THE DESIGN PROCESS OF AN ACTIVITY BASED COST (ABC) SYSTEM AT A CHEST FREEZER ASSEMBLY PLANT: A CASE STUDY

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Abstract

Activity based costing is one of the most important innovations in the field of costing and performance evaluation in operating systems. This paper presents a case study of the successful design and implementation of an ABC system at the chest freezer assembly plant of Electrolux Co. in Hungary. The strong international character of the implementation of the project and the interesting results provide information for both practitioners and researchers in this field. This paper presents the company background, the current costing practice, illustrates the theoretical and pragmatic considerations of the design process and finally analyses the difference between the old and new product costs.

Keywords: operations management, activity based costing, case study.

1. Introduction

To determine the real manufacturing cost of the products is a constant management problem. In the early eighties activity based costing was developed as a new tool both to supplant old overhead allocation practices and to provide a new overhead allocation philosophy [1], [4]. Since then many successful applications have been reported in the literature. While the early case studies concentrated on the structure of the activity centers (see for example COOPER [2]), the later ones focus more on the implementation process, on the relation of ABC to the different functional areas of management [6] or on the strategic effect of the change of the costing systems [3], [5]. The case study presented in this paper is unique in two respects. On the one hand it has a strong international character showing how a multinational company introduced ABC in a country with a transitional economy. On the other

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hand, the results contradict the general belief that in traditional volume based costing systems, small size products produced in small lot sizes are generally undercosted.

The case of a chest freezer production plant of Electrolux Ltd. provides an excellent example for a well founded application of ABC. The company wanted to introduce ABC on an experimental basis in its chest freezer assembly plant in Hungary with the following objectives:

- Before deciding on the increase of production quantity of the chest freezers, management wanted to know the real cost of its products.
- Management also wanted to know how much differences in the size of the products affect the determination of production costs.
- The experimental application in this plant was expected to provide useful information to guide the introduction of ABC at other company plants.

The objectives of this paper are to illustrate, with the help of a real case,

- that ABC is an internationally invariant method whose ideas can be implemented without difficulties in plants working in economically and culturally different environments,
- that sometimes ABC results may contradict the expectations based on the general logic of ABC,
- that the extended involvement of the people of the plant may facilitate the acceptance of the new costing system.

The paper first introduces the products and the production process of the plant where the ABC system was to be designed. Next the steps of the design process of the ABC system are presented. Finally, the results of the new cost calculations are analyzed and the most important conclusions are summarized.

2. Presentation of the Product and the Process

The Lehel refrigerator company was one of the most important industrial plants in Hungary before the social and economic changes of the early 90's. As a consequence of its high quality work force and the competitive products, the company had a leading role in the refrigerator market in central Europe. During the privatization program following the collapse of the socialist system, the company was bought by one of its long standing partners, Electrolux Ltd. The new owner improved the competitiveness of the firm by rationalizing its production technology, changing the organizational structure, and introducing western style work organization methods. Currently the company has the following five product divisions:

- compressor division,
- absorption division,
- commercial refrigerator division,
- aggregate division,
- radiator division.

The parts and components of the products are produced in three different plants in Hungary. ABC was to be introduced in a plant which is specialized for the assembly of the chest freezers (CFAP). This specialized plant also prepares the most important components of the chest freezers. The electrical and mechanical parts are produced and transported from the part production plant (PPP) of the company.

The objective of ABC is to determine the cost of the chest freezers produced in the CFAP. The products can be divided into three groups. The *small size (SS) chest freezers* are considered small based on their cubic capacity. The large size chest freezers are further split into *large size normal (LSN)* and *large size special (LSS)* products. The special products are produced with a thicker wall to provide better insulation. All the products are assembled from the following main parts and components:

- The *inner liner* is the part which contains the products kept in the chest freezer.
- The *wall* separates the tub from the environment and provides insulation with a special material injected into it.
- The *lid* serves as the door of the chest freezer. It also contains a special insulation material.
- The *back sheet* protects the chest freezer from behind and provides access to the electrical and mechanical parts.
- The *electrical and mechanical* parts provide the energy supply and the cooling process.

