COMPUTERBASED DECISION SUPPORT OF STRATEGIC PLANNING AND STRATEGIC MANAGEMENT WITH SYSTEM DYNAMICS MODELS ILLUSTRATED BY THE EXAMPLE OF THE GERMAN FEDERAL RAILWAY

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1. INTRODUCTION

The competitive situation of the German Federal Railway has visibly intensified due to the following factors: the way in which important customers (the coal and steel and fertiliser industries) are susceptible to crisis; the longstanding political favouring of road construction; the introduction of new technologies (video link-up, electronic mail etc.); and also the europeanisation of the transport market and the associated price decay (Deutsche Bundesbahn, 1987). The precarious financial situation, as well as growing pressure from the public, presents the railway management with the difficult task of, on the one hand, reducing costs, and on the other hand, of improving the standard of the service offered. In order to be able to cope with this problem, it is necessary to identify and formulate corresponding strategies, against the background of existing strengths and weaknesses, as well as growing chances and risks arising from environmental development. Through these strategies, and through innovation, investment and a reduction in costs, the railway can be developed from a bureaucratic institution to a modern and competitive tertiary sector company. Only in this way can the railway's ability to survive be secured in the long term (Zahn, 1988).

This paper presents a system dynamics model, which portrays an important area of the federal railway. With the help of this model, the interrelations and mutual dependencies of this complex system are to be demonstrated. The model provides a valuable article in the field of strategic planning, in which strategic decisions, which are often based on uncertain information, can now be founded on a sound basis, and therefore, the decision process can be effectively supported.

2. THE SYSTEM DYNAMICS MODEL

The problem of computer-aided strategic development and validation, with help from system dynamics models, is to be explained in the business field of railway maintenance of the German Federal Railway. This business sub-system can be identified by the following facts:

- Railway maintenance constitutes around 12% of total costs to the firm and is therefore very important for the economic stability and future security of the firm.
- This business area is characterised on the one hand by a high degree of complexity, which permits the sensible and useful application of system dynamics models. On the other hand, sufficient data about the parameters to be considered and also system sizes is available.
- The areas of sales and production, which are typical and important for a railway company, are heavily influenced by the technical area of railway maintenance.
- The importance of maintenance will increase further in the future (Biedermann, 1985; Schelo, 1973).

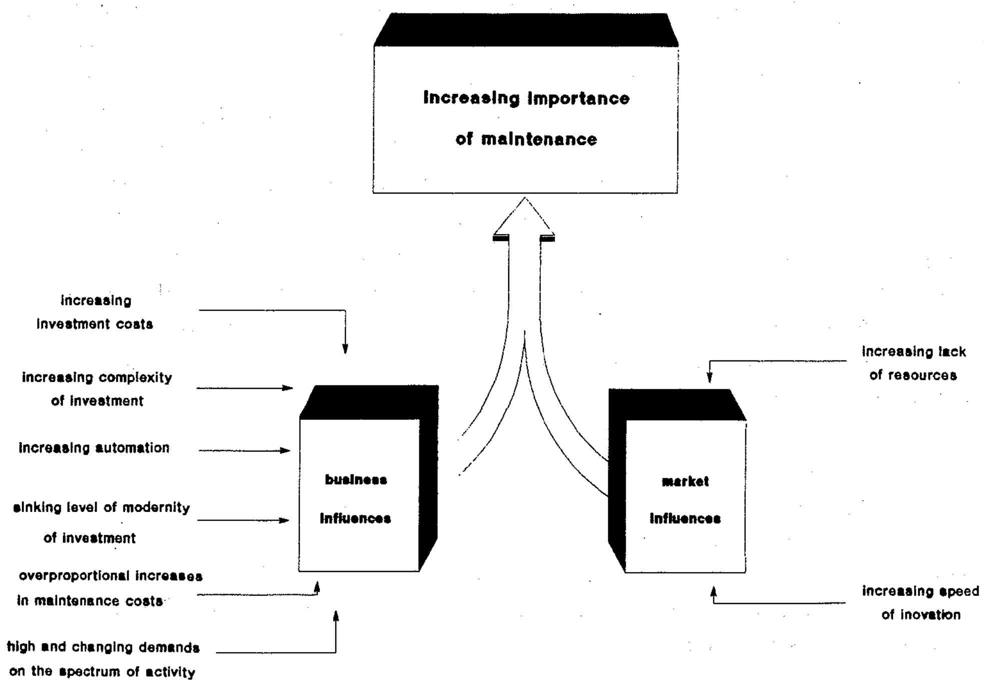

Figure 1: Causes for the increasing importance of maintenance.

