SALES-ORIENTED PRODUCT-INNOVATION-RATES A NEW SYSTEM DYNAMICS APPROACH TO RESEARCH & DEVELOPMENT BUDGETING

Georg Doll
Industrieseminar der Universität Mannheim, West Germany

Abstract

Research and development (r&d) are the source for planned invention and innovation and therefore play a crucial role for the success of a company. New products and processes become indispensable because of technical progress and competition. Early long-range r&d planning is required.

Despite the strategic importance of r&d budgeting, the usual approach resembles more a rule of thumb than a scientific method. The process most widely used takes a fixed percentage of sales for r&d. This sales orientation approach seems perhaps too simple, as there is no causal link between today's sales and tomorrow's products. Another method considers the product-innovation-rate; this is the fraction of total sales which comes from products that are younger than e. g. five years. The actual product-innovation-rate then is compared with an intended value (e. g. forty per cent) and the r&d budget is accordingly adjusted.

Contrary to previous studies, a System Dynamics simulation shows that the rather sophisticated product-innovation approach does not lead to better results in terms of cumulated profit. In its place, a modified approach, which avoids the disadvantages and combines the benefits of both the sales and the product-innovation-rate orientation methods, has been developped and implemented. This sales-oriented product-innovation-rate approach shows superior results in some of the scenarios tested, including expansion and shrinkage portfolio situations.

The handy but accurate System Dynamics model (less than hundred equations) is easily adaptable to individual circumstances of specific industrial enterprises and therefore offers practical support for strategic long-range planning.

PRODUCT INNOVATION RATES AS STRATEGIC INDICATORS

Product-innovation-rates specify the portion of new products in the total sales of a company. They are published in annual business reports and serve the following purposes:
- for documentation of the efficiency of r&d-departments,
- for intercompany and intertemporal comparison,
- for risk assessment in case of exaggerated product-innovation-rates and
- for prediction of future market chances with new products.

Product innovations are the results of successful r&d activities. The extent of these activities is determined by the allocation of financial properties in r&d budgets. Therefore and as product innovations determine

It's owing to Brockhoff that product-innovation-rates may be used not ex post as proof for the capability of r&d departments, but for the first time for the purposes of ex ante r&d budgeting (Brockhoff 1985). He proposes an approach claiming to show advantages over other budget rules by implementing a pre-control function in the sense of innovation strategy. In practice commonly used methods are often oriented on past data (e. g. sales share orientation) or are reactive (e. g. following the expenses of competitors), whereas a product-innovation-rate approach discloses further-reaching time horizons.

The aim of this study is to examine the aptitude of product-innovation-rates to stipulate r&d budgets. Therefore the innovation-rate approach and the per-cent-of-sales method are opposed in a System Dynamics model and simulation results of the two methods are examined for various company scenarios.

A SYSTEM DYNAMICS MODEL FOR THE SIMULATION OF BUDGETING DECISION RULES

System Dynamics is chosen for modelling as it provides complete and capable devices for the analysis of complex and dynamic systems which are characterized by information feedbacks.

Model assumptions

For the purpose of general statements, a hypothetic company is modelled. It produces long-living consumer goods, and has its own r&d department as well as its own sales organisation. A simplified overview of the structure of the model is given in the flowchart diagram in figure 1.

The assortment consists of products exclusively originating in the company's r&d department. The number of accomplished research projects depends on the r&d budget and on the actual project costs. These project costs rise with increasing frequency of product innovations. After the research phase one tenth of all projects has to be rejected as technically not practicable. After this, another thirty per cent of the development proposals are not reaching the development phase, as they are not promising in terms of economic success. In the next phase product innovations are introduced into the sales market. Only fifty per cent of them survive after the first market year; the other half is eliminated from assortment.

Products follow a standardized product life cycle with given patterns for sales and costs. Total sales during supposed ten year product life sum up to 200 million money units. Out of this amount 85 million contribute to the first five market cycle years equalling an actual innovation rate of 42,5 per cent. Higher product-innovation-rates shorten product life cycles due to the effect of assortment cannibalism.

Gross profits are calculated out of the difference between sales and product costs, which consist of variable and fixed cost portions. Net profits are obtained by subtracting r&d expenditures from gross profits. Cumulated net profits, bearing five per cent annual interest, are the main criterion for evaluation of the two r&d budget rules. Simulation time is thirty years.