The production process of the CFAP is split into three organizational units: part assembly unit, foaming unit and the final assembly unit. The production process starts at three different places at the same time. The assembly of the wall, inner liner and lid begins simultaneously.

The production of the wall and back sheet consists of cutting, bending, and drilling the metal sheets, and it is finished by the assembly of the insulation surfaces. The production of the inner liner consists of cutting, bending and assembling the inner liner and mounting the cooling tube system. The wall and the inner liner are then assembled and prepared for the foaming operation. The production of the lid begins with cutting, bending and drilling as well and continues with the forming of the plastic inner surface and the printing of instructions. The final operation is again the preparation for foaming. The foaming of the walls is prepared in a special machine with eight foaming frames. The foaming of the lid is prepared on

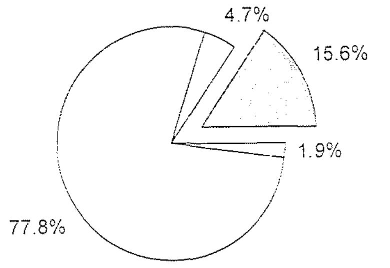

Fig. 1. The cost structure of the CFAP

another machine specialized for the simpler form of the lid. The foaming operation is followed by the final assembly. The work stations for leg assemblies, condensator units, lids, compressors, electrical parts, and leaking controls are situated along a rolling belt. After the last operation of this belt, the products are transported to the workstations where the injection of the cooling liquid and the installation of a second leaking control are completed. A two-hour test run, quality control and a packaging operation close the production process.

3. The Current Costing System

Fig. 1 shows the current cost structure of the CFAP. The direct costs represent the dominant part of the total cost. However, these costs are constantly decreasing as a consequence of technology development and changes in the work organization and motivation system. The production overhead of the CFAP was the main objective of this implementation of the ABC system (15.6%). In the current system, a certain amount of production overhead of PPP is also allocated to the CFAP. This allocation is based upon the work done on the parts produced by the PPP directly for the CFAP. The resulting transferred PPP production overhead is about 4.7% of the total cost. Finally, the remaining 1.9% of cost is for general company expenses paid for research and development, marketing, administration, materials, tools and equipment management. The current cost allocation system is characterized in *Fig. 2*. Currently the CFAP and the allocated PPP production overheads are pooled together and allocated to the products based on the direct labor cost. Material management costs are allocated based on the direct material cost. The marketing, R & D, Tools and equipment management costs are

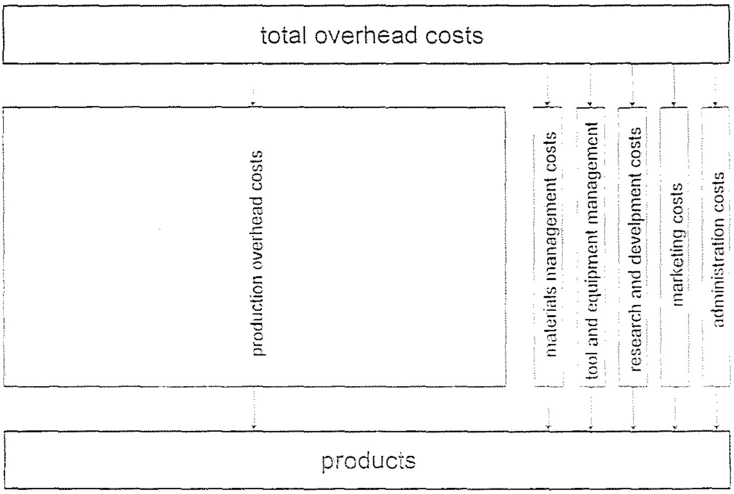

Fig. 2. The current cost allocation system

allocated based on the total revenue of the products. Administration costs are allocated based on the production quantity. It can be concluded that the CFAP and PPP production overheads, which are about 20% of the total costs, are allocated to the products based on a single volume sensitive cost driver. Company management considers this cost allocation process erroneous for the following reasons:

- In most cases overhead costs have no correlation with the direct labor. For several operations, maintenance, energy or material characterize resource consumption better than the direct labor.
- The ratio of the direct labor cost within the total cost of the plant is very small resulting in very high applied overhead rates. Due to this, every distortion of the current system is amplified.
- The difference of the small and large chest freezers is not reflected in the direct labor cost. In the case of several operations, there is hardly any difference in the time of the operations when small and large products are produced. However, the resource consumption can be significantly different (e.g. energy consumption at the foaming operation).
- Management believes that the allocation of production overhead of the PPP to the CFAP is unrealistic. They believe that the high proportion of those costs is not justified by the small and simple parts produced for chest freezers.

