INDUSTRIAL SITE PLANNING AS A TOOL TO CONTROL REGIONAL EMPLOYMENT - A DYNAMO MODEL -

H.H.E.W. Eijdems', D.J. Sweeny'', B.J. Brouwer''', W.R. Snel''', J.M. den Breeje'''

ABSTRACT

Holland is a little, crowded country with (like most nations in Europe) a high degree of unemployment. On the one hand the government tries to provide an adequate amount of industrial sites in attempting not to obstruct economic growth. On the other hand this puts a high claim on the amount of scenery still extant in our country. Therefore the council of the central province in Holland asked for an investigation about the relationship between the supply of industrial sites and the influence on the increase of employment in each part of the province. As there are six employment-office area's in this province, a partition was made in six regions. Several branches of employment have quite different effects on claims for industrial sites, so there was also a division made in three economic branches. This results in eightteen equations for many of the relationships in the same form, but with different parameters. Therefore the DYNAMO - III -language was used in model-building to take advantage of the array possibility. The final result is a computer-model comprising about fifty array-equations, which allows the calculation of the area of industrial sites in different stages of development in each region and gives the spreading of employment over the province until 1995.

INTRODUCTION

In spite of the high level of technical development reached in most western countries, manpower is still needed to maintain industrial production. For this reason it is not so hard to realize that the location of industrial sites in the neighbourhood will have impact on the demand for local working people.
As Holland is a small, crowded country with a high degree of unemployment still, there is a need for carefull planning of industrial area as well as creating optimal conditions for economic progress.
Research on the necessity of additive industrial site supply is mainly focussed on the provincial authorities. The consulting organisations in these matters (to the province council) are called "Economic Technological Institute (ETI)". It was this institute in the central province of Holland (called Utrecht), that requested the System Dynamics Group in Delft to investigate the possibilities of a Dynamo model for their purposes.
The provincial capital (also called Utrecht) is an agglomeration of people and activities with a strong urbanisation effect. Due to the central position in Holland the transport and services sector takes an important part of the provincial income index (up to 70 %).

student at the Delft University of Technology,'' staff member of the management group at the department of Civil Engineering, ''' members of the research department of the ETI in Utrecht.

The problem to solve was illustrated by the situation in Amersfoort
-Nowadays distribution of additive site area is based on the level of economic activities in each region (measured by employment figures)
-In the city of Amersfoort economic growth is suppressed by a shortness of industrial sites
-Employment in Amersfoort is decreasing due to the above effect
-Admission of new site area for Amersfoort is low because of the bad employment figures in the region.
This positive feed-back loop seemed well fitted to be modelled in a System Dynamics approach.
The main negative feed-back loop (of course) is formed by the demand for industrial sites that results in a diminishing stock. A smaller amount of free available area means higher prices and less qualitative choice so the demand decreases.
The assignment for the System Dynamics Group was to investigate the relevant factors in industrial site planning and employment and to build a model that links these two processes.

THE MAIN INFLUENCES IN THE MODEL

Employment aspects

The provincial employment prognoses are made by the ETI each year. For this they use material published by national institutes (National Planning Institute and National Institute for Statistics). These provincial prognoses are used as a basis for the Dynamo model. In the model a differentation of the prognosis for each region is based on a region-valuation, which can be influenced by all kinds of production stimulating factors. Only the influence of direct available industrial site area is taken into account as a dynamic factor in the present model. Other influences are brought in as constants, but of course can be formulated as system dependant variables in an extension of the existing model.
Not all working capacity is situated on industrial sites and a difference appears in the use of site area per employee in different sections of economic activity. Therefore a partition is made into three economic branches (public and private services, trading and transport, industry and agriculture). The influence of each branch in the region (site-) valuation is taken differently into account. The connection between a specific branch and the mean area of used site grounds in square metres per employee can be expressed in a characteristic ratio (effective site binding quote). This ratio is a constant value for each branch or may vary slowly in time (quasi-constant).

