

AMFORA

Alternative Multifunctional Underground Space Amsterdam
The City under the City



Strukton

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Zwarts & Jansma
Architecten

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AMFORA

(Alternative Multi Functional Underground Space Amsterdam)

“The City under the City”

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1. Reason

Amsterdam is a beautiful city. Although part of the glory days has been lost as a result of the intensive use of space and the mobility demands that come with it. AMFORA presents the opportunity to realise the so desired improvement of the living environment, without compromising the mobility demands.



And this need for accessibility is becoming more and more acute. The Municipal administration is daily struggling with the dilemma between the social and ecological developments on the one hand, and the economic developments on the other. How can environmental zones be introduced without causing a loss to the economic activity in the town centre? How can the specific character of the city be maintained and be attractive for tourists, an important source of income for the city? How can we keep the inner citizens from leaving the capital city as a result of the declining social climate?

The primary goal of AMFORA is to give the spatial- and picture quality of Amsterdam a strong impulse. In ancient times an AMFORA was a large vase for keeping oil and wine. Our AMFORA intends to restore the classic values of Amsterdam by housing certain functions in the underground space. By moving functions from above the ground to the underground, a rearrangement of the spatial structure will enable an uprating of the quality. A good quality city centre, in which havens, green spots can be found, with an international substance, causes people to wish to live, work and go out in the centre more than they already do. At the same time functions can be housed there for which there are no possibilities right now. This will increase the attraction for tourists; it will cause the air to be cleaner and the city to be safer and more accessible for its inhabitants, shops and companies. With that, AMFORA is a perfect example of multifunctional use of space.

AMFORA is a solution with far-reaching potentials, very innovative, a sustainable solution for the improvement of the living environment in Amsterdam and - not at the least - technically and economically feasible. It brings back a part of the glory days into the experience of the city of Amsterdam and at the same time meet the requirements of this era.

2. Innovative approach

AMFORA as a Multifunctional Underground Space requires a multidisciplinary approach. Strukton is the deviser of the plan and responsible for the entire co-ordination, the design, the construction methods and the business case. The latest technological developments will be used, for example in the field of Building Information Model (BIM) and 3D modelling, safety systems, traffic guiding, lighting and projection systems and energy and climate concepts.

AMFORA especially focuses on the aboveground urban rearrangement that becomes possible by the use of the underground space. The scenery will have to be adjusted to the new, improved situation. Zwarts and Jansma Architects and OKRA Landschapsarchitecten have mapped out and visualised the aboveground urban possibilities for development for a sustainable Amsterdam town centre.

DelftTech works with 3D laser scan techniques. For this study scans have been carried out of the Amstel towards the Blauwe Brug, Stopera and a part of the Herengracht to the Vijzelstraat. By linking the whole to the co-ordinate system, the work can be based on accurate dimensions, essential for working with prefab parts.

The TU Delft, department Traffic Transport & Planning, are investigating the traffic flows around Amsterdam, in particular the Ringweg A10, traffic flows from and into the town centre, the local traffic in Amsterdam, the optimisation of the slip roads from the Ringweg and the geometry of AMFORA for an optimal traffic handling. They are also investigating automatic transport systems for people and goods in AMFORA.

3. Explanation of the plan

Amsterdam is enclosed by the Ringweg A10. The southern part is bordered by the Noordzeekanaal, the IJ, the southern Ringweg A10 has many canals. In this part it is possible to create an underground network below the canals, which is built up in various layers. The top limitation of AMFORA is the bottom of the canal, approx. -3.50 metres N.A.P. and the bottom limitation is the layer of clay that is located at approx. -32 metres N.A.P. At a construction height of approx. 5 metres AMFORA may consist of approx. 6 layers. Because AMFORA is a multifunctional underground space, we have chosen for a space without columns, with a maximal span of approx. 30 metres. With that the underground space can be given a fully flexible layout for various functions.



As from approx. -32 metres N.A.P. to approx. -60 metres N.A.P. there is an impermeable layer of clay, which makes it possible to construct AMFORA according to the “polder principle”. The construction as a polder offers the great advantage that driving piles is not necessary, and can thus be constructed without causing (m)any vibrations, which will involve less inconvenience for the inhabitants.

