Planning for inland navigation in Western Europe

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The possibilities for inland navigation are quite different in the various countries of Western Europe. Especially where originally natural waterways were found these were used from ancient times for transportation. On the western european continent notably Germany, the Netherlands, Belgium and to a lesser degree France are the countries where inland navigation plays a large role. For that reason most of the figures mentioned in this paper will be confined to these four countries. *Table 1* gives a rough impression of the part played by inland navigation.

Of the total in- and export flows of commodities in tons carried by the three modes of transportation i.e. road, rail and water, 49% was transported by water. Especially for the Netherlands with over 70% and Germany with almost 50% the importance of inland navigation is very obvious. It would seem to make sense to pay first some attention to the problem of planning for the so-called "Wet infrastructure". With this we do not mean that it will be sufficient to think only of the planning of the necessary infrastructure. Also the development of the so-called institutional framework - that is the sum total of legal reulations and the implementation of the legal possibilities on behalf of the regulations of the branch by the industry itself - which the individual transport entrepreneur has to take into account for his own policy, should be organized in such a way that the individual transport entrepreneur can make his plans accordingly based on reliable data.

Table 1 - The share of 3 inland transport-modes in the total im- and export commodity-flows between 4 countries of the common market in 1974

Country	Inland transport-mode				
	Rail	Water	Road	Total	
				%	Millions of tons carried
Belgium	31	38	31	100	150
France	39	26	35	100	154
Germany	27	49	24	100	302
The Netherlands	8	74	18	100	194
Total	26	49	26	100	799

When we now first pay attention to the problem of infrastructure we can distinguish two main aspects. In the first place the supply of necessary waterways and secondly the design and equipment of the harbours, both seaports and the inland loading and unloading places alike.

THE WATERWAYS

When we nowadays in our part of the world speak about planning of infrastructure for inland navigation the thinking starts mostly from the existing waterwaysystem. What does this system comprise. (see figure 1). As said the development started centuries ago with natural waterways, especially rivers. These original natural waterways have by training, regulation and also by canalisation been modified to modern waterways. As exemples of these original natural waterways we mention the Elbe, the Weser, the Rhone, the Seine, the Meuse, the Schelde and of course as backbone the Rhine, with its tributaries Moselle, Neckar and Main and the dutch outlets of the Rhine as Waal, Lek and IJssel.

In addition to these natural waterways a network of

Table 2 - The share of the 4 different capacity-classes of the waterwaysystem of the 4 countries in 1974

Cap. classes In tons of vessels	Belgium	France	Germany	The Neth.	Total	
					%	Length in kms in 1974
50–250	1	13	7	21	13	2268
250–650	59	56	9	27	37	6629
650–1350	0	5	20	4	8	1464
1350– and more	40	26	64	48	42	7579
	100	100	100	100	100	17940

