Flexible Manufacturing and it's Benefits for the Financial Situation of an Enterprise

- A System-Dynamics-Assessment on Investment Calculation -

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Introduction

Over the past decade, as a result of world-wide stagnation - combined with the entrance of low wage competitors to the market - the situation of the manufacturing industries in the industrialized economies became more competitive. Although it is not accompanied by an increasing output, the application of flexible manufacturing as a new process technology seems to enable the enterprise to gain productivity and to push up it's competitive strength.

Therefore, the necessity to introduce these technologies is emphasized in numerous discussions. On the other hand these technologies require capital-intensive investments. So the capacity of reducing costs seems to be a decisive measure of the economic advantage.

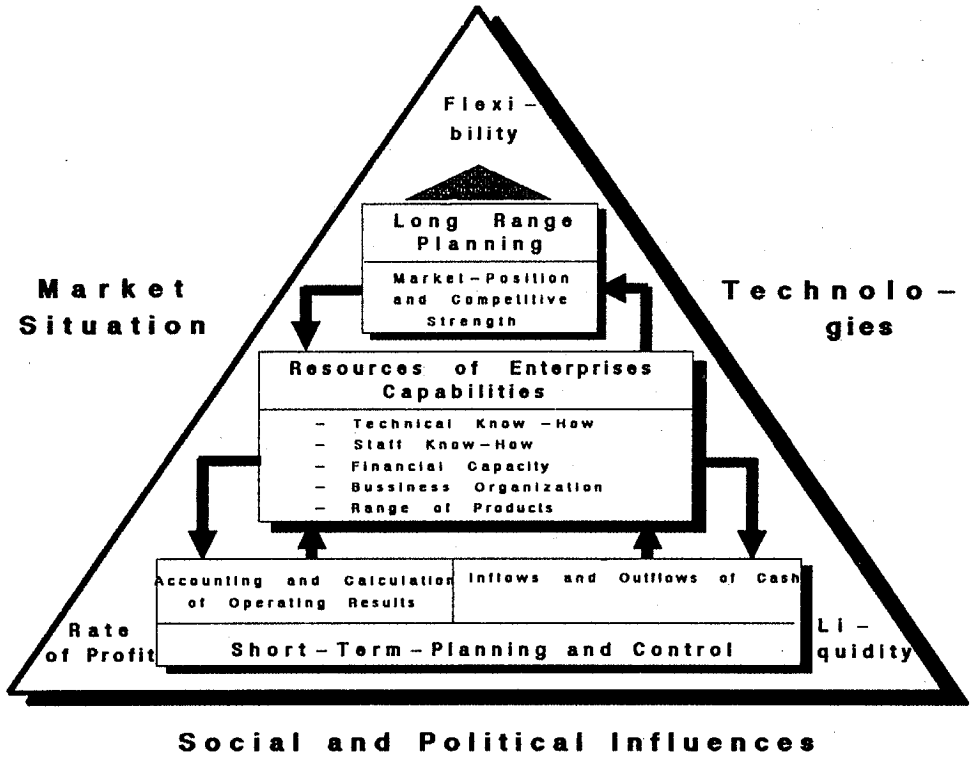
1. Flexibility – an economic necessitity for industrial enterprises

For todays industrial enterprises, investment in flexible manufacturing technologies are of crucial importance. Succesful installation increases the competitive strength significantly. On the other hand, capital-intensive investments in these technologies involve – particulary in face of an uncertain future – financial risks. Above all, an acceptable demonstration of the flexible technologie's economic efficiency is not available.

The wellknown calculation methods, such as the capital value method, the internal rate of return method or the annuity method of preinvestment analysis cannot prove an economic advantage of the flexible manufaction. This is due to the fact, that these methods assess only the rationalization effects. But the essential goal of the investment opportunity, to push up flexibility as well, is not considerated. The dilemma is, that there is no value X or Y of the flexibility, which could be directly calculated. Flexibility cannot be bought. Flexibility grows out of a network, determined by the combination of technology within an adequate organization, leaded by welltrained staff members.

So, the way to assess the flexibilitie's value is it's consideration within a holistic view of the "System Enterprise". The enterprise has to be seen in it's technical, economical, political and social framework. The investment planning system has to pay attention to short-term effects such as rationalization effects as well as to long-range goals of the flexibility, particulary the guarantee of the enterprises competitive strength, as shown in ***VIEW 1.***

VIEW 1:



2. The model

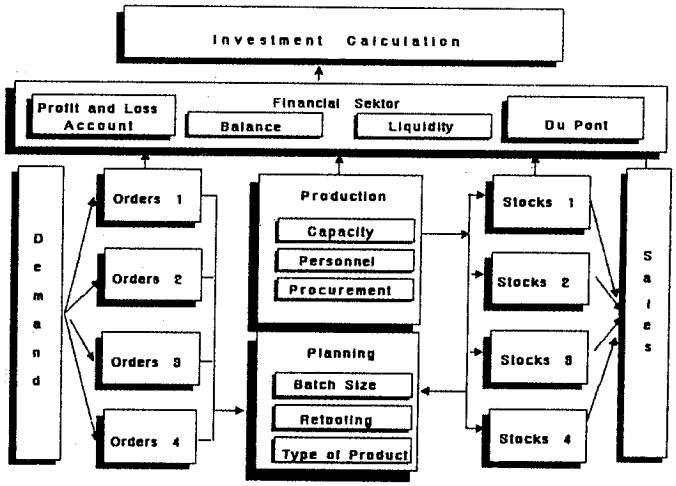
2.1. Components of the model

The model that is constructed to quantify the benefits of Flexible Manufacturing, contains all relevant sectors a real enterprise is composed of; only the price and the quantity of the sales are exogenously fixed by the market.

The enterprise manufactures four different products by turns on the same unit. In the beginning the enterprise has an equipment which is rather inflexible and causes high costs for retooling. This equipment will be replaced by a Flexible Manufacturing System (FMS), realized by a three-step-investment,which is distributed over one and a half year *(VIEW 2)*.

The investment calculation shall examine the profitableness of the investment in FMS.

VIEW 2: General map of the enterprise



2.2. Important loops of the model

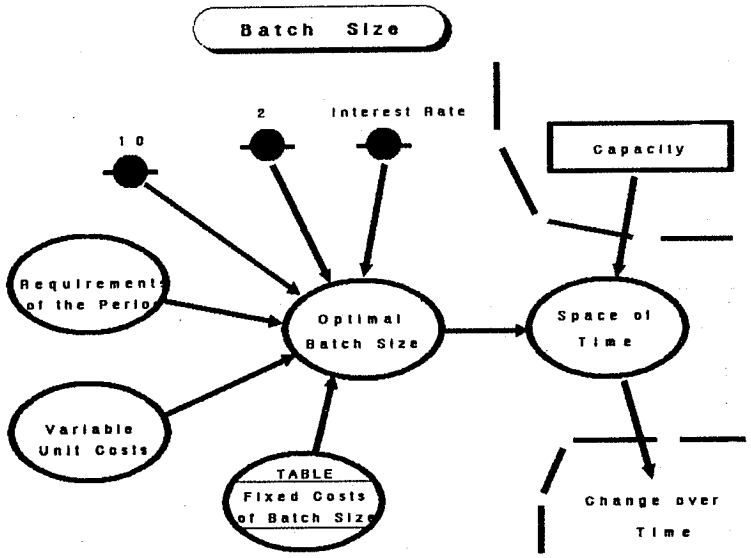
I. Batch size and change over time

This sector determines the space of time that one product type will be manufactured on the unit. The equation of the batch size (according to Andler) is:

$$bs_{opt} = 10 * \sqrt{\frac{2 * \text{requirements per period} * \text{Fixed costs per bs}}{\text{variable unit costs} * \text{interest rate}}}$$

This equation results in a feet-back-loop designed in *VIEW 3.*

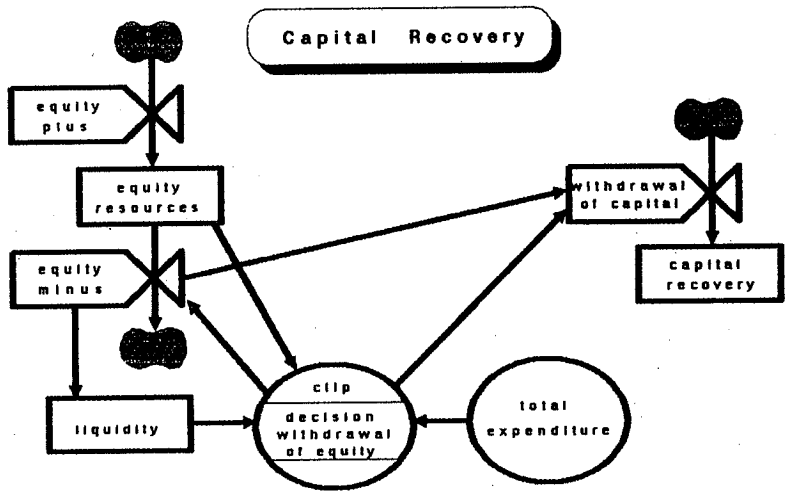
VIEW 3:



II. Capital recovery

To examine the profitableness of the investment all equity resources which are surplus and unnecessary for the enterprise are recovered and accumulated *(VIEW 4)*.

VIEW 4:



This sector represents the investment calculation – the "money-box" – of the model. Opposed to the "money-box" of an identical enterprise without Flexible Manufacturing Systems it quantifies the monetary benefits of this investment.