The company decided to design an activity based cost system for the CFAP. The main objective of this system was to improve the allocation of the production overhead generated in the assembly process. However, the allocated PPP overhead had to be treated differently as well. The preferred solution to this latter problem would be the introduction of ABC at the part suppliers and the application of a realistic transfer price system. This solution was, however, planned for a later stage of the project. To overcome this difficulty a method had to be worked out to estimate the effect of the introduction of ABC at the part production process. In the following, the steps of the design process of the new costing system will be presented.

4. The Design of the ABC System at the CFAP

To develop an ABC system that reflects the resource consumption of the products and that would be accepted by the staff, the design process was split into five steps.

4.1. The Overview of the Activities of the Production Process

The objective of the first phase is to collect information about the activities of the production process. A questionnaire was used to interview the workers and managers responsible for the different activities of the production process. The structure of the questionnaire and a sample response are presented in *Table 1*. The first column contains input information and identifies the origin of the material arriving at this activity. The second column examines whether this activity is different for the various types of products produced. It also tries to identify variables that could be used to measure the difference. The third column identifies the destination of the material after completion of the current operation. The fourth column reveals whether the resources used for this activity are shared by other activities as well. This interview was used not just for identifying the activities but also to improve the production process. The two questions below the table address this issue. 35 people participated in the interviews and as a result 28 activities were identified.

Table 1 provides an example of the lid foaming activity. The part comes from the lid preparation workstation and goes to the final assembly operation. The worker identified the injection time of the insulation foam as the most important characteristic to describe the difference of the activity at the different size products. 100% of the time of the foaming machines is spent on this activity therefore the resource is not shared by other activities. The change of the form of the lid and the leaking of the foam were identified as problems. The worker suggested modification of the injection head to solve these questions.

Table 1.

The questioner used in the interviews Name of the interviewed person: Róbert Varga

Input	Activity	Output	Resource consumption
Where does the material come from?	Do you experience any difference when you perform this activity at the different products?	Where does the material go from here?	What per cent of your time is spent on this activity?
Wall preparation work station	Activity: lid foaming Difference: injection time of the insulation liquid	Final assembly of the lid	100%

Do you experience any problem when performing this operation?

1. Deformation of the lid at the foaming operation
2. Leaking of the foam

What do you recommend to solve this problem?

1. The injection head of the machine should be modified.

Table 2. The activity centers and the cost drivers

Activity center	Cost driver
part production and final assembly	production quantity
inner linear part preparation	direct labor time
injection of the foam in the walls	injection time of the insulation foam
foaming of the wall of the small chest freezers	production quantity
foaming of the wall of the large chest freezers	injection time of the insulation foam
injection of the foam in the lid	injection time of the insulation foam
refrigerant charging	quantity of the cooling liquid
other activities	ratio of the allocated other costs

4.2. Decision on the Activity Centers

A team was formed to determine the activity centers of the new costing system based on the information collected during the interview process. The team consisted of representatives of company management, accounting experts, the plant production manager, a university professor specializing in ABC, and an ABC expert from the headquarter of Electrolux. The team identified the following special principles for the new system:

- Since the plant has no experience in ABC, in the first step a simple cost system should be designed with few activity centers.
- Although the plant is currently implementing a sophisticated management information system, activity centers with easily measurable costs and cost drivers are recommended.
- When the activity centers are identified, activities of different organizational units should not be pooled unless absolutely necessary. Activities of the same organizational units should be pooled if other factors are not against it.

Based on the general principles of ABC and the pragmatic considerations of the team the 28 activities were pooled into the eight activity centers listed in *Table 2*.