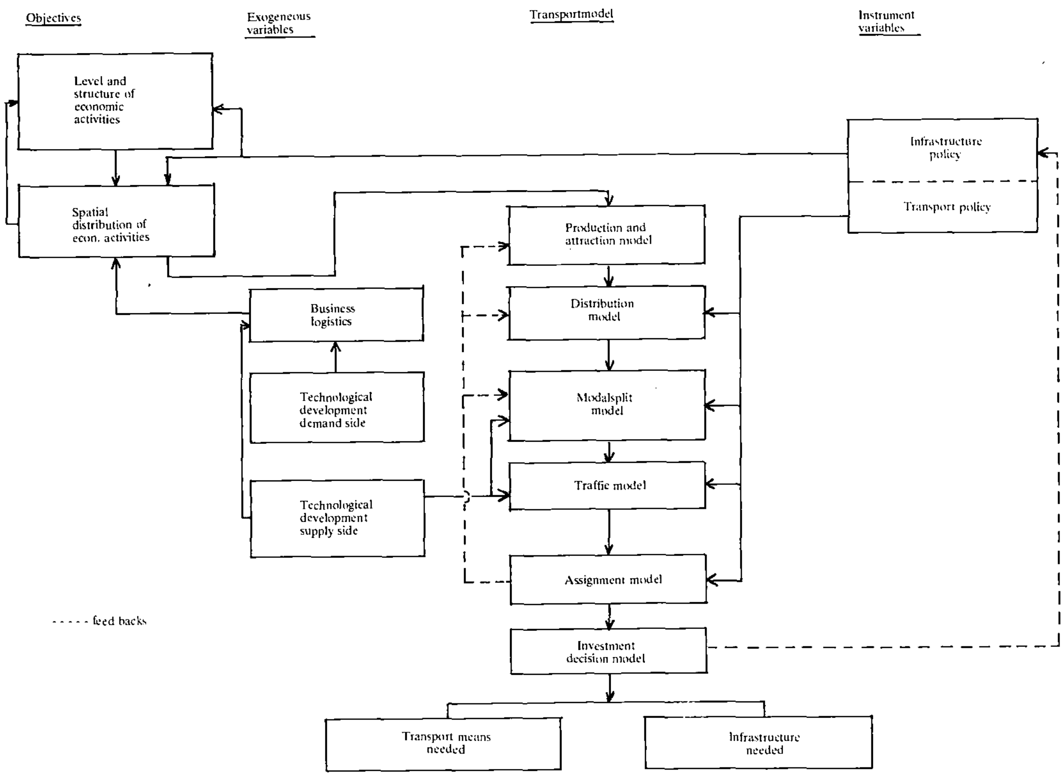


Figure 2 - The basic structure of the freight policy information system

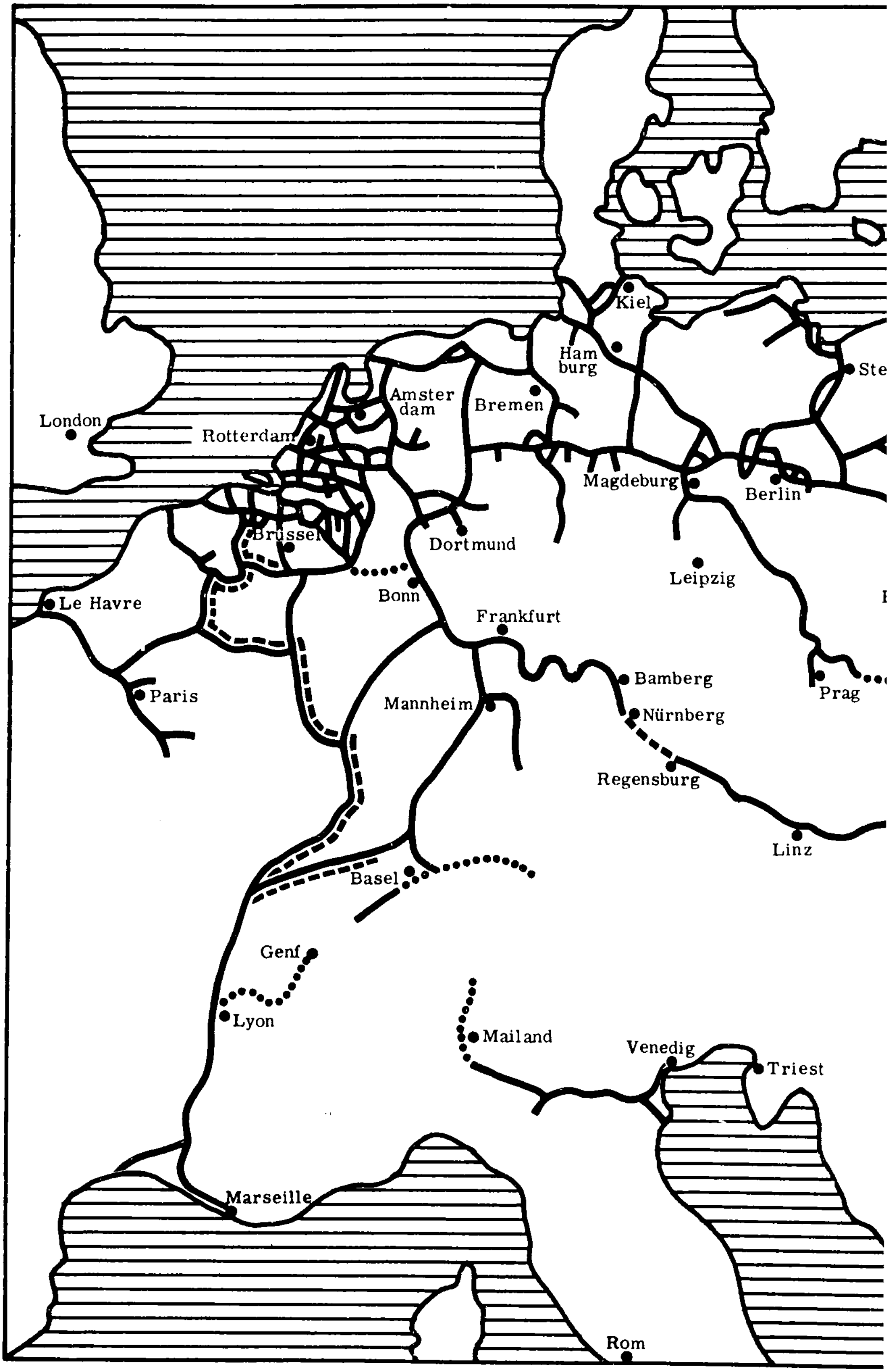
canals were built. Here we should mention the canals from Amsterdam and from Antwerp to the Rhine, the canals from Ruhrort to Dortmund and on to the German North Sea harbours and the canals in Belgium to Bruxelles and Gent and from Antwerp to Liège, as from Duinkerken to Lille/Valenciennes. Also the approaches to the seas were improved. Thus was constructed an interconnected system of navigable waterways. The total length of the regularly used waterways in the four countries Belgium, France, Germany and the Netherlands, is about 18.000 km. This total length can be divided into different categories depending on the size and the loading capacity of the vessels that can pass. *(table 2)*

