SECOND MAASVLAKTE: PRACTICE PLANNING AND DESIGN THROUGH SIMULATION-GAMING

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Abstract
After long negotiations with central government, it has been decided to proceed with the construction of an offshore land extension project in the North Sea, the ‘Second Maasvlakte’. This is a project of great socio-technical complexity, with many uncertainties and dependencies. The responsible harbour authority, Port of Rotterdam, therefore wishes to take a flexible approach to construction and land allocation. Choices made in the early stages must not restrict later developments.
A simulation-game has been developed to ensure the independence of choices made at the start of the process, such as where and when construction will commence and which site is to be allocated to the first paying customer. In the simulation, Port of Rotterdam staff are assigned various roles which represent the departments involved in the decision-making process for the development of the Second Maasvlakte. The simulation covers a period of thirty years, the objective being to achieve a fully functional Maasvlakte, with maximum commercial profitability. This paper regards the construction of the Second Maasvlakte as a socio-technically complex project and describes how the gaming simulation can assist in the decision-making process.

Background
Rotterdam Harbour is to see further expansion in the years ahead. Prognoses indicate that greater quantities of cargo will be handled, and that a greater number of commercial enterprises will wish to locate in the immediate area of the harbour (Gemeente Rotterdam 2004). According to current growth, available space will be fully occupied by 2010, whereupon it would be impossible to meet further demand.
The growth of the harbour is not only good for the city of Rotterdam itself, but will also support the economic development of the Netherlands as a whole. Accordingly, central government and the Port of Rotterdam (PoR) have decided to proceed with the construction of an offshore harbour extension, the ‘Second Maasvlakte’ (MV2).
The MV2 project is an ‘extensive and complex undertaking’ (Port of Rotterdam 2004) which demands a thorough, well planned approach. The objective of the project is to reinforce the position and quality of Rotterdam as a ‘mainport’. Because it will involve considerable investment, and because the costs can only be recouped if enough users can be attracted to the new area, the motto is ‘build on the basis of customer demand, with respect for nature.’ Accordingly, the construction of MV2 will first follow market demand, customer demand becoming the key consideration at a later stage. Given the uncertainty of current market demand, the extension and construction of the outer contour will be undertaken in two phases, the second of which will involve the outer contour being moved further offshore to create more parcels.
Market and customer demand will be taken into consideration at three ‘decision moments’ which have been incorporated into the development process. The first will be the go/no-go decision regarding the construction of the outer contour itself. This will be made jointly by central government and the PoR, based on actual demand at that time. At least one commercial organization must have announced the intention to locate on the new MV2. The second decision precedes the commencement of the second phase of the project, and again there must be adequate demand. The third decision relates to the designation of land usage and its apportionment into parcels for allocation to users. Before the construction of the embankments and dockside quays can commence, there must be a ‘launching customer’ who has already entered into a firm contract with the PoR.

Given the uncertainties of the construction process, market development, the relationship between the construction process and land allocation, and given the involvement of several departments of the PoR authority, the MV2 is undoubtedly an ‘extensive and complex project’. The decision-making process must take this complexity into account.

**Understanding complex infrastructural systems**

The development of Rotterdam harbour, and the MV2 in particular, may be regarded as a complex socio-technical infrastructural system. Complex systems comprise elements with certain characteristics, each having a certain relationship with the others. Complex systems are dynamic and can display ‘emergent behaviour’ caused by feedback and the ongoing changes in the setting (Holland 1995). In addressing socio-technical systems, it is important to take both their technical and social elements into account. These too are interrelated and can not be viewed separately (Geels 2004).

Infrastructures may be regarded as complex socio-technical systems because of their technical or physical infrastructure within a certain social setting, which will include various actors with various interests. The expansion of Rotterdam harbour is a complex infrastructural system. Both the physical construction process and the negotiations with potential ‘customers’ are complex in nature, and are again interrelated. Moreover, the process is influenced by the wider economic and political setting.

In the development of socio-technical infrastructures, various effects which hamper the decision-making process may be seen. In the case of the MV2, the project involves very high investment costs. Revenue will be generated only after the first customer becomes operational. Investments therefore precede income, which means that insufficient demand will result in unoccupied space and a very high costs-to-returns ratio.