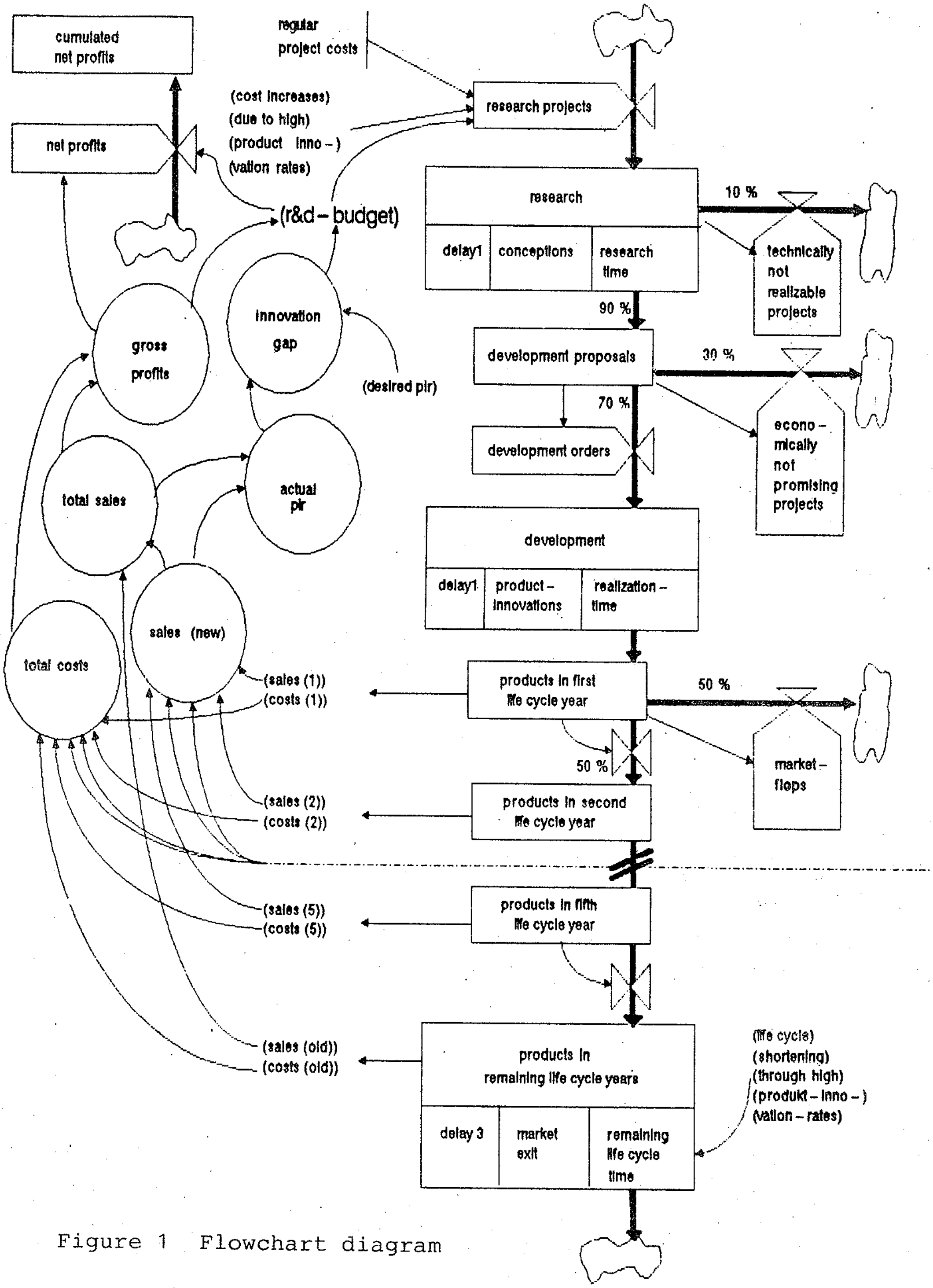

Figure 1 Flowchart diagram

Starting simulation, the modelled company is in a steady equilibrium; all products, thirty by number, are equally distributed over all market cycle years, leading to an actual innovation rate of 42,5 per cent. Total sales in the first simulation year amount to 600 million money units.

R&D BUDGET DECISION RULES

The r&d budget rules are determined as follows:

Product-innovation-rate approach

The r&d budget

- is increased, if

1) the actual product innovation rate falls below the desired value (innovation gap) and if gross profits are sufficient. Increases are limited to twelve per cent for reasons of steadyness.

- remains unchanged, if

2) gross profits are not sufficient for a planned increase in budget.

- is reduced, if

3) the actual innovation rate exceeds the desired value; i. e. sales of new products are above plan. Budget reductions underlie a ten per cent limitation to avoid too violent fluctuations.
4) gross profits are negative; i. e. the company is losing money. Again reductions are limited to ten per cent.
5) cases 3) and 4) coincide. Then the stronger reduction of both is executed.

Per-cent-of-sales approach

Budget allocations are determined in analogy to the product-innovation-rate approach; the essential difference is that the desired sales share is now used as goal value. The budget rule then tries to avoid deviations of the actual sales percentage under observance of the same financial restrictions as mentioned above. Also the same limitations for increases (max. twelve per cent) and reductions (max. ten per cent) are in force.