Site demand aspects

The demand for site area is gathered from three different sources. First a variation in the level of employed manpower may occur, resulting in an additive need for site area (this need can be negative !). The variations in employment originate from an expansion of economic activities (the foundation of new companies,

expansion of existing companies or migration of companies between different regions).
A second reason giving demand for sites is the wish of some existing companies to move from their actual location to an industrial site accomodation. Reason for removal might be the positive effect of clustering, better infrastructure, status of accomodation etc.
The third reason is caused by government policy in particular new rules and laws for the defence of nature and environment. According to town and country planning some companies are dislocated and are forced to move to industrial sites within a certain time period. This last demand is supposed known and is taken to have a constant average value within the model time horizon.

Site supply aspects

In the supply of industrial sites we can distingiush different stages directed by authorities at different levels. The area of fallow land that is destined for an industrial site function in provincial plans is determined by the province council (at the proposal of the ETI). This stock-level (called potential site supply) is the margin for regional development plans. Local authorities may decide to develope potential supply to salable site area in order to fulfil a need or according to their potential to attract employment to the city. When a certain site area is fixed in the city development plan we call this a hard supply. The part of the potential supply for which no local plans exist is called a soft supply. The determination of an area status in the city plans is not sufficient to obtain salable sites. The salable stock-level is filled when works are executed to prepare the hard supply area for housing of companies and to enable traffic access by providing a fitting infrastructure. in the end not all the sites in a salable condition are freely available, because options may be laid on some sites by companies and part of the salable stock might be obtained for contract procedures or moving-in activities. In the model site ground gets into use at the moment that manpower is settled down, this is necessary because manpower is directly connected to used site area in the effective binding quota.

Region valuation aspects

A high level of industrial site supply will give a high score in the valuation process of a region. The attractivity of a region for new employment is not only determined by the level of free available sites. We also have to regard the existing demand. The level of the existing demand for sites is a result of the time delay that occurs between the decision to obtain an industrial site settlement and the moment manpower moves in. A high level of free available site area might be flattered by an even higher level of demand for sites. In the model the difference is calculated between the supply and demand level to operate as a stimulator for economic growth.
The function that gives the relation between site remainder and region valuation is not lineair. In effect it is not quite correct

to speak about attractiveness of site remainder. In practice the influence of site area on employment figures is rather negative. Only a shortage of sites in a region will have a direct impact on the economic situation. When a certain level of remainder is reached the valuation stays further constant. This level is called the iron stock of site supply. As a rule of thumb this iron stock is defined as the average value of a one-year-demand. In theory it should be that level of demand above which neither qualitative, nor quantitative fulfilment of demand is obstructed.

Difficulties in modelling

The main difficulty in solving the requested problem in a System-Dynamics approach was (is) the boundary condition of the total provincial employment figures. The summation of all regional amounts in the alteration of employed manpower has to equal the (artificially imposed) provincial prognosis (negative or positive) in each economic branch. Therefore a cumbersome relation between one regional remainder or shortage of sites and the influences on the provincial employment had to be set up.
To simplify this problem an approach was choosen in which a negative influence on the provincial employment in a branch was only borne by negatively valuated regions. In case of no negative regions at all, a partition was made on a proportional base. For positive influences a reverse procedure was formulated. This approach may lead to some little inaccuracies (especially for small regions) in the regional levels of employed working people.

THE MODEL STRUCTURE

The array implication

For this problem the same relations could be formulated for each region and each economic branch with only different parameters. For this reason the Dynamo-III compiler was used to take advantage of the array-facility. A disadvantage of this approach is the huge amount of interactions that might hamper the understanding of the results. When setting up a new model it is quite important to get insight in the mechanisms that cause certain results. When all mechanisms function reliably and react in accordance to the expected behavior, it is no problem to raise the number of elements in the array.
In the approach followed we first divided the province into two regions and two economic classes. When trustworthy results were obtained we made a partition up to six regions and three economic classes. The original request intended thirteen economic branches. A reduction to three was made, due to a lack of trustworthy input data for such a detailed model.