4.3. Assignment of the Costs to the Activity Centers

The objective of this stage is to decide which cost items belong to the different activity centers. At this stage it is possible that the costs of some activity centers may prove to be difficult to measure. In this case, the system of activity centers would have to be modified. This would not be just a task of assigning cost items to the centers but would also require a revision of all the costs. The output of this stage is the total cost of the activity centers. At Electrolux 1995 data were used to make test calculations. This design step was carried out by the accounting department of the plant with constant consultation with the team described previously.

4.4. Measuring the Activities (Decision on the Cost Drivers)

At this stage a decision has to be made on the cost drivers. These are variables that must be measured throughout the production process; therefore, practical and well defined parameters must be chosen. As a result of a team effort the activity centers and their corresponding cost drivers are shown in *Table 2.* The following considerations were used at the various centers:

- The cost driver of the 'part production and final assembly' activity center is the *produced quantity*. Based on interviews and on technological considerations, activities in this center are independent of product characteristics and therefore it is reasonable to conclude that the costs can be divided equally among all the units produced.
- The cost driver of the 'inner liner and part preparation' activity center is *direct labor time*. The activities of this center differ for the different sized products. Larger products have longer operation times. The differences in activity performance for the different products are best reflected by the duration of the operations.
- The cost driver of the 'injection of the foam in the walls' activity center is the *injection time of the insulation foam*. The quantity of the resources used by this activity is well reflected by several technological parameters describing the dynamics of the injection process. These parameters, however, are difficult to understand by nonspecialists. Keeping in mind the requirements of measurability and understandability the injection time was used as cost driver.
- The 'foaming of the wall of the small chest freezers' activity center contains one activity used for one type of product therefore the cost can be spread among these products equally. The cost driver is the *production quantity*.
- The cost driver of the 'foaming of the wall of the large chest freezers' is also the *production quantity* for the same reason as the one for the previous activity center.

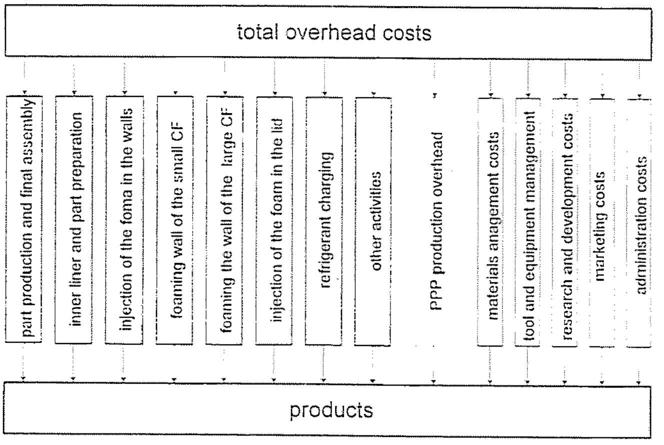

Fig. 3. The new cost allocation system

- The cost driver of the 'injection of the foam in the lid' activity center is the *injection time of the insulation foam*. The reason is the same as the one considered at the other foaming activity centers.
- The cost driver of the 'refrigerant charging' activity center is the *quantity of the refrigerant* used to fill the chest freezers. There are again several technological parameters to describe this process but the quantity of the refrigerant can be measured easily and correlates well with the consumption of energy and deterioration of the machines and tools used in the process.
- The cost of the 'other activities' activity center is allocated to the products based on the ratio of the costs of the previous seven activity centers. It was considered that the 'ther activities' are necessary because the main activities have to be carried out, therefore the cost of this center should be assigned proportional to the other costs.

It can be seen that several cost drivers reflect the physical and technological differences of the products, but there are cost drivers which consider the products equal in their use of the activity.