Table 3 - The development in the waterwaysystem of the 4 countries to higher capacity-classes in the period 1960 to 1974; 1960 = 100

Cap. classes in tons of vessels	Belgium	France	Germany	The Neth.	Total
50– 250	24	57	44	38	45
250– 650	85	84	61	95	84
650–1350	0	179	119	113	119
1350– and more	152	173	120	102	125

Table 4 - Classification of European inland waterways and standard dimensions of vessels

Class of Waterway	Conventional navigation: General Description	Characterist. Tonnage (Tons)	Length (M)	Beam (M)	Draught (M)	Pusher navigation: Barges Length (M)	Barges Beam (M)	Classes defined by the ECE (Geneva) deadweight capac. (tons)
1	2	3	4	5	6	7	8	9
1	Barge	300	38.50	5.00	2.20			250– 400
2	Campine barge	600	50.00	6.60	2.50			400– 650
3	Dortmund-Emskanal type	1000	67.00	8.20	2.50			650–1000
4	Rhein-Herne-kanal type	1350	80.00	9.50	2.50	70	9.50	1000–1500
5	Large Rhine barge	2000	95.00	11.50	2.70			1500–3000
6	Pushed convoy	10000	185.00	22.80	3.85	76.50	11.40	3000 and over


Kiel
Ham
burg
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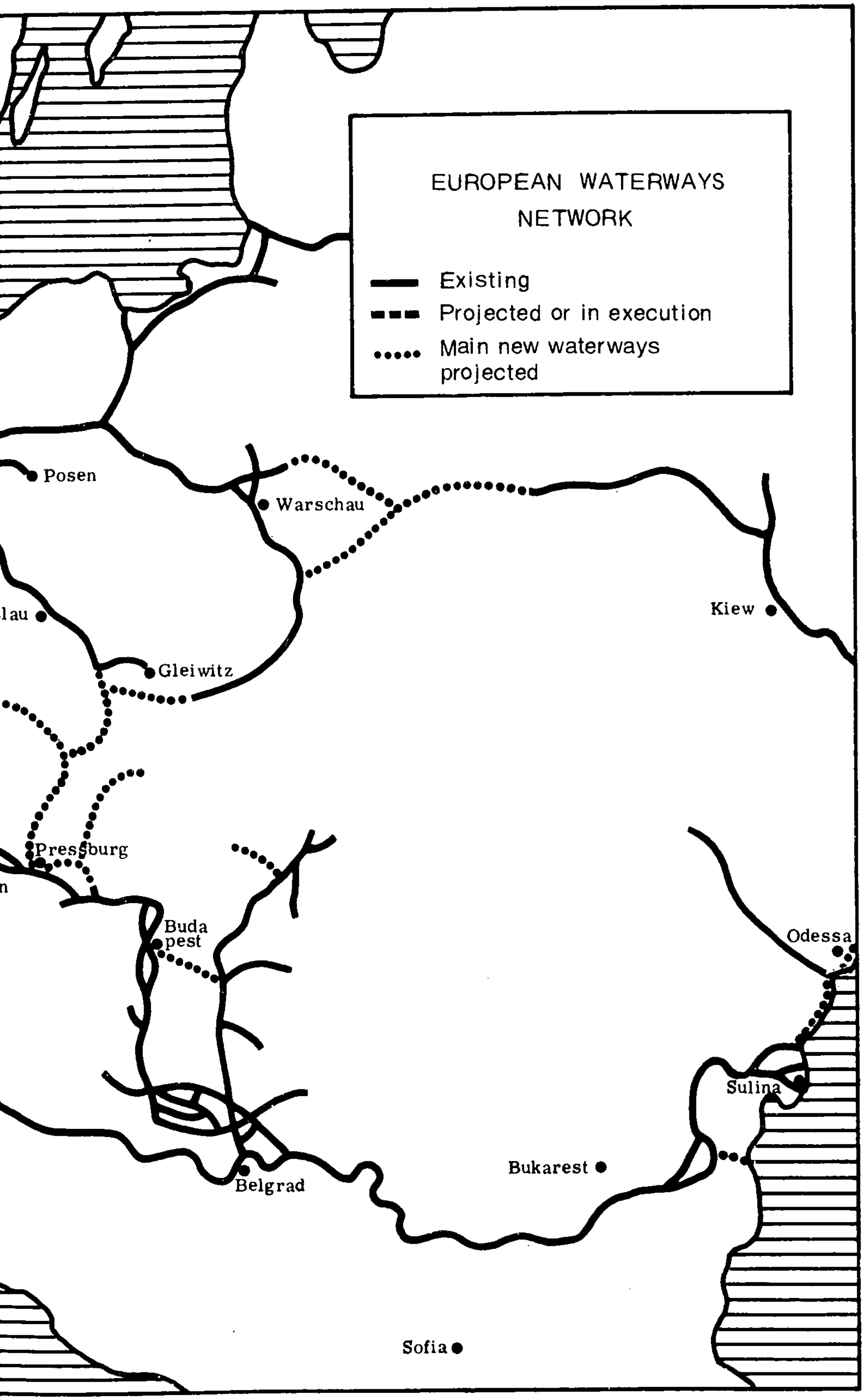
Rotterdam
Magdeburg
Berlin
Brüssel
Dortmund
Leipzig
Le Havre
Bonn
Frankfurt
Bamberg
Paris
Prag
Mannheim
Nürnberg
Regensburg
Linz
Basel
Genf
Lyon
Mailand
Venedig
Triest
Marseille
Rom

Figure 1


EUROPEAN WATERWAYS
NETWORK
Existing
Projected or in execution
Main new waterways
projected
Posen
Warschau
Kiew
lau
Gleiwitz
Pressburg
n
Buda
pest
Odessa
Sulina
Bukarest
Belgrad
Sofia

The total length of the waterways that exclusively can be used by vessels smaller than 250 tons has diminished to less than half since 1960.