2.1 THE CAUSAL RELATIONSHIPS

The service provided by the railway is demonstrated by three components:

- Quality (by this, the comfort and safety of passenger services, as well as the avoidance of damage in the case of freight, is to be understood.)

- Time (minimisation of the journey, for example, transportation times and the reduction of delays)

- Price of the service

Maintenance measures directly influence the quality and time components of supply, and therefore the competitiveness of the railway. Price effects are actually possible, but should , in the following , be ignored, since the price fixing policy of the railway is more demand than cost orientated and will also be politically influenced.

Through maintenance work, disruptions of the production process (running process) will be caused. These so-called operating handicaps (additional stops, diversions, a reduction in authorised speeds) cause delays or irregularities in timetables and therefore reduce (through the deterioration of the time component) the attractiveness of the service.

Maintenance measures, however, increase the quality of the track (running quality), which is expressed in increased comfort, higher speeds and increased safety. With this, they contribute to an improvement in competitiveness (time and quality component) of the German Federal Railway.

The complex connections of the business field of maintenance, as well as the interdependance to other internal and external business areas are shown by the feedback structure diagram. The model essentially consists of the following four sectors:

- capacity sector
- market share and calculation of wear and tear
- budget sector
- costs, turnover and success calculation

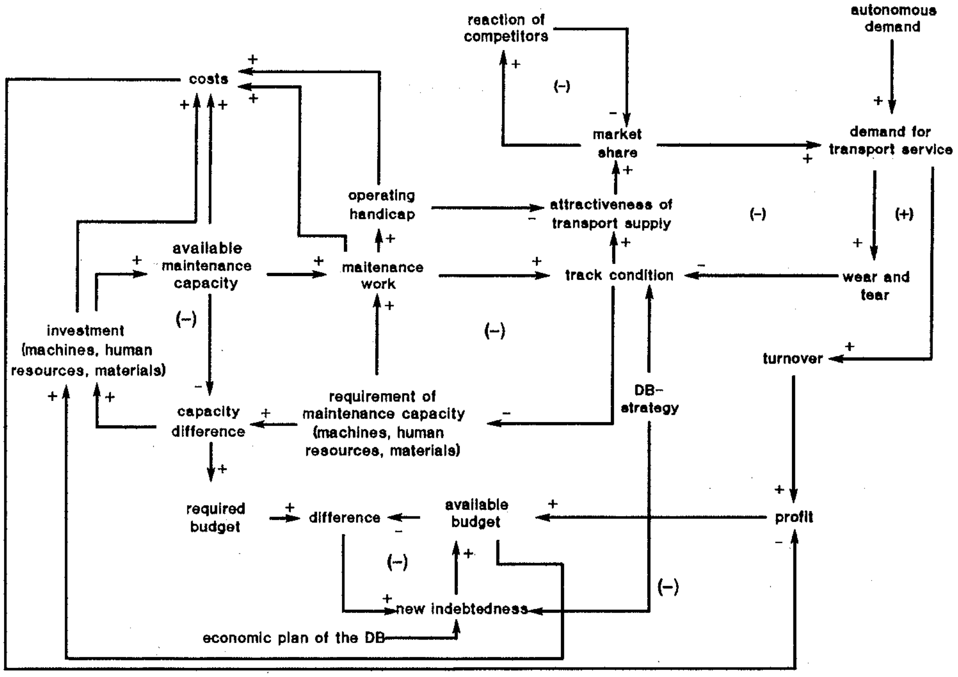

Figure 2: Basic feedback structure

The causal connections of this module will be briefly explained as follows:

Capacity Module *(condition of the track / maintenance capacity / maintenance work)*

If the condition of the track deteriorates, this results in an increase in the required capacity. If the actual capacity is constant, the discrepancy in capacity will therefore increase. Corresponding to the available budget, this discrepancy will be compensated through investment in machines, human resources and materials.
The investment raises the existing maintenance capacity (actual capacity) and allows better maintenance work to be carried out. Intensive maintenance work leads to an improvement in the quality of the track.
The undertaking of maintenance work results in an increase in the running difficulties. Through the increase in timetable irregularities and delays connected with this, the attractiveness of the service will be negatively influenced.

Market share and wear and tear calculations *(condition of the track / market share / wear and tear)*

The condition of the track is a fundamental determinant of the attractiveness of the transport service. The more attractive this is, the better the competitive position, and the market share of the railway in total goods and passenger transportation will be increased.