Secondly, there is path-dependency. Infrastructural and/or commercial decisions made at a certain moment will automatically reduce the margins for future action. The location of the MV2’s first customer will have a major influence on the siting of those who come later, since these will have certain preferences as to whether they wish to be near the first customer or not. Moreover, it is not possible to predict with any accuracy how many customers there will be, what types of commercial activity they represent, or what their specific requirements will be.

‘Lock-in’ effects will also be seen. Once a certain path or strategy has been chosen, it will be difficult to change course. In many cases, the structures used are those which have been used successfully in the past (Gifford 1996). In this case, while the port authority has extensive experience in negotiating with customers, it now wishes to follow a new strategy of clustering customers in order to achieve economy of scale. This demands a new approach. Furthermore, once it is decided to conduct construction activities in the closest possible succession, it will be difficult to call a halt to this process.

There are several different departments within the PoR authority which will influence the layout of the MV2. Although there are no direct conflicts of interest between these departments, they are dependent on each other for information. For example, if the Commercial Affairs department wishes to finalize contractual arrangements with future customers, it must be in possession of full information regarding the progress of the construction process. Similarly, the Operational Management department must have a clear impression of the likely demand for premises. Only then is it possible to take the decision to commence new construction activities.

The complexity of the project renders it extremely difficult for managers and designers to gain an overall view of the possibilities whereby the infrastructure and its dynamics can be controlled and directed. One way of gaining a better insight into the complexity of the project is to use gaming simulation, which allow experimentation with various process management techniques and strategies. Gaming simulations are able to show the complexity of the actual system and to communicate this complexity effectively (Mayer and Veeneman 2002; Duke and Geurts 2004).
A gaming simulation for the development of the Second Maasvlakte

The expansion of Rotterdam harbour by means of MV2 will entail high costs. At present, revenue remains uncertain. In order to reduce the risk of achieving only an unoccupied Maasvlakte, the PoR wishes to maintain maximum flexibility within the construction process. It further wishes to establish clear conditions with regard to the customers wishing to locate here, in order to maximize future revenue. The planning and allocation of space to various parties, whether in the existing harbour area or the new extension, is not a simple process. The immediate allocation of a parcel as soon as a new customer comes forward brings with it the risk of fragmentation of resources, and of poor synergy between the various companies active within the harbour region.

A gaming simulation enables those involved to experiment with certain decisions, and negotiation strategies, in a safe environment which closely reflects the actual situation. The simulation enables the parties to learn about the design and allocation process in the various stages of the project. It can be used as an experimental environment in which to test variants and strategies, and to reveal their consequences. The SIMMV2 simulation seeks to answer several needs:

1. To gain a better insight into unforeseen, unintended or undesirable effects of one or more allocation strategies and design variants in the medium to long term (10 to 30 years), taking exogenous uncertainties and the strategic behaviour of the parties concerned into account.

2. To encourage an integrated and multidisciplinary approach within the PoR with regard to commercial and technical-infrastructural considerations, interests and preferences.

3. To achieve a better negotiation outcome with regard to land allocation and the design of the harbour as a whole.

The game and the rules

SIMMV2 is a computer-based gaming simulation in which the main processes of planning, design and space allocation for the future MV2 project are recreated. PoR staff can use the simulation to gain experience in the type of decisions they will soon have to make in the ‘real world’. The overall objective of the game is to arrive at joint decisions regarding the design of the MV2 area and allocation of land thereon, geared towards the efficient realization and operational management of the project during the period 2006 to 2036. The game concentrates solely on the effects of those decisions on the project itself: the broader effects, such as those on the Dutch economy or the quality of the human environment, are not taken into consideration.

In order to make the simulation as realistic as possible, the data and design variants are based closely on the actual possibilities. Moreover, the players are required to make the same type of decisions as they would in the real-life situation. However, to ensure that the simulation does not become overly complex, the number of possible choices and variants has been pared to a basic minimum. One of the choices which is not variable during the game is the physical layout of the MV2. The negotiations with potential customers include only a limited number of variables.

