

Interaction between design and urban surrounding: the multiple complexity of the North South Metro line of Amsterdam.

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Summery.

Planning and building a new major public transport infrastructure in a densely built up area like the historical inner city of Amsterdam is a complex matter. The design and the construction technology used are greatly influenced by the restrictions caused by this urban surrounding. The multiple complexity is the result of three factors: the urban environment, the chosen construction technology and the long duration of both planning and building period. A simple model is given to assess and quantify the complexity of projects.

To handle these challenges a specific approach is followed. With regard to the planning of the project, an intensive interaction between the transport demands like the alignment and number and location of stations, the design possibilities and construction technology took place. With regard to the actual building, special measures were taken to prepare the city. Also space for the building process needed to be created. Last but not least a tailor made communication strategy is applied.

1- The project.

It took almost two decades since building the first metro line before even the word metro could be mentioned again at City Hall in Amsterdam. Already during the building the first metro line in Amsterdam in the seventies, the East line, the city council decided that further extensions of the system should be postponed. The reason for this decision was the great opposition that developed during the planning and building of the East line. Building of this line required demolition of houses (see figure 1) because the construction was based on building from level using pneumatic caissons.



Figure 1.

Only when the possibility of underground construction by means of tunnel boring machines (TBM's) became available, new plans were developed to further extend the system. These new plans rapidly focused on what is now called the North South metro line. This line goes underneath the old historical inner city and connects the northern part of Amsterdam with the southern part. The plan of the North South metro line is shown in figure 2.



Figure 2.

It is without question a challenging project. Not only will construction take place in one of the most sensitive area's of Amsterdam: the historical inner city, also new construction technology is used.



Figure 3.

2- Multiple complexity.

Looking at the complexity of a project three factors of major influence can be distinguished:

- (1) The complexity of the project itself.
- (2) The requirements set by the surroundings in which the project has to be built.
- (3) The time scale of the project.

Looking at a project the complexity can be caused by the construction technology used. This may range from fully proven and accepted to state of the art or even beyond. Also other matters may cause a situation that requires special attention; a stiff time frame or mixed financing of the project may require special measures. To assess the complexity of a project one should look for special requirements regarding time, money, technology, communication and organisation.

Looking at the surroundings the influence may range from optimal to imposing very heavy constrains upon a project. Optimal can be seen as favourable soil conditions, no nearby buildings, good accessibility and no groundwater constrains. Heavy constrains on the other hand can be soft soils, a high water table, limited building space and sensitive buildings close to the building site.

The time scale also has its influence. If a project takes a long period of planning and building, it becomes more difficult to secure the original scope. Also rules, guidelines and laws may be subject to change(s).

Rating a project on the aspects mentioned above makes it possible to assess the complexity of a project in a more objective way. This assessment makes it possible to identify the aspects to focus on. As an example several recent tunnel projects in the Netherlands are rated in this way and plotted in the graph shown in figure 4. The complexity of the project (horizontal axis) and the surroundings (vertical axis) are rated from -3 up to +3.

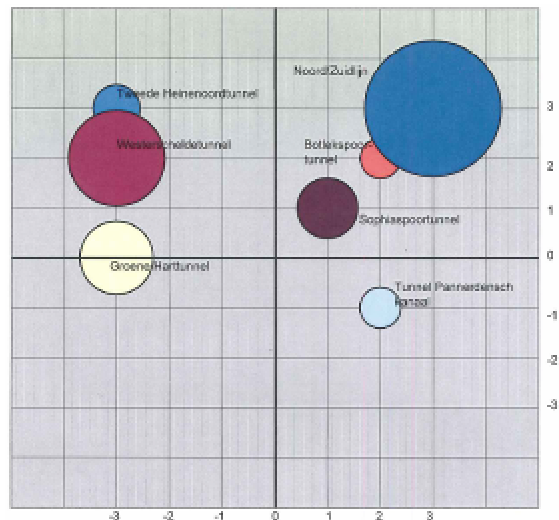


Figure 4.

