especially in the packaging stage.
  - (f) Factories that produce consumer goods can have an extensive, labor-intensive packaging phase.
  - (g) Due to uncertainty in pricing, quality, and supply of raw material, several recipes are available for a product.

In most cases a limited number of these characteristics is present. We use the list above for examining, describing and analysing real-life situations. Each of the factors presented, has to be taken into account for planning and scheduling purposes. E.g. high set-ups and an orientation to use capacity as much as possible, cause planning of long production runs and stocks of end products.

### 4. Decoupling point in food processing industry

The previous sections elaborated upon the general influences of market and process characteristics on the position of the decoupling point and on the characteristics of the food processing industry. This section will relate the two. For each factor the effect on the decoupling point for a certain product/market combination will be discussed under a *ceteris paribus* clause for other factors. This

Table 2  
Market characteristics and their influence on the decoupling point

Market characteristic	Presence/value in food	Effect on DP
Delivery reliability	High	Downstream
Delivery time	Short	Downstream
Predictability of demand	(rather) unpredictable	Upstream through information sharing
Specificity of demand	Great variety end products (with common recipes)	Upstream possibilities

analysis is performed from the point of view of a producer of food products, delivering to retailers (nowadays, usually supermarket chains, or integrated combinations of wholesaler with a number of outlets).

With respect to the *market characteristics* we may conclude that, as was already stated in the introduction, delivery times are usually short and customers (such as retail chains) need a high reliability. Both tend to have a downstream effect on the decoupling point. These short delivery times seem to go hand in hand with a relative unpredictability of the demand from the point of view of the producer. In a number of cases the retailers try to pass all the uncertainty in demand onto the producers by asking instant delivery within very short time, without adequate support in forecasting demand. Nowadays better opportunities emerge in forecasting by analysing point-of-sale and scanning data. Better co-operation and sharing of these data between retailer and producer could bring mutual benefits within easy reach and even open possibilities for a longer lead time. Although actual demand of the consumers might be still erratic, such joint efforts in forecasting might improve overall performance of the supply chain. A last point to pay attention to, is the specificity of demand. As noticed above, food processing industries have divergent product structures. Often the diversity of products originates from the large number of packaging sizes, labels and brands. Specificity also comes into being through the best-before-date. It is interesting to note that many products have a technical best-before-date which is reasonably long. However, retailers do not accept succeeding deliveries with identical best-before-dates. The result is that from a technical point of view products are still

fresh, but from a commercial point of view obsolete and in fact, extremely perishable. All in all, the factor specificity offers some potential for an upstream repositioning of the decoupling point if commonality can be used and intermediate storage between processing and packaging is technically possible. The above discussion is summarised in Table 2.

With respect to the *process and stock characteristics* it is clear that part of food processing industries have an uncontrolled process with variable yield and, due to variability in natural materials, variable quality of products. Such factors cause a downstream effect on the decoupling point, because storing a product after the uncontrolled process safeguards undisturbed delivery. Cleaning times and set-ups (which are often sequence dependent) are an important factor in production in food processing industry. If these are large, the effect on the decoupling point will also be downstream. An upstream effect on the decoupling point might be expected for the remaining factors: stock levels (and costs) and risk of obsolescence. Both factors relate to the nature of food: it's perishability. Retailers always want the most recent "best-before" and stock might easily become out-of-date due to the best-before on the product. This might occur even if the technical shelf-live is still quite long. The value of stock is related to this aspect. There are two major factors that contribute to the value: the value added in production and the value of the materials purchased. A high value added in production will have an upstream effect on the decoupling point, as it is financially beneficial to store low-value goods instead of higher valued end products. The value of the materials is only a relevant factor if purchasing can be postponed until actual usage in

Table 3  
Process characteristics and their influence on the decoupling point

Process characteristic	Presence/value in food	Effect on DP
Lead times & costs	Relevant set-up times	Downstream
Controllability	(sometimes) low	Downstream
Value added and costs of stock-holding	Unclear (in general)	—
Risk of obsolescence	High	Upstream

production. In a number of food processing industries e.g. coffee, coffee beans of a desired quality can only be purchased once a year. In that case there is no financial reward for changing the decoupling point. In factories for canned meat, however, the purchasing of meat can be postponed until production starts. In such a case the aggregate level of inventories can be lower and an upstream movement of the decoupling point may have a financial effect. The above discussion is summarised in Table 3.

There are some special points of interest in the food processing industries, which may influence the possible location of the decoupling point.

The first point relates to the capacity of the production system. In many cases there is some kind of a bottleneck capacity: either in the processing stage or in the packaging stage. In general a bottleneck capacity is less suited for producing to order, as more variation can be expected in direct customer orders than in stock orders. Consequently, if the packaging department has limited capacity the possibility for locating the decoupling point upstream from the packaging stage will be limited. If the processing stage has limited capacity then locating the decoupling point between processing and packaging is possible, setting aside potentially restricting characteristics of products.