The starting situation

The simulation begins in 2006: the plans for the construction of the harbour are ready, the legal procedures have been completed and the first customer has expressed serious interest in acquiring space on the Maasvlakte. In other words, all conditions for the commencement of construction have been met. The location of basic infrastructure is set at the beginning of the simulation as part of the definitive approved Master Plan. Minor infrastructure is beyond the scope of the simulation. The players are given prognoses of economic development and the demand for space over the next few years. Their first task is to determine the construction strategy, the allocation strategy and the preferred siting of the various industries. They then have thirty years in which to construct the MV2, negotiate with potential customers and allocate the land parcels. At the end of the thirty-year period, the situation is examined to determine the success of the venture.
The decision-making team
During the simulation, decisions regarding the MV2 are made by a decision-making team of colleagues from the PoR. This team, comprising between four and six people, takes all decisions on behalf of the port authority. Its members have both individual and joint tasks and responsibilities. They must coordinate their various decisions with each other as effectively as possible. Tasks are assigned at the beginning of the game, but the team may re-assign tasks and responsibilities as the simulation progresses, should they decide that this is likely to assist them in meeting the various challenges. The decision-making team includes the roles of three port authority departmental directors. The Director of Commercial Affairs is responsible for negotiations with potential customers. The Director of Infrastructure and Management is responsible for the construction and (operational) management of all harbour infrastructures. Last but not least, the General Manager acts as chairman of the decision-making team and is responsible for the coordination between the other two departments, as well as for financial performance. By including the roles of the different departments within the port authority, the simulation reveals the dynamics between those departments. Some joint decisions are bound to conflict with the individual wishes of one department. The method adopted also provides an insight into the interdepartmental information flows required to arrive at well-reasoned decisions.

Other roles in the game
Besides the various departments of the port authority, the simulation includes a number of external roles. Among the most important are those of the potential customers. The Commercial Affairs department can acquire information about the customers and negotiate with their simulated counterparts. The computer model and the game’s moderators assess the customer’s response to any offer made by the port authority. The simulation involves several types of customer: container terminal operators, chemical companies, distribution companies and ‘miscellaneous others’ - a category which includes new types of industry such as a biomass production plant or firework storage facility, as well as ‘temporary’ customers who will use a certain site for a limited number of years. The roles of other stakeholders, such as the government, social groups, industry organizations and local residents, are taken by the game moderators as necessary.

The scenario
SIMMV2 is played in four rounds. The first round covers the period prior to 1 January 2006 and involves determining the strategy that the players wish to follow. They develop their outline ‘Allocation Plan’, showing the desired location for each of the various types of customer. The players then determine the construction strategy they are to apply and the initial strategy for negotiations with potential customers. These are crucial decisions in that they influence the form of the entire simulation thereafter. Each of the subsequent three rounds covers a period of ten years. The players must consider and discuss two types of decision: the physical construction of the harbour and the negotiations with customers. The same types of decision remain possible throughout all rounds, although construction aspects will clearly dominate the second round, giving way to the land allocation decisions in rounds three and four. At the start of each round, the players are given a ‘trend report’ setting out the economic climate for the period concerned. The round ends with a review of progress and results, and a re-evaluation of strategy: is this to be maintained or is it time for a change of course? At this point, time is suspended. Following brief feedback, the next round commences.

The construction of the Second Maasvlakte
At the beginning of the game, construction activities have yet to commence. No land has been raised, the outer contour is not yet in place: all there is sea! However, a design variant has already been selected and is not subject to any modification. The required construction activities are known and have been clustered within various construction strategies. Four possible construction strategies are offered. They vary in terms of the extent and combination of activities which are to be contracted out. One strategy includes no phasing for the construction of the outer contour: it is an ‘all at once’ undertaking. Each of these strategies has certain consequences in terms of costs, lead time and flexibility. The choice of strategy is made at the start of the game, whereupon it cannot be altered. However, during the simulation, the players must decide exactly when each of the construction activities is to commence. In doing so, they must take the likely lead time of that activity into account. Players are able to expedite one or more activities, but this will, of course, incur additional costs.
**Negotiations with future clients**

The second main activity within the simulation is the negotiation with customers. In the first instance, this will rely on the outline allocation plan showing the desired clustering of activities. The players must then agree on a pricing policy, whether to allow options on certain parcels to be taken, and whether to require guarantees with regard to the quantity of cargo to be handled. There are two strategies from which players can select. The first is based on the premise that ‘the customer is king’, whereby each is offered a suitable solution in line with his stated requirements. The second requires customers to meet all conditions laid down by the port authority before they can locate on MV2.

The form of the negotiation process will depend on the type of customer involved. In the case of container terminal operators, chemical companies and ‘miscellaneous others’, there is some room for negotiation. An application is submitted to the port authority, which provides its response. The customer then has an opportunity to submit a counter-offer. The port authority can choose to accept the offer and draw up a contract, or it can decline the offer. In the case of distribution companies, the negotiations are brief, rapid and straightforward: the application is either accepted or refused.