A rising market share implies an increasing demand for transportation services. If the capacity remains constant, this leads to a heavier usage of the track, and also to increasing wear and tear, and so to a deterioration in the condition of the track. As the German Federal Railway has increased its market share profits, this has led to losses of market share for the existing competitors (oligopolistic market structure). An expansive development in the market share will therefore attract a stronger marketing policy on the part of rival companies, which in turn hinders the further growth of their own market share.

Budget Module *(required budget / available budget / new indebtedness)*

From the capacity discrepancy, the required budget can be calculated. A balance results from the comparison with the available budget. This balance will be compared independantly from economic plans and the supposed business strategy will be balanced completely, or only partly through new debts.
The available budget, which will be increased through the proportional profits gained from good management, limits the investment available to balance the arising capacity deficit.

Turnover, costs and proportional profits

From the demand for transport services, the proportional turnover can be calculated. From this difference between proportional turnover and costs, the proportional profit results. By proportional profit, we understand the profit which is gained through good management of maintenance work.

2.1 SIMULATION RESULTS

The following diagrams show the simulation results of the computer program, whereby the data for the main removal routes (HAS-network) and the passenger services forms the basis of the model.

Figure 3 shows the different developments of the profit for the base run, as well as for two strategy alternatives.

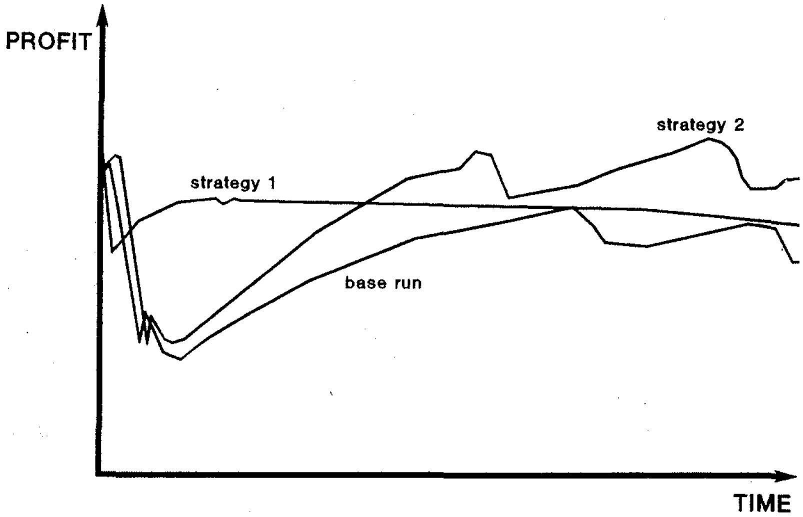

Figure 3: Profit development of various strategies.

Strategy 1: Under the first strategy alternative, it will be assumed that the necessary capacity is available punctually and without delay, in contrast to the base run. (Just-in-time strategy)

Strategy 2: Under the second alternative, the investment policy will be changed in contrast to the base run. Under this strategy, investment will take place in anticipation. This means that the amount of orders are orientated not only towards past figures, but the actual loading and wear values will also be included in the calculations (anticipatory strategy).

It is plainly recognisable, that both the just-in-time strategy and the anticipatory strategy lead to clearly better results than the base run. The fluctuations in the development of the profit of the base run and the anticipatory investment strategy (strategy 2), in contrast to the just-in-time strategy (strategy 1), are caused by the heavy investment activity and the increase in overcapacity caused by this.

Figure 4 shows the market share development of the three simulations.

Once again both strategy alternatives lead to markedly better results than the base run. The most steeply sloping curve represents the market share of the base run. Strategy 1 actually leads to a better result. However, essentially it cannot stop the reduktion in market share. Only with the help of strategy 2, is it successful in stabilising the market share of the company at a high level.

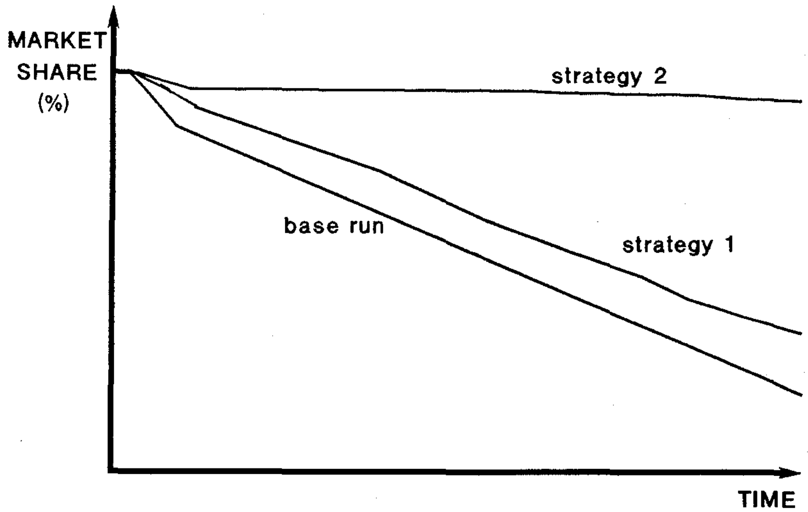

Figure 4: Market share development of various strategies.