SIMULATION RESULTS

Budget Multiplier

The budget multiplier specifies the correlation between the innovation gap and the budget change rate. Increases and reductions are limited to twelve respective ten per cent to avoid disturbances from heavy budget fluctuations which might confuse sensible scienticists. Brockhoff suggests a curve which is described by the trigonometric function hyperbolic tangent (see figure 2). Simulation experiments with various curves show, that a linear correlation using a TABHL function is not only quite handy and simple, but also generates better results.

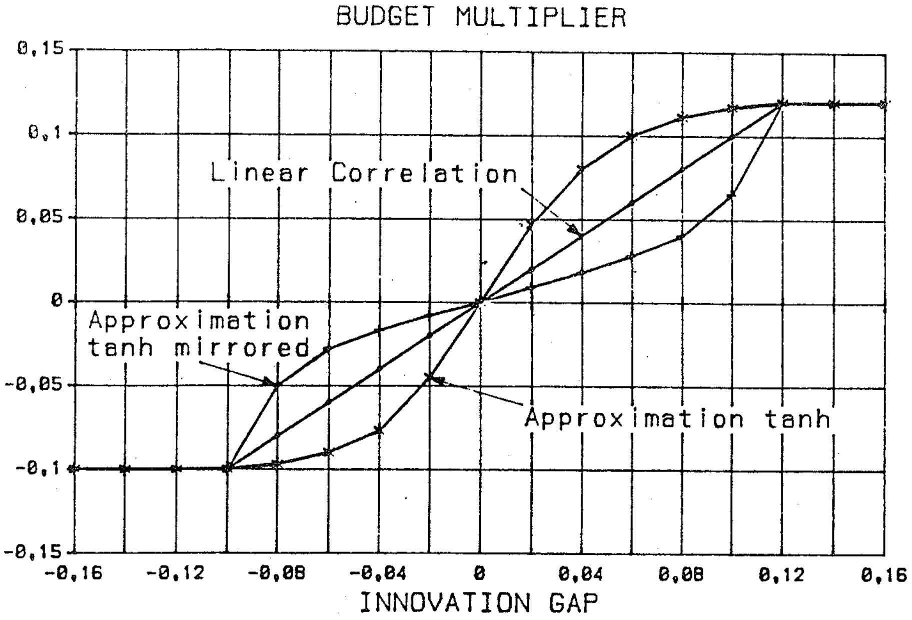

Figure 2 Variations of the budget multiplier

Product-innovation-rate approach

The first question to be answered by studying innovation oriented budgeting regards the proper goal values. Figures 3 and 4 show simulation results for sales and net profits using comparative plots for desired innovation rates from 35 to 55 per cent in steps by five per cent . Desired innovation rates below the equilibrium value of 42,5 per cent lead to insufficient r&d efforts and finally collapsing market shares. On the other side, exaggerated innovation goals imply high r&d expenditures resulting in unsatisfying return on sales. Best results are achieved with goal values for innovation which are about ten per cent above equlibrium.

Per-cent-of-sales approach

Applying goal values for r&d sales share from three to eleven per cent with steps by two per cent, comparative simulation runs show best results for a desired sales percentage of seven.