**Economic uncertainty**

Needless to say, the decision-making team cannot control everything. Much depends on the global and regional economic situation. The team is therefore given a ‘trend report’ for the coming ten years. In times of strong economic growth, demand for space in the harbour will be greater. When there is significant technological innovation, it is possible that customers (including new types of customer) will have different requirements and demands in terms of location and facilities. Economic stagnation will also have a marked effect on the demand for space. In such a situation, the decision-making team will have to take a more proactive approach to customer acquisition and may well have to make certain concessions before contracts can be entered into.

**The computer simulation**

Time is a crucial factor in SIMMV2, therefore it was decided to develop a simulation model underlying the game interface. The simulation model allows the scheduling of events on the time line. The dynamics of the game are shown in an animation screen, which shows a geographical representation of how the MV2 develops over time.

The simulation model is built in Java using the Distributed Simulation Object Library (DSOL) (Jacobs, Lang et al. 2002), which was developed at Delft University of Technology. The advantage of using DSOL is that it allows us to develop a simulation that can be used remotely, which means that players have web access to the simulation. Players can have their own personalized interaction with the game through a web portal where they can access both static information as well as dynamic information.

Static information could be customer profiles, which are made available as soon as a new customer is generated by the simulation model. Dynamic information is e.g. made available through an animation screen to show the development of the region over time.

**Indicators for good operational management**

At the end of each round there is a brief opportunity to review the effects of the decisions that have been taken. At the end of the final round, the results of the simulation are subject to more extensive scrutiny, with an examination of the success of the chosen strategies and the decisions made by the team. A number of indicators have been identified to support this process of reflection. The first is a map showing the current situation on the MV2. It reveals the status of construction work, how many parcels have been rented out, the types of company which have located here, and whether there has been any clustering of specific industrial activities.

The second indicator is the financial information. Players are given a summary of income and expenditure. The costs are those of the construction of the MV2 and the commercial management of the various sites. Income is derived from ground rent and harbour fees. A third indicator of the success of the decision-making team’s agreements relates to options taken on sites and guarantees of cargo-handling quantities. The negotiations with customers offer the opportunity to make agreements with regard to these points, whereupon the results can be included in the evaluation.

**Anticipated results**

The simulation is currently in the test phase. Accordingly, it is only possible to describe the anticipated results rather than any actual results.
Using this simulation, players will be able to gain a better understanding of the likely consequences of their decisions given a certain strategy. Firstly, they will gain an insight into the relationship between the construction process and that of allocating space to new customers. Players will discover what information they must exchange in order to ensure coordination of the processes. In addition, the degree of coordination (or lack thereof) will affect the financial performance of the harbour. The players may decide to construct the MV2 quickly in order to ensure that space is available on time. However, if no customers are then forthcoming, there will clearly be adverse financial consequences. The simulation also provides its players with an insight into the long-term consequences of the very earliest decisions, demonstrating the ‘lock-in’ effects and path dependency. The first ‘launching’ customer is likely to affect the way in which all other areas on the Maasvlakte are allocated. A stringent selection policy may result in few customers, although those that do ‘pass muster’ will be of high quality. A less rigid policy could lead to fragmentation and a lower quality of customer, but with full occupancy of the available space. In addition to providing insight into these processes, the simulation may also result in creative ideas for policy with regard to options and cargo-handling guarantees. It will be possible to test these ideas. The players can also experiment with strategies to deal with uncertainties and to ensure maximum flexibility of the construction and allocation approaches.

Conclusions
The construction of the Second Maasvlakte is complex socio-technical project with many dependencies and uncertainties. Various departments of the responsible management authority, PoR, are involved in the process. They must work together to ensure a flexible design and to maximize profitability. SIMMV2 is a gaming simulation which recreates the entire process of construction and land allocation. Port authority staff involved in the MV2 project can use the simulation as an experimental learning environment. Having completed the simulation players will have a better understanding of the various decisions they must take, and of the interdependencies of the various processes. The players also have a safe environment in which to generate and test creative ideas regarding, say, options on sites and transhipment guarantees. The simulation will promote and encourage an integrated and multidisciplinary approach, whereupon PoR will achieve better results.

References