3. Simulation

3.1. Implementing of the simulation

The present model realizes – in contrary to the usual System-Dynamic view of processes – a more microeconomic contemplation, which leads to a very disaggregated structure of the model. The advantage of this variation is, that also short-term processes can be included in the model. Therefore the model contains 21 level, 39 rates, 88 auxiliarys, 20 constants, 5 tables, 26 clip- and 3 switch-functions; the length of one simulation period represents in reality only one week, and the total simulation covers a space of four years (=200 periods).

Because of the extreme stability, the model can also be simulated for 20 years or more (=1000 periods or more), but there is no remarkable change in the results.

3.2. Results of the simulation

The important outcomes of the model with FMS will be compared to those of the model without FMS, listed below in tabular form, and only the most important results are presented more detailed.

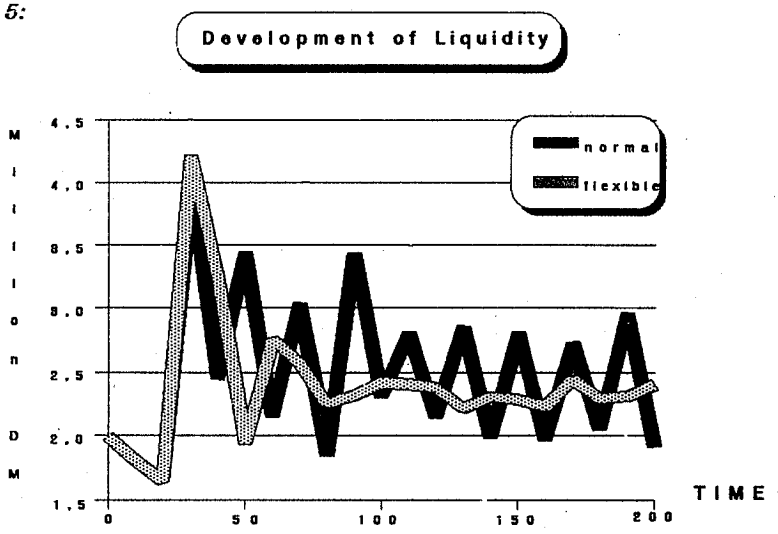
Tabular of results

	with FMS : without FMS
fixed assets	+ 30 %
current assets	- 15%
return on investment	+ 280 %
years net earnings	+ 375 %
costs per unit	- 5 %
finnished product stocks	- 15 %
delivery incapacity (*)	- 90 %

(*) Orders which can't be performed at once

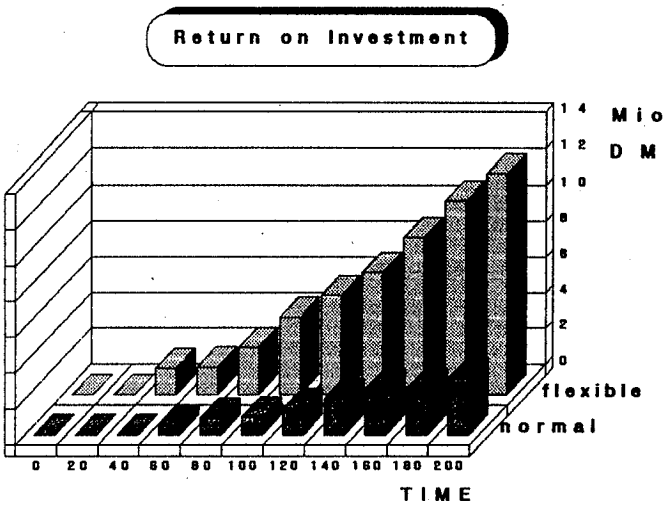
Besides these results which were expected and only had to be quantified, another unexpected effect could be noticed. The liquid funds, largely oscillating in the model without FMS, are nearly constant in the model with FMS. This leads to a more reliable planning of the finnacing and can be utilized for a reduction of the liquid resources. This effect is created by a more regular turnover respectively revenue. And the turnover is also nearly constant, because the enterprise with FMS is able to deliver faster the ordered products although it has to keep lower stocks of finnished goods which leads to to a diminution of the intermediate financing. Generally can be declared, that FMS effects an appeasement of the oscillation of the activities of the enterprise ***(VIEW 5)***.

VIEW 5:



Finally the investment calculation. The introduction of FMS increases the capital recovery for about 300 % *(VIEW 6).*

VIEW 6:



This fact elucidates the profitableness of FMS and in combination with the other results it corroborates the supposition, that this technologie is unalterable to preserve in future the enterprises competitive strength.

A holistic view will be developed describing an enterprise with a certain number of products. The model analyzes the impacts of modern process technologies, such as flexibility, quality, stock-level and return on investment, on the financial situation of an enterprise.

The System-Dynamics model represents the reduction of costs, the shifting of financial funds in the balance from current to fixed assets and the return on investment realized by the installation of flexible production equipment in an industrial enterprise.