Per layer of approx. 1 million m² approx. 50,000 cars can be stored. Since there are approx. 100,000 cars in the town centre, the parking section will have to consist of at least 2 layers. In order to be able to store extra traffic from outside, a total of three layers would be required. Besides the 2-3 layers for transport and parking, another 3-4 extra layers are available to house all sorts of functions. Examples are shops, parking facilities, sports halls, cinemas, provisioning, storage of archives, air-raid shelter, cables and pipes, passenger transport, the possibilities are countless. Moving functions underground also provides all sorts of possibilities for spatial developments aboveground!

One of the main aspects of using underground space is the experience. Experience of space, of safety and a good orientation. An experience of a pleasant “city under the city”. These aspects form the main point of departure in the design of the underground space and are also made possible by the utilisation of state-of-the-art techniques.

4. Aboveground potential

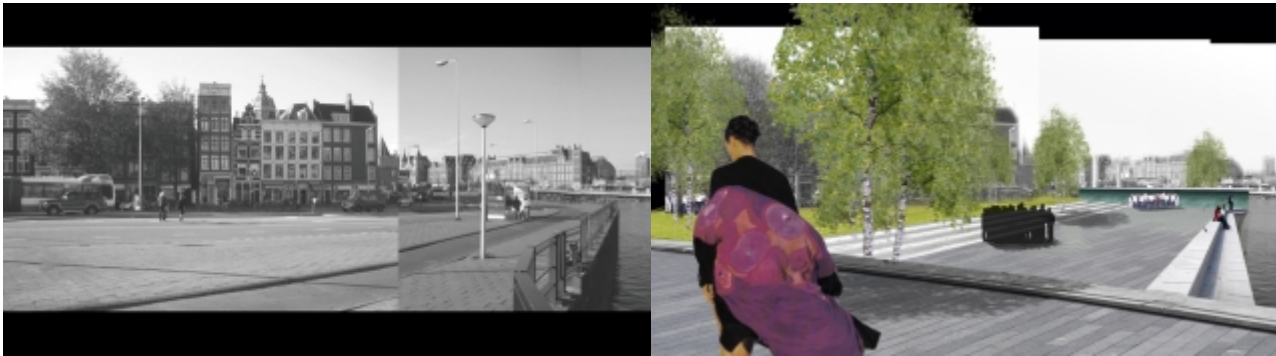
The picture of the present public space shows a substantial discrepancy with the picture that people expect from a vital and attractive city centre. The city centre is becoming disorderly and the public space no longer fulfils the picture of a stratified, dynamic and sustainable city. Essence of the task is to create an attractive public space, which involves more than a cosmetic operation. The public space must contribute to the city centre as a public domain. This can be done by strengthening the system of public spaces between the various focal points and by focusing on the characteristic Amsterdam spots. The focus of the public space changes, in which the public space will produce a city where walking and living are possible. We shall focus on more differentiation in public spaces.

By creating more green spots, a continuous green structure arises in the city streets. The city will be improved by adding a range of green courts in the housing environment, by creating green spots and enhancing the green structure. By further bringing the sewerage system and other cables and ducts underground, a space is created in the profile of the street for the green structure. The combination with sports and leisure can be made by linking small-scale aboveground facilities in a park to underground activities, such as indoor squash and tennis.

The focus lies on making a linked city, with more public space for pedestrians and cyclists. The city centre becomes accessible in a targeted manner via the underground system, focused on a ‘park and walk’ system. The ‘park and walk’ system provides an optimal accessibility, by the connection of good pedestrian routes above and underground. On the

surface level the radials form long lines in the city, that are much better usable for public transport and bike and pedestrian routes that are attuned to each other [1]. This is possible through the space that becomes available by taking the car traffic underground.

Amsterdam has fine water squares, but they are hard to reach from the city centre. In a number of places the water can actually regain more importance in the city. Besides the physical presence of this urban large water, there is the experience of the water. The water presents itself much more in the city, when the quays are free of cars on the waterside. Passages across the water and under the railway are relieved. The bridges change from traffic routes into places to stay.



5. Health, Environment and energy

One of the greatest advantages of AMFORA by taking a large part of the traffic underground, is the possibility to clean the underground ventilation air of exhaust gases, including fine particles [2]. At the same time, future building activities will not be obstructed by an exceeding of the standard for fine particles. It means a huge profit in the field of air quality in the city centre, without this being at the expense of the accessibility of the city. Environmental zones have thus become superfluous.

With the development of AMFORA the canals will get a new impulse. They will be freed from polluted water, sludge and all the objects on the bottom. By profiling the concrete roof of AMFORA, the canals will be easier to keep clean. It will be safe once more to swim in the Amsterdam canals!