3- Planning.

During the planning of the North South metro line project a delicate balance between the following aspects had to be found:

- (i) Quality of the public transport system.
- (ii) Risks during construction.
- (iii) Hindrance of city life during construction.
- (iv) Costs.

Finding the right balance between these four aspects has lead to an interaction between the design and the urban surroundings. To illustrate this two examples are given.

Number of stations.

The quality of the public transport system is best served by an optimal number & location of the stations. Within the inner city of Amsterdam only a limited number of possible locations for stations are available when one has to take into account that it was not allowed to demolish buildings and city life should be able to continue during construction. Limited space is available, not only limited space for the station itself but also for the building logistics. In the early planning stage of the project two stations were considered in the old inner city, as is shown in figure 5.

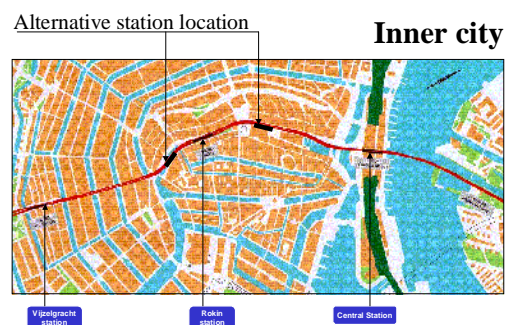


Figure 5

During the planning it became clear taking into account the risk and hindrance during construction, these locations were not possible. Limited space and the presence of historical buildings were the cause. A compromise was needed and found in bringing back the number of stations in this part of the city to one. This location is also shown in figure 5, and is situated just south of Dam square. Here space could be made available for building a station within the boundary conditions.

The northern entrance is very close to Dam square, which means a direct link to this historical and important place. The southern entrance is situated at a location where a good connection is made to the existing tram lines. Overall a good compromise was reached.

The horizontal alignment.

Already in an early stage of the project the horizontal alignment of the line in the inner city was fixed. Following the street pattern and connecting the planned stations left very little room for alternatives. The southern horizontal alignment however was the subject to discussion for a considerable period of time. The first chosen alignment was based on reduction of risks and minimizing hindrance during construction. In this part of the alignment two stations were planned. When this alignment was discussed several parties had objections against it. Among other arguments foremost the station near the RAI conference and exhibition centre was considered to be at the wrong place. After having examined and discussed a number of alternative alignments and location of stations, a different alignment was chosen. In figure 6 both the original and the chosen alignment are shown.

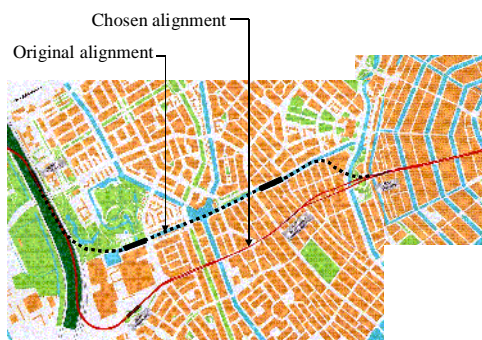


Figure 6

With this change of the southern alignment the balance between the earlier mentioned aspects was in favour of the quality of the public transport system. The location of the RAI station improved but the construction risks increased considerably.

4- Building.

To limit the hindrance during construction, tunnel boring machines are used for driving the track

tunnels and the stations are built using the cut and cover method. Both methods contributed to the decision to further extend the Amsterdam metro system after a period of stagnation.

But reduction of hindrance required more measures. To be able to build a project like the North South metro line in Amsterdam the city had to be prepared to make way for the project. During the preparation process the following activities can be distinguished:

- Inspection and, if necessary, renewal of foundations of buildings adjacent to the project.



Foundation renewal and structural improvement of buildings.

Figure 7

- Rerouting of cables and ducts at the location of the stations.



Figure 8.

- Install diversions of roads and rail tracks.
- Relocation of shops.
- Construction of several platforms above the channels for several functions.