4.5. The Calculation of the New Product Cost and the Evaluation of the Results

The cost allocation structure illustrated in *Fig. 3* results from the previous analysis. The costs allocated to the products based on this system are given in *Table 3*. The third column of this table shows the change of the allocated production overhead compared with the original system. Based on the results the following conclusions can be drawn:

Table 3. The change of the allocated costs

Type	Product	Change of the allocated CFAP production overhead costs	Change of the total (CFAP+PPP) production overhead costs	Change of the total product unit costs
SS	CF 115	−5.64%	−11.2%	−2.28%
	CF 145	−3.16%	−9.23%	−1.80%
LSN	CF 200	−9.38%	−16.88%	−3.59%
	CF 280	−5.93%	−14.14%	−2.82%
	CF 400	−1.13%	−10.33%	−1.90%
LSS	CF 210 E	0.90%	−8.69%	−1.72%
	CF 310 E	7.84%	−3.22%	−0.57%
	CF 360 E	12.16%	0.20%	0.03%

- The small size chest freezers are overcosted in the old cost allocation system. The primary cause of this distortion is that a cost allocation based on direct labor cost does not reflect the real resource consumption of the products. For example, at the foaming activity the direct labor cost obscures the differences between the small and large size products. The salient characteristic of this operation is not the amount of direct labor performed, but the use of the expensive and complicated machinery during the injection process. If overhead costs of the machine are allocated based on this injection time, then the allocated costs should better reflect the differences among the products. The same can be said about the charging operation as well. It can also be seen that overcosting is the biggest for the smallest product among the small size chest freezers (−5.64%). For the other product of this group the overcosting is smaller (−3.16%).

- Similar tendencies can be observed for large size normal chest freezers. This is, however, the joint result of two causes. The allocated overhead costs of the foaming activities are lower for the large products when allocation is based upon the direct labor rather than on injection time. This would result in undercosting in the old system. This is combined with the fact that the traditional system overcosts the normal large size chest freezers compared to the special large size chest freezers. When the foaming production overhead costs are allocated to the products based on the injection time, then higher costs will be assigned to the special products. The result of these two processes is that the normal large size chest freezers are undercosted because of their size and overcosted because of the thin wall. The effect of the overcosting is greater than the effect of the undercosting; therefore, the normal large size chest freezers are overcosted in the old system. Again this effect is

higher for the smallest chest freezers among the large normal products (−9.38%) than for the largest large normal product (−1.13%).
- The large size special chest freezers were undercosted in the old system for two reasons. Less production overhead was allocated to them because of the large size and because of the thick wall. This undercosting is the smallest for the smallest product among the large size special chest freezers (0.9%) and the highest for the largest product among the large size special chest freezers (12.16%).

In the old system 20% of the total production overhead cost was transferred from the PPP. A realistic costing system ensures that the correct amount of overhead is carried over to the CFAP, which is justified by the resource consumption of the parts. Management believed that the old system was incorrect because the parts used at the CFAP are not very complicated and use low value machines and simple technology. The highest cost activities of the PPP are generally for products not produced for the CFAP. Since the sum of the transferred overhead is calculated based on the total production overhead of the PPP and not based on the overhead of those activities that are producing parts for the CFAP the actual system introduces distortions into the cost allocation process. The preferred solution would be the introduction of ABC in all plants of the company and the use of a transfer price system based on the real cost of the parts. At this stage of the project, however, the company wanted to introduce ABC only at the CFAP. To have a realistic product cost, a method was worked out to estimate the possible effect of the introduction of ABC at the PPP. We determined the overhead costs of those activities at the PPP which are producing part for the CFAP. Just that part of this overhead was transferred to the CFAP which was justified based on the direct labor hours. This process resulted in a 50% reduction in transferred production overhead. The reason for the difference is that the overhead expenses for high value and expensive processes were included in the old system, although they were not used for the parts used in the chest freezers. The production overhead costs transferred from the PPP were allocated to products based on the production quantity, because these parts are used in all the chest freezers, and are very simple and very similar.

The changes in the allocated joint production overhead costs (both the CFAP and the PPP overheads) compared with the old system are presented in the fourth column of *Table 3*. Since less PPP production overhead was allocated in the new system, undercosting increased (e.g. at CF115 the −5.64% decreased to −11.2%), overcosting decreased and sometimes turned into undercosting (e.g. at CF210E the 0.9% decreased to −8.69%). The reasons of these two phenomena are the following:

- those products which have received too much production overhead in the old system will receive less costs on the one hand because of the introduction of the ABC system and on the other hand because of the decrease of the transferred PPP overhead cost.