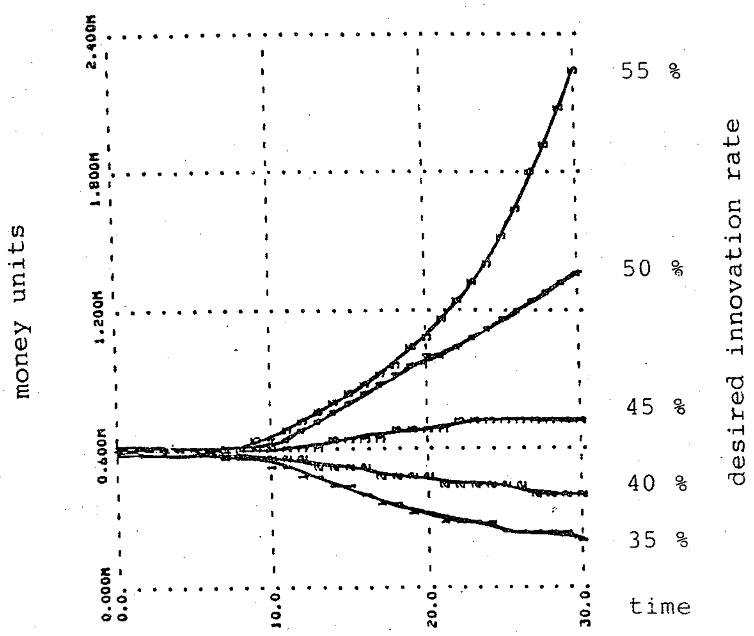

Figure 3 Sales results for various desired product innovation ra´es

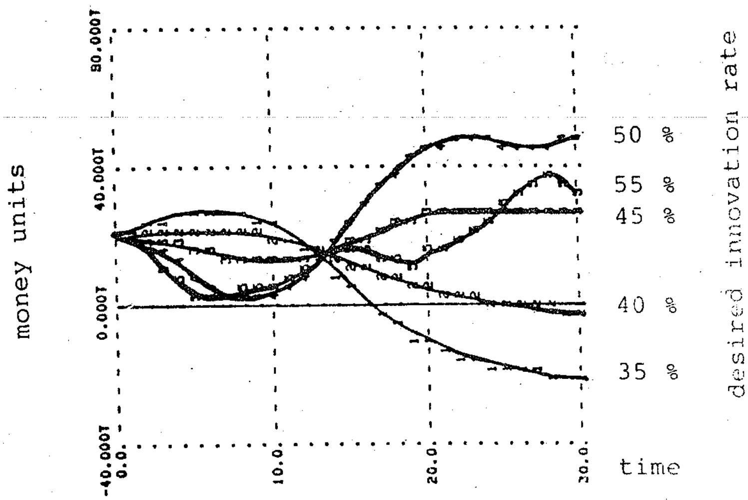

Figure 4 Net profits for various desired product innovation rates

Comparative consideration

Opposing the findings of innovation and sales orientation approach, surprisingly the per-cent-of-sales method shows superior results in terms of net profits. This is ascribed to a certain nervousness in r&d allotments determined by the innovation oriented method. In accordance with the thereby used budgeting rule the innovation goal cannot be achieved and observed exactly in the long run; as a consequence r&d allotments lack the necessary steadyness, which in turn results in smaller net profits. Further simulations of growth (actual innovation rate at simulation start: 47 per cent) and of shrinkage (innovation rate at start: 38 per cent) portfolio situations confirm the superiority of the sales-oriented method.

SALES-ORIENTED PRODUCT-INNOVATION-RATES AS A MODIFIED APPROACH

In order to benefit from the conceptual merits of the product-innovation-rate approach and from the practical advantages of the per-cent-of-sales method, a new combined approach is developped. The principle of innovation orientation is maintained, but the new approach does not directly determine the r&d budget. Now the budget multiplier affects the desired sales percentage, which then again is used as the goal value for sales orientation.

With this combination the nervousness of a sole innovation-rate orientation is diminished and the advantages of both approaches come into effect. Simulations of this sales-oriented product-innovation-rate approach show that goal values are reached in the first ten simulation years and afterwards actual and desired values are close by. Especially in the last third of simulation time steadier and higher net profits are gained.

Table 1 shows a summary of the results of separate and combined application of the two approaches. The combined sales-oriented product-innovation-rate approach indeed shows in some cases better results than the single applications. It is noteable that the highest cumulative net profits are obtained with a nominative innovation goal of forty per cent (which is close to equilibrium) and high percentages for sales shares. Behaviour shows that this constellation implies a business policy, which begins with financing r&d expenditures in the first periods and continues with cut backs. This is called a skimming policy, leading to high profits by neglecting the chances of innovations. This kind of policy, despite its better numerical results, has to be rejected in the sense of strategic innovation management. More convenient is the parameter constellation of fortyfive per cent desired innovation rate value and six percent desired sales share, as it shows better behaviour in terms of balanced portfolio structure during passing simulation time. The goal values of this best combined approach are smaller than those of the best separate approaches, leading to smoother budget adjustments.

cumulated net profits in mio. money units	combined approach	desired product-innovation-rates in %					per-cent-of-sales approach
		35	40	45	50	55	
desired sales share in %	5	1501	1784	1986	1304	1304	1902
	6	1662	1985	**2156**	1304	1304	2055
	7	1807	2153	2138	1303	1304	**2125**
	8	1937	2293	2097	1304	1304	2032
	9	2053	2347	2020	1304	1304	1906
product-innovation-rate approach		1230	1468	1738	**1850**	1352	

Table 1 Cumulated profits after 30 simulation years; results from the product-innovation-rate, the per-cent-of-sales and the combined approach

CONCLUSIONS

As a result of this examination it has to be noted, that to evaluate new approaches it is essential to compare them with other common methods, which are used as reference. The flexibilization of the simple and efficient percent-of-sales method by combining it with product-innovation-rates integrates strategic aspects into the process of r&d budgeting, leading to improved sales and profit gains. Yet a final validation of this concept can only be accomplished in practice.

REFERENCE

Brockhoff, K. (1985), "Die Produktinnovationsrate als Instrument der Strategischen Unternehmensplanung", Zeitschrift für Betriebswirtschaft, No. 5, pp 451-476.