GUIDED BY TIME

creating a perpetually green terminal building

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IMAGINE

Schiphol Airport, 08:15. *'Interesting don't you think?'* Lucy, his personal guide, a small brunette holographic woman whose features he selected just a few hours before, urges James Hobbles not to miss the view of the lobby. He leans over the railing to admire the enormous void that runs up through the middle of the terminal building.

The cool light of morning streaming in through the glass dome gives him a breathtaking impression of this tower. Far below he sees people lingering at the shopping area on level 3. High above him a KLM Aircoach Fold-Wing takes off, its thundering engines almost inaudible.

A green message lights up in his visual periphery. *'Got the 3 am flight from JFK, an hour earlier than expected, due to arrive @ AMS @09:15. Got a bed-seat, so will be fine. CU soon X'*. Alice, his wife. Good. That means they can have breakfast together.

'Why don't the two of you meet in our French restaurant,' suggests Lucy turning towards him. *'You know she loves croissants. Besides, boarding will be at 10:25. Plenty of time.'* When he nods, she starts walking, blending in perfectly with the other passengers around them admiring the view. They even step aside to let her through! Amazing technique, James thinks, and so easy to get used to!

How different this place feels now from how it did last night. When he arrived the center of the terminal was lit up cozily to create an intimate homely feeling. Now the building feels like a nature reserve - the lushly planted atrium and flowing water giving him energy. He takes a deep breath and inhales the fresh air.

Turning away from the hotel wing, they take the huge elevator platform down, passing the offices and Schiphol's renowned sport complex with its multiple fitness areas and yoga facilities. The huge infinity pool looks out across the new Haarlem tulip fields. Swimming here is like floating above a landscape painted in Van Gogh colors. He resists the temptation to test the swimming trunks that he bought last night in the Fokker brandstore. Better not, he decides. But a haircut would be nice.

He checks with Lucy, who starts punching her keyboard and speaking Dutch at the same time. *'Not a problem. Tony & Guy can fit you in right away. Mind you, they are a creative lot'*. She looks at him, frowning slightly. *'Now you're in a productive mood, shall I reserve an office desk? It looks like your Inbox could use some attention. The Singapore hotel needs a confirmation.'*

James marvels at the efficiency of Schiphol's data-backbone. The Chinese are good, but Europe has definitely taken the lead, even offering space aviation at this very terminal.

'Good idea.' He smiles at Lucy. 'While you're at it, be a dear and make reservations for the 11.25 flight. I don't want to rush. We still have to check-up with the kids and I'm pretty sure Alice wouldn't mind a visit to the mall - to buy tulips or something. Singapore can wait another hour.'