The following two diagrams show the consequences of a drastic reduction in the maintenance funding in the last third of the simulation.

It is recognisable that the condition of the track has greatly deteriorated as a result of this budget restriction. Through the deterioration of the track condition, the time and quality components of the service provided by the railway will be negatively influenced and the market share falls strongly a few periods later (cf.diagram 5)

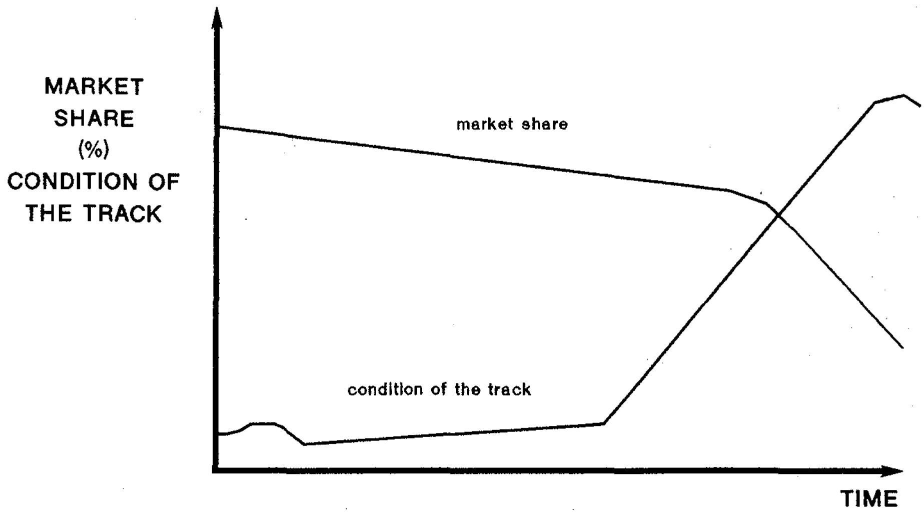

Figure 5: Budget reduction.

Similarly grave are the effects on turnover and profit. Diagram 6 shows that turnover and profit seriously deteriorate after this budget reduction.

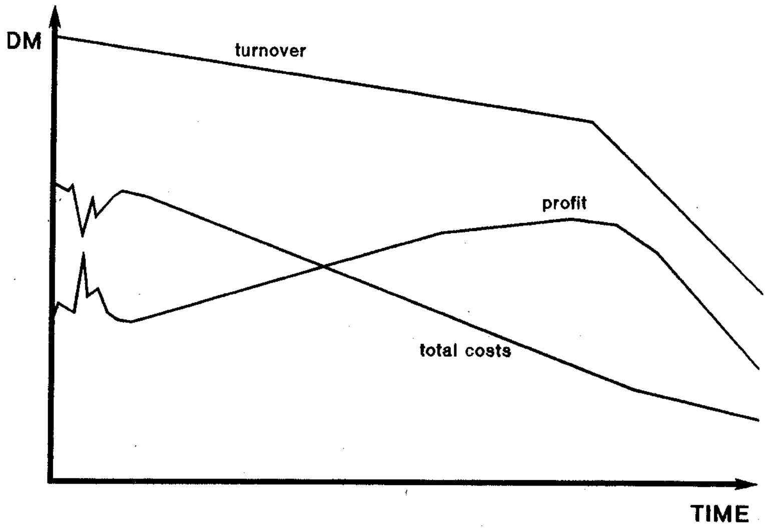

Figure 6: Budget reduction

A cut in the maintenance work results likewise in the future earnings of the company being drastically reduced.

3. SUMMARY

Through the illustration using models, and simulation of the maintenance system and its interdependencies, the problems and interrelations of a railway company may be clarified and the development and assessment of corresponding strategies adopted to solve these problems may be effectively supported.

In an additional step, further business spheres will be included in the computer simulation and the system dynamics model may be implemented by the German Federal Railway, as an important instrument for the support of decision making in the field of strategic company planning.

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