The ability to use bigger vessels has primarily come about by widening and improving the substandard existing waterways. This process of improvement of existing waterways has taken place in all of the four countries mentioned *(table 3)*. Expansion of the network of waterways in the various countries was prompted primarily by the extensive traffic on the main artery of the western european waterway system: the Rhine. At the Treaty of Paris in 1815 the foundations were laid of a supranational policy with respect to this so very important waterway.

It is the Central Rhine Commission at Strassbourg who promoted and still promotes the improvement of this river as a navigable waterway. The possibilities to the transport industry that arise from the activities of improving the Rhine navigation have also their direct impact on the design of the, nowadays mostly with the Rhine interlinked, infrastructure of waterways. The process of growth since 1815 and 1868 (Act of Mannheim) and the closer international relationship, especially after the second world war, led to more formal standardization of planning goals. Thus the European Council of Ministers of Transport adopted in 1954 a report by a Group of Experts on standards for waterways of international importance, classifying these into five categories *(table 4)*.

Basis for the classification were the dimensions, especially the length and the beam of 5 different types of vessels that were selected out of a great number of types existing in the different countries at that time. The Economic Commission for Europe of the U.N., to which all european countries and USA belong, followed the E.C.M.T. initiative. Finally after many years of discussions also the E.C.E. Commission agreed, as E.C.M.T. did earlier, to accept class IV as waterway of international importance. So the vessel of 1350 tons (length 80 m, beam 9,50 m) "Rhine-Herne Canal type" set the minimum effective dimensions of locks. This size vessel came to be known as the Europe type vessel.

With the coming into being of the Common Market by the Treaty of Rome in 1958, besides Strassbourg also Bruxelles became of importance to the realisation of the transport and infrastructure policy. For an adequate planning of the needed infrastructure also of waterways it is essential to ensure compliance with the other governmental policies and to act in this respect in an integrated way.

The Dutch situation presents a good illustration of the various coherent laws and regulations affecting the planning of waterways, with issue by public authorities of so-called 'Vaarwegennota' and a 'Struktuurschema vaarwegen". The structure scheme is meant as an instrument to plan land use to enable future construction and improvement of big infrastructure projects. Emphasis is here on the long term policy (up to the year 2000). The aim is to prevent that the decisionmaking with respect to separate projects gets an ad hoc character. An integrated planning of waterways, which also means improvement of waterways, and the planning of land use on different governmental levels is needed. For the Netherlands it looks as though this is now being done while also the development of the international commodity flows are taken into account; an integrated European approach however would of course be a better starting point for what is now basically a set up along national considerations.

What are the perspectives in this respect? Well, in Oktober 1973 the European Commission issued a Communication concerning the development of the common transport policy. According to this communication the European transport policy would no longer as in the past mainly be shaped by market regulation but should aim as well to be subject and part of a planned infrastructure.

A more detailed specification about the action relative to the infrastructure was given in the communication of June 1976. A first modest step into the direction of a more European approach of the infrastructure policy is made herewith. How can scientific transport research be subservient to the realization of an infrastructure policy that harmoniously fits into the whole of governmental responsibilities with respect to the various policy grounds that are connected with this infrastructure? It might be interesting for the answer to this question to pay some attention to the NEA-transport [1] model as it was in the first instance developed and implemented for the Dutch situation and as it is being made operational for the E.G. countries and some other European countries affiliated with the E.C.M.T.