CO₂ neutral is the point of departure for the energy concept. This can be achieved by the application of heat and cold storage under the canals. De (diaphragm) walls of AMFORA will be provided with pipes, linked to the prefabricated steel reinforcement. The pipes will assume the soil temperature of Amsterdam, about 10-12°. By combining this temperature via a heat wheel with the outside air temperature, the underground space can be kept at a stable 18°C all year long. Additional temperature requirements can be met by local climate systems. In this design a surplus of cold will arise, since the underground need hardly be cooled. In this manner city cooling can be offered in summer to replace local air-conditioners. The electricity that is saved in this manner can be utilized for the (green) electricity requirement of the underground space. In the underground space the use of electricity will be restricted to a minimum, for example by the utilisation of LED lighting.

6. Technical feasibility

6.1 Construction

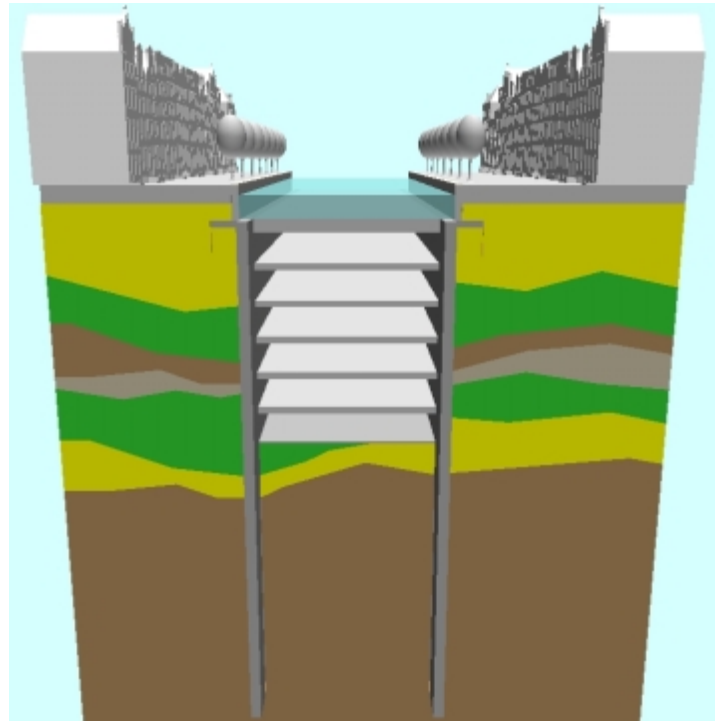
In the design of AMFORA we have started from a construction that produces the least possible nuisance for the inhabited environment, and the largest possible freedom for the layout and the use of AMFORA, at low costs. For these reasons we shall make use of a column free space with a maximum span of 30 m, which is also maintained as a maximum standard cross-section. For broader canals such as the Amstel this consists of 3 parts of 30 metres. If the canal is less than 30 metres wide, the span will be attuned to this width. Because AMFORA has been designed on the basis of the polder principle, pile driving activities are not needed.

To begin with, all houseboats have to be moved to a different location. After that the canal can be cleared out. To spare the inhabited environment as much as possible, two canals between the bridges will temporarily be filled in with sand to the top of the quayside. The plateau that is created in this manner will be used as a work location on which also a work

road will be constructed for the transport of materials. After the work location has been set up, the diaphragm walls will be built along the existing quayside. For the optimisation approx. 1 out of 3 diaphragm wall panels will go into the 3rd stratum of sand. The intermediate diaphragm wall panels end in the impermeable clay stratum (Eem clay).

To make the construction pit impermeable, a bentonite cement wall will be applied crosswise on the head ends in front of bridges. After this, excavation to the bottom of the first perimeter beam will be carried out and the sand will be removed hydraulically. When the perimeter beam is finished, the prefab beams of approx. 30 metres will be placed on the perimeter beam, reinforcement rolled out and the compression layer will be poured.

The soil under the roof will be excavated to the bottom of the next perimeter beam. After this the perimeter beam will be poured and the prefab beams of approx. 30 metres placed on the perimeter beam, reinforcement rolled out, and compression layer poured, after which the cycle is repeated until the bottom layer is finished. The soil is excavated in the dry and then removed hydraulically via pipelines. Because the soil can be evaluated visually in this manner, the soil that doesn't qualify for reuse is poured into a depot outside Amsterdam via pipelines. The sand that can be used for reuse or addition is poured into a temporary depot in the Amstel, which is formed by sheet piling.