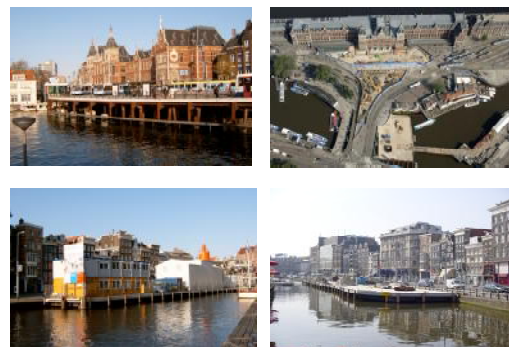


Figure 9.

These activities are expensive and require careful planning and coordination with the parties involved. If insufficient attention is given to the preparation of the city, the risks increase not only with regard to possible damage to buildings and facilities, but also the logistics of the building process will be frustrated.

Another aspect of the building process in the old inner city of Amsterdam is the large number of obstacles present in the subsurface. Not only the functioning small infrastructure for various facilities but also old foundations, abandoned sewers and old quay walls are present as a result of seven centuries of city development. Despite research in several archives not all of these artefacts can be identified before construction starts, and when they are identified often differ from the information given by the drawings. As a consequence some of the original working methods to remove underground obstacles had to be changed. A good example is the method used to remove the foundations of old quay walls. It turned out to be impossible to remove the old pile foundations along the route of the diaphragm walls without causing settlement of adjacent buildings, using small building pits. A different method was required. This method was drilling a large diameter open steel pile up to pile toe level of the old wooden piles, and to remove all soil and objects within the pile by force. See figure 10.



Figure 10.

5- Communication.

Realizing a project like the North South metro line cannot be done without professional communication. In all different stages of the project the communication plays an important role in achieving the goals that are set. During the construction the main goal is to stay on speaking terms with the people and businesses that are affected by the project. The effects range from

pollution of the roads, to noise nuisance, to lack of accessibility and even to outplacement. The original communication strategy had two levels. The first level focused on those who were directly affected. The content of the information was based on giving reliable and topical information. The receivers of this information are the people living and working close to the project. This communication is aimed at specific groups and the information is tailor made for each different building site. The tools used are information letters, meetings and individual appointments.

The second level was the so called corporate information. Main objective of this line of communication was to give more general information about the project to everyone who showed interest. The tools used are an information centre, a website, articles in local newspapers and items on local television, a corporate brochure and fact sheets.

After the first building activities started, the original communication strategy turned out to be insufficient. Two reasons for this insufficiency could be identified. First the impact of the building sites and the equipment used was underestimated. Figure 11 gives an impression of the site and equipment.



Figure 11.

The second reason was the unbalance between the hindrance caused and the results obtained. At the

start of the works very little to nothing can be shown of the future result and the inconvenience is enormous. This phenomenon is expressed in the graph shown in figure 12.

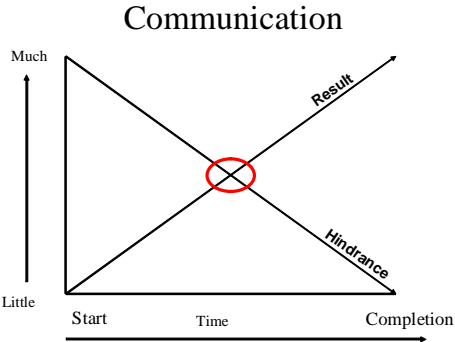


Figure 12.

To improve the effectiveness of the communication new tools needed to be developed and implemented. For each major building site a plan was made based on the experiences so far and some additional research. The outcome was that the original approach was too limited and additional tools were needed. These additional tools were among others: financial compensation for periods of noise nuisance, additional sound proving of houses, alternative working locations, periodical cleaning of windows and public space. Also the registration of complaints was organized more central.

Although these measures proved to be effective and the construction of the North South line is ongoing, the balance between the acceptance by the people living close to the building sites and the project remains fragile.