THE NEA FREIGHT TRANSPORT MODEL

As regards its basic structure the model can best be shown in its entirety as in *figure 2*. It is obvious from this chart that the transport model in a narrower sense is part of a larger system, the policy information system. The transport computer model in its narrower sense is fed by three categories of data, i.e.:

- the general objectives of government
- the economic and technological variables exogenous to the transport sector
- the instrumental variables

Furthermore, the feedback from the transport model to the three categories of data is explicitly shown in the chart. This feedback possibility is extremely important. In planning it will be necessary to take into account the dynamic relationship existing between the transportation of commodities and land use planning. Well, the NEA model offers the opportunity to simulate the consequences of alternative starting points with respect to the regional distribution of the transport production.

It should be taken into consideration that a transport model divided as it is in a number of submodels is based on the so-called production and attraction model. In this submodel one has to explain the total volume of incoming and outgoing transport per region including the interregional and international transport. The distribution model is used to calculate the transport volume per origin/destination pair and has as determining factors the transport times, transport costs and -distances per relation weighted. Within the *modal split model* the shares of the different modes on each transport relation are determined. The determinants can be the total volume of transport (i.e. the total per relation calculated in the distribution model), the ratio between the times and costs of transport for each mode and quality of available infrastructure. The cost and time of transport by each mode are determined inter alia by the quality and the size of existing and future infrastructure.

Per mode, also for inland navigation, the *traffic production* model converts the flows of transport (tons carried by various origin destination pairs) into movements of vessels and barges. Similarly the number of empty movements is determined. The *assignment model* is used to load the infrastructure network. So given the forecast of the number of vessel movements in 1980, 1990, 2000 and the traffic technological characteristics of the dutch waterway system it was possible by using the model to forecast the traffic intensities per link of the waterway system for each of the future years mentioned.

Considering the specific characteristics of inland navigation the originally for road traffic developed as-

signment techniques had to be adjusted and completed before they could be applied. As specific characteristics of inland navigation we mention:
a) varying restrictions with regard to the loading capacity of the vessels on the various waterways
b) speed differences between vessels with varying loading capacities depending on the class of the waterway
c) the occurrence of overlay times at locks and bridges.

Crucial in the assignment model are the route choices by the masters of the vessels, as these determine the ultimate traffic intensity per link of the waterway system.

In this connection our basis was the assumption that always the route with the lowest transport costs will be chosen. The transport costs in inland navigation are depending on the factors travel time and distance which thus are the ultimate determinants of the route choice. In view of the just mentioned navigability restrictions and the apparent speed differences we had to assume that the choice of route for vessels of various loading capacities may differ. The traffic movements that had to be assigned were for that reason differentiated into a number of loading capacity classes. For every loading capacity class a representative standard vessel was chosen with known technical characteristics as length, width, draught, enginepower and so on. The traffic assignment model was built in such a way, that the vessel movement could be put into the network separately per loading capacity class on base of the characteristics of the respective standard vessels. The model was fitted for two assignment techniques:
a) all or nothing assignment
b) capacity restrained assignment

In an all or nothing assignment the travel times for the various links of the network are calculated on a base of so-called free - no capacity restrained - waterways, i.e. no overlay times at locks and bridges, and no negative impact of a certain traffic intensity on the speed of the vessels. For every origin and destination pair and for the respective loading capacity classes one route was defined namely the one with the lowest costs. All traffic is further in accordance with these routes assigned to the model.

The all or nothing method gives in certain cases a good picture of the traffic performance; if however the traffic intensity (I/C-ratio) gets so high that a certain traffic congestion results, it will be likely that a part of the traffic will switch to alternative routes when available.

The method of capacity restrained assignment is based on the mutual interdependencies that exist between the route choices of the participators in the traffic. The traffic time per link is then no longer an unchangeable datum, but becomes to be an endogenous variable which is dependent on the intensity/capacity ratio. The method aims at a balanced distribution of the traffic over the alternative routes, that means a distribution in such a way that taking another route would not be advantageous to any traffic participant. The results of the assignment model deal with many aspects of the traffic performance. Besides the data about the traffic intensity per link of the waterway, the chosen routes, transport costs, transport time and - distance per transport relation per loading capacity - class are defined.