Where bridges are crossed, AMFORA must continue to dispose of the same cross-section as in the canal, therefore AMFORA must be constructed under the bridge. The connection under the bridges will be carried out using freezing technology. In this connection the final partitioning provisions will be included. The foundation of the bridges is then taken over by AMFORA, so that the cross-section remains the same. The cycle is repeated until all the canals are provided with an AMFORA.

By including the whole in the GIS and linking this to the 3D model, the dimensions are exactly fixed. In this manner it will be possible to construct the underground space entirely prefab, so that the building time is hugely accelerated. It is then a box in a box, so to speak. Thanks to this prefab solution it is also possible to adjust the underground space afterwards. When the box is closed, construction activities underground can continue, so that we shall not cause any trouble above the ground. The underlying floors can then be finished according to the "Cut and Cover" method. The aboveground nuisance must remain restricted to a minimum. Thanks to the application of prefab, much transport through the city is avoided, also because this can be effected via the underground space that has already been constructed.

6.2 Security

As persons in AMFORA are provided with an RFID chip, too, they can also be observed by the detection system, so that it is clear where people are located. This makes it possible to take specific measures in case of calamities. The computer can speedily give a survey of how many people are present in a certain space. The problem area can be mapped out immediately by passing on co-ordinates. The problems are recorded by sensors so that an adequate reaction can be given without loss of precious time.

Because the location is known, the emergency services can be on the spot speedily. The remaining users who are at another location will not notice anything of this calamity, so that no panic will break out and safety is guaranteed.

Because AMFORA is constructed differently under the bridges, the construction is made in concrete that is poured on the spot; it is possible to include partitioning provisions. Due to this, AMFORA can for example be closed off between two bridges in case of a calamity. For safety's sake AMFORA will basically be partitioned in parts of approx. 200-300 metres. In this manner it is possible to pump the space full with CO₂ for example in case of fire.

6.3 Transport guidance

By making use of the extensive system of canals in the centre of Amsterdam, a complete underground infrastructure arises, which is built up of several layers in which various functions can be placed. The Ringweg A10 is used as a main transport road for the traffic through AMFORA. At a number of strategic places of the Ringweg slip roads will be built for radial access to AMFORA. All the local traffic from the Ringweg goes underground via the canals to all parts of Amsterdam. All the traffic will remain underground at all times.

One of the feeder roads runs via the Amstel to the Centre of the city. In this manner the traffic has the possibility to turn left and right to, for example, the Achtergracht, Prinsengracht, Keizersgracht, Herengracht, Singel, etc. AMFORA in the Amstel consists of three separate parts of approximately 30 metres wide. The middle part is used as a feeder/transport road and the two parts on the outside can also be used as parking space for the office blocks along the Amstel and off the Amstelstation, the Amsteldijk, environment Amstelhotel, Carré, Stopera and the inhabitants adjacent to AMFORA.

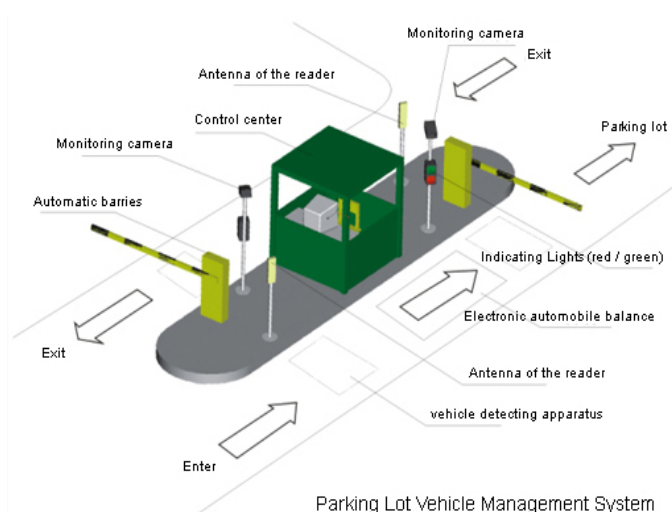
AMFORA is however, not only limited to the ring of canals but will also be extended to Oud-West, the Rivierenbuurt, Kattenburg and the new areas along the IJ. Places that attract many people are also included in the plan, such as around the RAI (via the Boerenwetering), Artis, Scheepvaartmuseum, Universities, Central Station and the blocks of houses and offices along the IJ.