The second point is related to regulations and laws aiming at protecting the safety of consumers. More and more, food processing companies have to obey to strict regulations, which demand demonstrable safety through HACCP (hazard analysis of critical control points) and traceability. This puts not only a pressure on registration and information

flows, but might also restrict the possible location of the decoupling point as intermediate inventories are less controllable and traceable than inventories of materials and end products.

A third point of interest is the attention given to and the introduction of the concept of ECR (efficient consumer response). One of the important so called improvement concepts within this frame is continuous replenishment. For food processing industries this concept can result in two kinds of consequences. On the one hand, retailers can demand short delivery times, without communicating forecasts or information on sales. This results in a downstream effect on the decoupling point, as mentioned before. On the other hand, this might result in a closer cooperation between retailer and producer and more intensive exchange of relevant information on sales will take place. As a result more production to order is possible.

A fourth point, which is interesting for the location of the decoupling point, makes a small adaptation to the assumptions and statements made in the introduction. In food processing industries production to stock is usual, but especially in exporting firms we observe a combination of make-to-stock and make-to-order. Usually the (large) orders for foreign countries are separately dealt with and production to order is possible due to longer lead times. Often production to order is necessary as these orders arrive with great intervals and specification and magnitude is not known in advance. For our discussion this observation is important because these companies already cope with different decoupling points and combine make-to-stock with make-to-order.

## 5. An illustrative case

The case concerns a manufacturer that builds a new facility. In the old facility production to stock was the only possibility due to the technological limitations. The new facility has the possibility to store a number of semi-finished products in silos and the management of the factory aims at producing as much as possible to order. So, the question was which products were to be made to stock, which products to semi-finished product and which

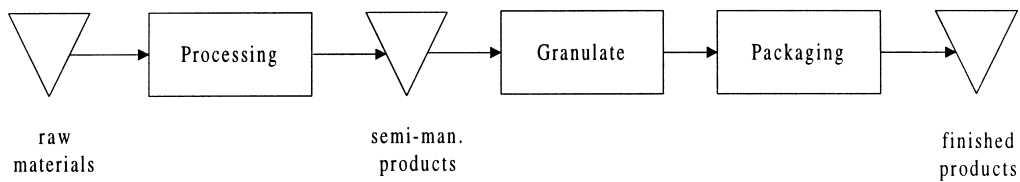


Fig. 3. The production process of the case.

products totally to order. In other words, the question is where the decoupling point ought to be located for each product. To answer this question the afore-mentioned characteristics were analysed. We will briefly describe the results.

### 5.1. Process

The production process has three steps: processing, granulation and packaging (see Fig. 3).

The processing stage consists of several steps: mixing of raw materials according to recipe and a number of subsequent processing steps which are executed without interruption or intermediate storage. Then the semi-manufactured product may be stored in one of the silos or can be granulated, directly. Next, the product is separated into several fractions that are made of the same recipe but differ in the size of the granule. In the last step the product is put into big bags or smaller bags of 5–25 kg with (sometimes) a client-specific text on it. Now, the finished product can either be delivered to the customer or can be stored. Throughput times for each batch are approximately two hours for processing and half an hour for granulation. The production rate (in kilogram/hour) of the first step is about half the rate of the second step. Set-up-times are relatively large for both processes and are sequence dependent. The production process is reliable in quality and amount of output.

### 5.2. Market

The company produces some 200 different products, which differ in recipe (40 different recipes), granule (30 different sizes) and packaging. Demand is stable in an aggregate way but irregular (both in amount and time) and not easy to forecast on

a detailed day-to-day or even week level. Five recipes (which are the basis of several finished products) account for about 70% of total demand. The number of customers is high and even the largest customers have a share in total volume of less than 10%. The lead time for delivery has a standard of 5 days, but quite a few customers ask for shorter delivery. On the other hand, some important customers order in a regular way with a lead time of 2 weeks. Some customers ask the company to keep a certain amount of stock dedicated to them, for immediate delivery. Customers ask for dependent delivery, as is usual nowadays.

### 5.3. Product and stock

The product can be kept for almost half a year. However, the producer has to guarantee his customers a shelf life of 4 months at least. That means that slow-moving products have a risk of becoming obsolete. As said before the management of the company aims at lower inventories.

Each of the three storage points has a limited capacity: the capacity of the silos is most restricting having a storage capacity of a little more than 1 week of average sales.

Due to the nature of the product, the quality required and the way it is produced, there are restrictions with respect to the minimal batch sizes in the processing stage, the granulation and packaging stage. These restrictions are incorporated in the production technology and will be treated as limitations that cannot be changed.

### 5.4. Locating the decoupling point

From the description of the production process it is clear that, theoretically, three possible decoupling

ling points exist: the stock of raw materials, the stock of semi-finished products (in silos) and the stock of finished products. The storage space for semi-finished products is limited by the number and capacity of the silos. So, in this case it seems natural to investigate first, which products should be stored there.