Main causal loop diagrams

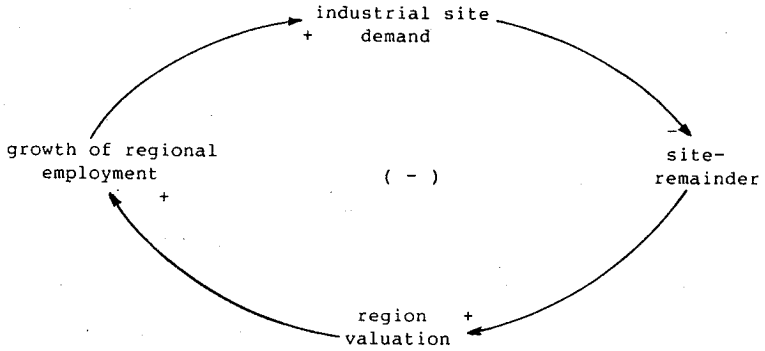

Figure 1 : Negative loop caused by a lower valuation after fulfilment of demand

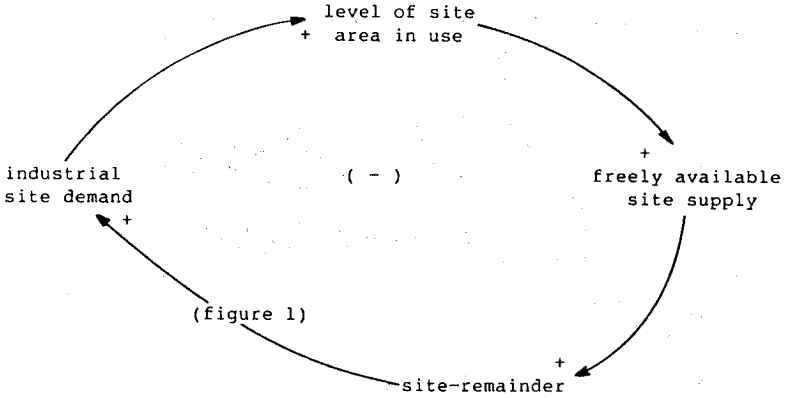

Figure 2 : Negative loop caused by decreasing supply level after fulfilment of demand

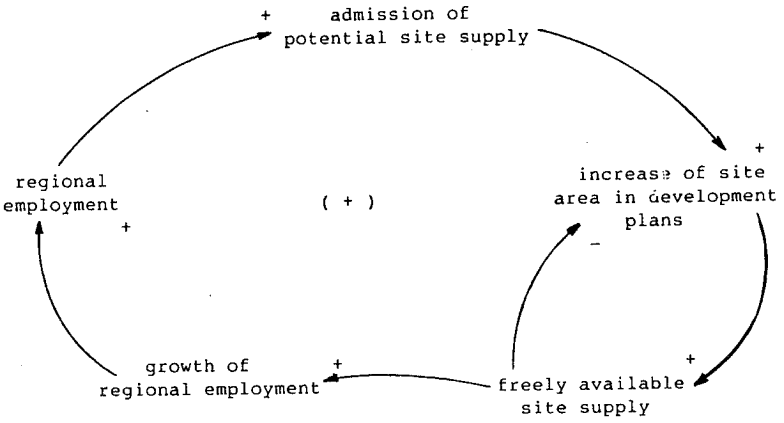

Figure 3 : Positive loop caused by supply-admission policy of authorities

RESULTS

In this part we will only show some characteristic reactions of the model, because presenting specific provincial figures might not be so intresting. We use the results of the two by two model for easy comprehension.

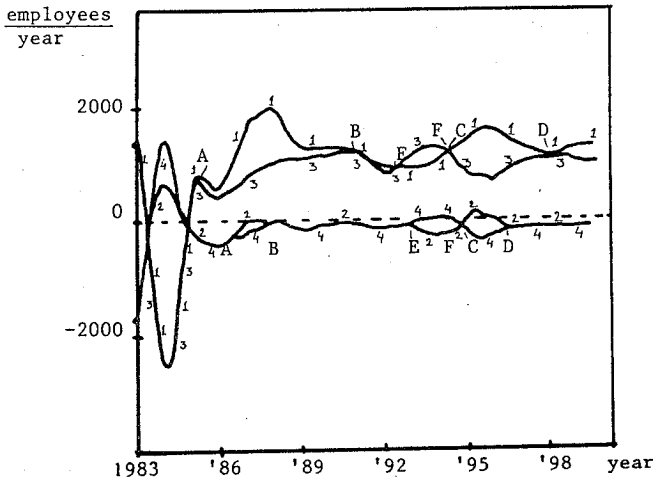

Figure 4 : Growth of employment

The growth of employment is shown for the services sector (lines 1 and 3) and the sum of all other sectors (lines 2 and 4). The city of Utrecht is represented by the lines 1 and 2 (so for instance line 1 depicts the growth of employment in the city of Utrecht). The sum of the rest of the province is represented by the lines 3 and 4.