- those products which have received too little overhead in the old system will receive more costs on the one hand because of the introduction of the ABC system and will receive less costs on the other hand because of the decrease of the transferred PPP overhead cost.

It should be emphasized again that the procedure for the calculation of the new transferred PPP overhead cost is not considered to be a substitute for the introduction of ABC in all plants of the company. The procedure just helps to estimate its effect on the product cost.

Fig. 1 shows that the CFAP overhead and the transferred overhead from the PPP are approximately 20% of the total cost. Therefore, the change of the total unit cost of the products will be less than the change of the allocated overhead cost. The change of the total unit cost of the products compared with the unit cost in the old system is given in the fifth column of *Table 3*. It can be seen that among both the small size and the large size chest freezers the smallest products were overcosted, the most in the old system.

5. The Conclusions of the ABC Design Process

This paper has presented the design process of the ABC system at the chest freezer assembly plant of Electrolux Ltd. in Hungary. Management decided to introduce the designed system and the project is now in the implementation stage. The design process revealed that in case of an assembly operation with such an extensive interrelationship with the part suppliers all the benefits of ABC can be taken advantage of only if it is introduced at the part production plants as well. Provisionally the effect of an ABC system of the part production process on the unit total cost of products can be estimated but on the long run the introduction of ABC in all stages of the process cannot be avoided.

In the presented design process about 50 people of the plant were participating. This ensured a broad participation of workers and management. Throughout the interview process and in meetings many employees learned about ABC and understood its benefits. This will certainly facilitate the implementation and the successful operation of the system. Although experts and users with different nationalities and with different educational and cultural background were participating in the project, there were no serious problems attributed to international incompatibility. Most of the cost concepts and the basic philosophy of ABC were clear to all the participants and the problems addressed by the ABC methodology were present and understood even before the privatization of the company.

Evaluating the numerical results of the new product costing system, two conclusions can be drawn. First, in the old system the small products were overcosted while the large product were undercosted. The new system assigns higher cost to the larger products, so there is justification for emphasizing the difference of size in the price of the products. This result contradicts the conclusions of COOPER [1] who showed how the volume sensitive cost drivers generally overcost the large products. Cooper's results are certainly true when resource consumption is overestimated by the volume sensitive drivers. At the foaming and filling operations, however, the problem is just the opposite. The direct labor hour underestimated the use of the high value machines. The new cost driver expressed the resource consumption better and allocated even more overhead costs to the large products.

Secondly, when the total unit costs are considered, the new values differ only very slightly from the old ones. The difference ranges between 0% and 3.6%. Although the concrete values of the new unit cost are hardly different from the old ones, the cost structure has considerably changed. The new structure reflects better the real resource consumption resulting in more accurate information for planning decisions.

Finally, it has to be mentioned that currently approximately 20% of the total cost of the plant is included in the ABC system. This ratio is constantly increasing. Next year direct labor cost will be treated as independent of the production quantity and will be considered as production overhead. Furthermore, the company is planning to improve the production process by installing new machines with high fixed costs. The suggested ABC system is a useful tool to reflect the effect of these plant changes in the product cost, and it is also an excellent experiment to facilitate the implementation of ABC in the whole company.

References

[1] COOPER, R. (1988): The Rise of Activity-based Costing - Part One: What is an Activity-based Cost System? *Journal of Cost Management Summer*, pp. 45–54.

[2] COOPER, R. (1989): The Rise of Activity-based Costing - part four: What Do Activity-Based Cost Systems Look Like? *Journal of Cost Management Spring*, pp. 38–49.

[3] HOBDI, T. – THOMSON, J. – SHARMAN, P. (1994): Activity-based Management at AT & T. *Management Accounting* April, pp. 35–39.

[4] KAPLAN, R. (1991): New Systems for Measurement and Control. *The Engineering Economist* Vol. 36, pp. 201–218.

[5] Ness JA and Cucuzza, TG (1995) Tapping the Full Potential of ABC. *Harvard Business Review* July-August, pp. 130–138.

[6] RUPP, A. (1995) ABC: A Pilot Approach. *Management Accounting* January, 50-55.