Firstly, we observed that a number of semi-finished products is used in one finished product, only. That kind of products can be excluded from storage in the silos. The underlying logic is that these products are client specific as soon as the first operation is started. Consequently, intermediate storage has no advantage and production can be either to stock or to order, depending on the amount asked for and the lead time needed. About one-third of the semi-finished products is so excluded.

A second observation is related to the limited capacity in the processing stage. To use capacity as efficiently as possible the number of set-ups and cleaning times in the processing stage has to be restricted. Thus, it is advantageous to produce in relatively large batches, which is only necessary for products having a relatively large aggregate demand. The products with sufficiently large demand are subsequently stored in the silos to limit the stock of finished products and still being able to deliver fast. In applying this rule, we could choose the right number of products to be stored in the silos. For the products stored in the silos the dilemma between efficiency and responsiveness seems to be solved: processing is in large and efficient batches, while granulation and packaging is conducted in response to the market.

Some products that we would like to produce to order (e.g. due to irregular demand) will be produced to stock if the amount asked for is smaller than the minimum batch sizes. The minimum batch size causes an amount of stock of the finished product. This stock has a relatively high risk of becoming obsolete. Resolving this problem is not straightforward and affects the market strategy. For products which are ordered irregularly, but in larger amounts than the minimum batch size there is no problem and these products are of course produced to order. In other words, the decoupling point is the stock of raw materials.

### 5.5. Results

As a result of the above location decisions about 75% of the number of the finished products will be produced on order. An important reason to have stock of the other articles is the very short lead time asked for (often in combination with the wish of customers to let the producer keep an amount of stock dedicated to them). Another reason is regularity in demand: each week a number of orders for a certain product.

Changing the DP for a number of products affects other performance measures as well. However, it is hard to make a comparison with the previously existing situation because a complete new factory is built. Still we can highlight some. First, it is important to note that customer service (in terms of dependability and speed) is improved, largely due to the fact that too many end items were stocked in the old situation, which caused problems with inventory control and shelf lives of products. The number of obsolete products is thus reduced as well as the inventory costs. Normally, producing on order could result in less utilisation of capacity. However, here aggregate demand and capacity needed is quite stable. Moreover, some orders have a longer lead time which enables a smooth production plan and high utilisation.

Another result of the decisions with respect to the decoupling point relates to a better knowledge of the market and the production capabilities and their interrelationship. Gathering information about products, the demand and the patterns in demand and orders, and lead times, gives a lot of information not yet available to the company in that way. This opens up discussion regarding the profitability of certain articles or the possibilities for using the same recipes for more products. So a start is made with discussing the marketing and market strategy. In such a discussion production capabilities play an important role.

### 5.6. Discussion of the case

The case teaches us that the frame helps us to detect the relevant factors for locating the decoupling point and to decide which products should be made to order or which made to stock. It is clear



that the case has some specific elements in it, such as the possibility to stock intermediate products and the way capacities in subsequent stages are balanced.

In the description of the case no attention has been paid to planning and scheduling. Some comments can be made, however. Due to the restrictions made regarding the minimum batch sizes and the production in larger quantities of product for intermediate storage in silos, the capacity in the processing stage will be used effectively. The capacity in the granulation and packaging stages is such that the time needed for set-ups leaves enough spare capacity. Most important, however is that demand is stable in terms of the need for capacity. Still, planning and scheduling will be more important than it was previously and more interaction between production and sales department will be necessary. However, that can only be advantageous.

## 6. Conclusion

This paper develops a frame for a decision, managers face in food processing industries: which products have to be made to stock and which products have to be made to order. To support such decisions the general decoupling point concept has been adapted to the specific characteristics of the food processing industry. The frame offers a systematic means for food processing companies to find the important influencing factors in the market and in their production system. This results in a means for making this kind of decision as is illustrated in the case. An important insight from this paper is that, at least in the food processing industry, the decoupling point theory can be transformed into an applicable decision aid for managers. This paper also contributes to our knowledge in applying this theory.

The paper shows some problems in decoupling point theory such as the development of general applicable rules for (changing) the location of the decoupling point. In fact, balancing the diverse factors influencing the location of the Decoupling Point (both in a qualitative and quantitative sense) is missing in the original writings of Hoekstra and Romme as well. In this particular case, the frame

supported us to develop appropriate decision rules. Other cases are needed to elaborate these rules further for a decision logic for the positioning of the decoupling point in the food processing industry. We think that progressing along the lines as put forward in this paper will unveil such a logic which is, at least in the food processing industries, generally applicable.

Further research should also be directed towards the consequences of changing the position of the decoupling point. These consequences apply to the planning and scheduling (how to combine make-to-stock and make-to-order) and to the capabilities of the production systems (see also [4]). Other areas of attention are the organisational arrangements such as the relation between planning, production and marketing and the flow of information. Experiences in case studies suggest that besides the problem of finding a balance between the factors influencing the position of the decoupling point, a major point of concern in implementing changes is to overcome organisational and cultural barriers.

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