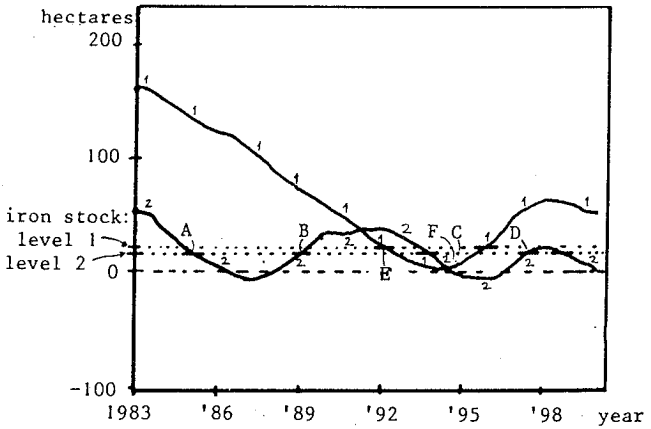

Figure 5 : Remainder of free available industrial site area

Line 1 gives the level of remainder in the city of Utrecht, the rest of the province is gathered in line 2.
The steep fall in figure 4 of the lines 1 and 3 between 1983 and '86 is caused by the provincial prognosis data. When a shortage of site supply appears in the province (figure 5 , line 2 between A & B and C & D) it is clearly seen that the growth of employment turns into advantage of the city of Utrecht (between A & B and C & D in figure 4). The reverse process occurs between E and F in both figures.

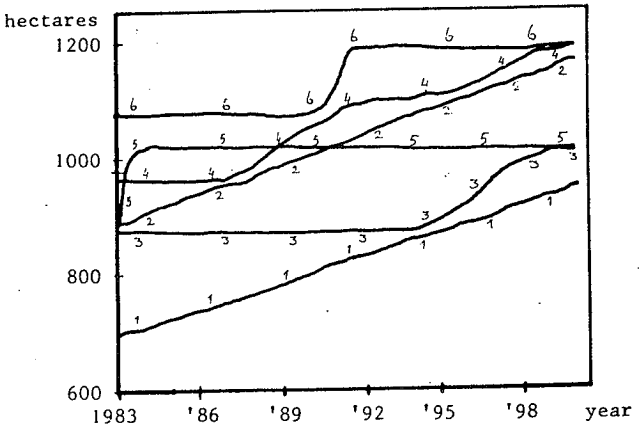

Figure 6 : Site supply levels

In this figure lines 1 and 2 represent the level of industrial site in use, lines 3 and 4 give the site supply as determined in town development plans, lines 5 and 6 illustrate the site area as determined by the province council.
The odd numbers belong to the city of Utrecht, the even numbers give a summation for the rest of the province.
During the time span of the model the potential supply (lines 5 and 6) can be raised once. Figure 6 clearly shows at what year this is needed in the different regions.

CONCLUSION

The System Dynamics approach appears to suit well for modelling of industrial site supply levels. The results give a clear insight into the consequences of policy decisions and by data and parameter variation the results of a different policy can be checked.
To provide a certain level of free available site area a town has to invest in land and works. So a large remainder of site area will give a great loss of interest costs. Parameter estimation for minimalizing these costs could be done with this model.
The connection between site area and employment figures can hardly be based on industrial site remainder only. An extension of this model for other production-stimulating factors would improve the regional prognoses considerably. Then a careful tuning of the region valuation is necessary, which could be obtained from simulation of time series in the past.
The provision of industrial sites appeared to be a useful tool to regulate regional unemployment as long as the level of free available site area does not exceed the iron stock level. In practice however (in the province investigated) this is usually the case!

REFERENCES

Pugh ,A.L.III.(1976) Dynamo users manual 5-th ed.
The MIT PRESS, Cambridge, Massachusetts.

Several ETI-authors, (all reports in dutch !)
-Room and space for services sector (1981)
-Industrial and office sites in the province of Utrecht, 1984-1995 (1984)
-Method of employment prognosis (1981)

County Council of Utrecht,
-Employment notice (1985)