The canals in transverse direction can also be connected to AMFORA by using short radius curves to make a connection between these two Amphoras. In this manner an underground network of parking spaces is created. In the Amstel broader underground spaces can be built to which all other underground spaces will lead in transverse direction. If this is done at various levels, crossing traffic will not cause any inconvenience either. At larger water areas, such as near the Amstelkade, junctions can be created. Originally, all the canals run around the city and a few large waters run from North to South through the city. Nature already had a north to south line. We can make use of this for the so-called parking infrastructure.

To get vehicles (especially the cars of inhabitants, commuters and visitors) out of the streets or the quays of the canals, a good parking provision must be provided. To come above ground from AMFORA, a fine-meshed structure of ramps has been planned in which the connection with above ground is provided via elevator shafts with a maximal walking distance of approx. 100 metres.

6.4 Vehicle Identification systems

To steer the traffic flows in the right direction, various detection systems will be installed. By making use of RFID traffic streams can be mapped out.



Access to AMFORA from the Ringweg must be effected in such a way that this will not lead to congestion in the entrance of AMFORA. Therefore a distinction is made between the various users and the traffic flows will be split up into ticket holders and visitors.

The vehicles of holders of permits are provided with an RFID chip. When entering AMFORA, each vehicle is recognised by the detection systems and the computer checks whether the vehicle is authorised to enter AMFORA. Because the traffic flows are already separated, there will incidentally be a vehicle that is not authorised. This vehicle is then immediately steered to another lane, to prevent congestions.

At the visitor's entrance the driver has to pull a ticket from the machine in a conventional manner. This ticket is also provided with an RFID chip so that the detection system has recognised the vehicle. All vehicles are now in the computer system so that the traffic flows in AMFORA can be mapped out. By making use of artificial intelligence, these traffic flows can be optimised so that traffic forecasts can be generated. These data can then again be processed in dynamic traffic management systems.

Since AMFORA is fitted out with detection antennas the vehicles can be followed. By making use of intelligent sensors, every parking space can be monitored by for instance making use of US detection or by means of a camera system developed within Strukton. This camera system can also be used for the security system of AMFORA.

All these data are stored in a computer so that the parking system knows where there is a free parking space available. In this manner an optimal filling of AMFORA can be achieved.

It is possible to generate a signal in AMFORA that is recognised by a navigation system which makes it possible to direct the vehicles to an optimal parking space. This has many advantages, as the vehicle will reach its destination in the shortest possible time. It is not necessary to search, so that the environment is spared, fewer exhaust gases are produced, less fuel is used, time is gained, etc.

By making use of RFID techniques, access to AMFORA can be guaranteed as well. Gates will open up automatically, so that no traffic jams arise. The RFID chip can also be used for access of elevators.

7. Economic feasibility

Description	Inhabitants no	Cars no	Places no	Area/Layer [m2]
Around Artis	60,000	24,000	5,200	104,000
Amstel	62,000	24,800	17,000	340,000
Ring of Canals	80,000	32,000	16,500	330,000
Ring	30,000	12,000	9,000	180,000
Total	232,000	92,800	47,700	954,000

To get an idea of the economic feasibility, a model has been made, in which all the costs for making AMFORA are included. We have departed from the previously mentioned quantities, and for the time being only the ring of canals and the environment around Artis have been considered. The total surface that will be available per layer is approximately 1 million m2.

Because not all the data are available, an estimation has been made of the number of inhabitants and the number of vehicles that are present in the ring of canals. The quantities are represented in the table above.

If we assume that per vehicle approx. 20 m2 are required, two parking layers will be needed to put away the vehicles of the inhabitants. To put away the vehicles of commuters or visitors to Amsterdam, another parking layer will be required. The other layers can then be used for other purposes. Companies that are established in Amsterdam can rent or buy parking places or other spaces.

AMFORA consists of 6 layers, per parking place this boils down to an amount of approximately € 25,000.- to € 30,000.-. Because of its multi-functional nature income from other proceeds may be deducted from the costs of a parking space. If we compare these amounts to aboveground amounts, we may conclude that AMFORA is economically feasible [3]. Above-mentioned amounts are exclusive of loss of interest, VAT, operational costs, diverting cables & pipes and moving the houseboats.

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* All in Dutch