So the use of the model provides an insight into the future use by the transport industry of the various links of the waterway system. Bottle-necks that may arise can be foreseen, while the assignment model also offers the opportunity to show the consequences on the traffic intensities on the waterwaysystem as a result of changes in parts of the system.

Table 5 - The share of loading- and unloading time in the turn-around-time of dry-cargo motor vessels in inland navigation in the Netherlands

Phases of turn-around-time	200–300	300-400	400-600	600-1000
		In % of turn-around-time		
Loading time	15	17	16	17
Unload. time	32	36	38	42
Total	47	53	54	59

THE IMPACT OF PLANNING AND DESIGN OF HARBOURS ON INLAND NAVIGATION

Besides planning of waterways much attention is devoted to designing and planning of ports especially seaports and also inland ports. This work has tremendous impact on the operational possibilities of inland navigation. If e.g. in Rotterdam a seaport can be planned where the admission of inland vessels is prohibited it significantly affects the modal split possibilities. But also the complete separation of inland navigation and sea going transport has its impact on the operational possibilities of the inland transport industry. The same can be said of the loading and unloading facilities in the inland ports. That for the economy of inland navigation the loading and unloading facilities are of major importance can be seen from the break-down of the average turn around time of the inland vessel as shown in *table 5*.

We only mention these themes here very briefly, but in the planning of inland navigation much thought should be given in an integrated overall approach of the total transport chain to these items. The available models might be very useful in this respect.

As we saw the first agreements on dimensions aimed at the Europe type vessel of 1350 tons and somewhat later the for Europe new technique of push barge operations raised the standards required for international waterways. In harbours the technological developments increased the loading- and unloading capacities in tons per hour enormously. Most of these investments in waterways and harbours was done both by local as well as national and even international authorities. In general the transport industry had to cope with these developments on its own. In the transport research it is necessary to pay attention to the development of the transport industry itself.

This kind of research is done by the Economic Bureau for Road and Water transport. In this field three types of research can be distinguished:
– basic research, to get an insight into the structure of a certain branch of industry
– research that enables following the developments of a certain branch
– cost price research to find i.e. a base for the fixing of a tariff foundation.

As example of basic research as far as inland navigation is concerned can be mentioned an investigation into the structure of the Dutch transport industry as far as dry cargo was concerned.

Other examples would be a similar investigation of the Dutch tanker vessel operations. An investigation into the structure of the fleets of Belgium, France, Germany and the Netherlands and an inquiry into the needs of the shippers with regard to inland navigation in these four countries.

With regard to research as far as the developments in certain branches are concerned we mention:
- monitoring the profitability of the transport firms concerned
- investigation into the relations between water levels in the Rhine, loading depth of the vessels and freight rates as well as seasonal fluctuations and fluctuations in waiting times of empty vessels before rechartering

The cooperation of the Netherlands Institute of Transport and the Economic Bureau for Road and Water transport has proven to be very effective, many of the data about inland navigation and road haulage that are made available by the research program of the Economic Bureau for Road and Water transport are of great value in an aggregated way as input in the transport model.

At the moment the existing NEA transportmodel is provided with a cost price simulation model. This model enables creating a tariff structure for the Dutch inland navigation with which it will be possible to keep the future tariff structure up to date.

Many other applications of the NEA model with regard to inland navigation can be mentioned:
- calculating consequences of imposing user charges
- delivering basic information needed for cost/benefit analysis with regard to certain infrastructure projects
- predictions about the size and composition of the fleets needed in the future. Confrontation of these sizes and compositions with the available capacities gives information with regard to investment of desinvestment plans.

So in the cooperation between the institutes with the model a unique instrument has become available to the authorities and the industry as well setting policies relative to planning inland navigation. An instrument which has proven and still will prove to be of great value.

FOOTNOTE

1. NEA: The Netherlands Institute of Transport; Economic Bureau for Road and Water Transport; Administration and Computer Centre for Professional Transport.