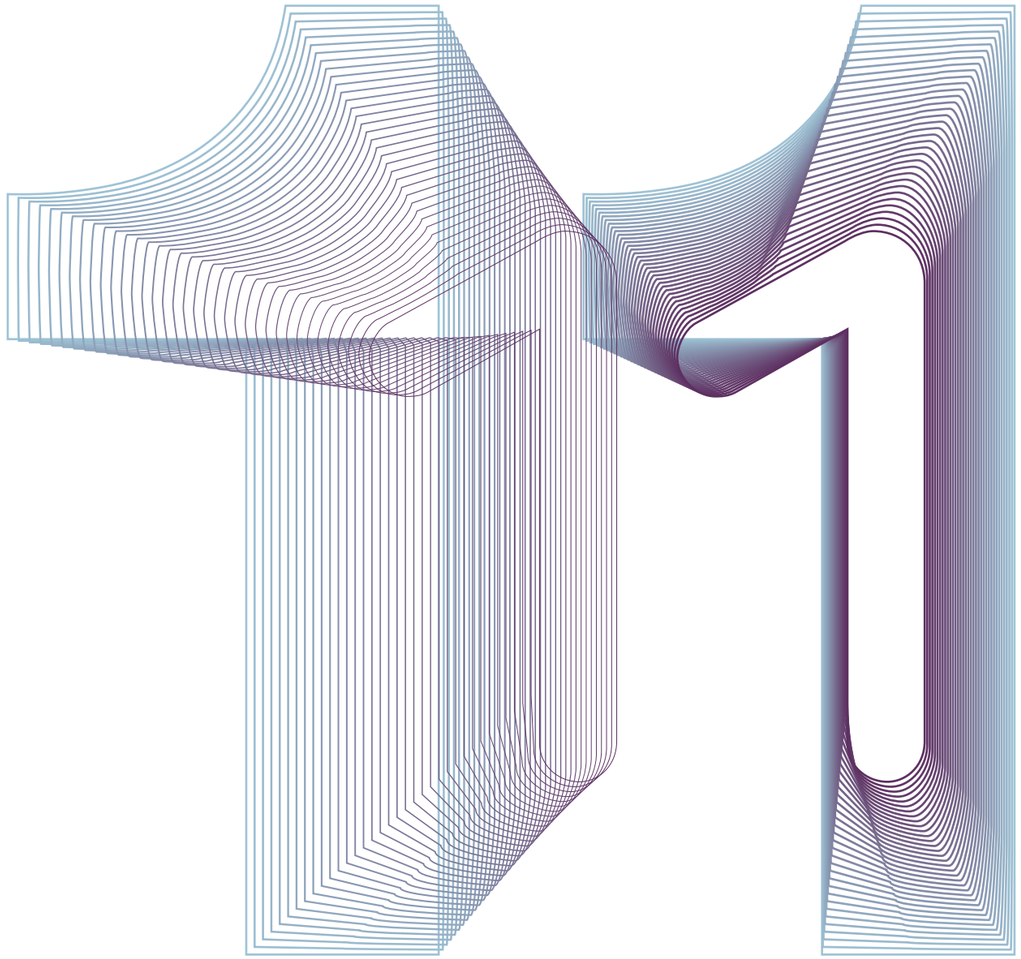
INTRODUCTION

Schiphol Netherlands BV is contemplating a future where it handles 50% more traffic. These ideas are in the process of formation, have no specific timing yet, and are pending discussions with stakeholders. Important here is that in these plans something beautiful takes place: sustainability is already a topic.

Schiphol Airport already deploys numerous green solutions in its airport infrastructure. A good overview can be found on the Schiphol Group website[1] in a document titled Corporate Responsibility. Although commendable, the next step will be to move beyond ad-hoc measures and to create and implement a full-scale sustainable concept. It is Schiphols' vision that the airport of the future is like a city. In such a concept, a strategy on sustainability will be relevant for Dutch society as a whole.

In order to inspire and stimulate the intellectual debate on this strategy, four whitepapers have been written. This paper focuses on green terminal buildings. Further related papers[2] entitled *Low Carbon Aviation Technology, Low Carbon Airport Processes* and *Regional Urban Integration* are also available.

1. http://www.schiphol.nl/SchipholGroup1/NieuwsPers/SchipholFactsheets.html **2.** To be obtained from theGROUNDS, visit http://thegrounds.com/



ABOUT THIS PAPER

Much has been claimed and said in the debate on green buildings. It is probably wise to accept that sustainability is a relatively new concept and still not fully developed. In this paper we will argue that being green is about balance: a balance that is holistic and can be maintained over time. As technological options and our perceptions of 'green' will change in ways we cannot predict, the challenge will be to remain relevant.

The objective of this paper is not to come up with easy answers. It is meant to spark a discussion and encourage everyone to contribute. Some of our courageous ideas may seem far-fetched, but in putting together this document, we have come to the inspiring conclusion that all the tools required to build a perpetually green terminal are actually already available.

One of the ideas our team came up with was to use a space station as a metaphor for a technological environment in perfect balance. What elements do sustainability and rocket science have in common? What can we learn from what they are doing right now miles above us, up in space? Please bear this question in mind as you read further. We hope that you will find our ideas interesting.

Team 't'

THOUGHTS ON TIME

To anyone traveling, time is important. Time can be the reason for travel - for instance, making time to meet business contacts or time to spend with friends. Time can be lost as a result of delays and, in international travel, it is even possible to gain time and end up arriving at your destination before you have left your point of departure!

Time has also found its way into the design of Schiphol Airport as we know it today[3]. A conscious decision was made to use pedestrian corridors and not shuttles as the connections between terminals, as shuttles might inconvenience passengers due to the lack of flexibility they offer.

'Will I be able to find the shuttle? Will it run on time? How far will I then have to walk to my gate? What if I take the wrong shuttle or get out too soon?'

Worries like these probably make many passengers take an earlier shuttle than necessary to avoid the risk of missing their flight. Consequently they end up in a non-commercial area long before they are due to depart. This is detrimental both to the passenger (who has a less positive travel experience) and the airport (which loses out on commercial opportunities).

Passengers spending time at entertainment outlets at airports probably suffer similar worries: in venues like cinemas *(what time does the movie end?),* spas (*the stress of only having a certain period of time in which to relax!)* or in swimming pools *(is my watch really water proof?).*

Time at airports is actually so important that it justifies violation of fundamental interior design laws. At Schiphol airport for instance, the casino actually has a clock in full view – something you will not find anywhere in Las Vegas!

3. We obtained the spark for our inspiration from an excellent guided tour of Schiphol's current terminals by Mrs. Carijn Grassi-Manders of theGROUNDS.

Time has thus inspired us to choose an appropriate project name for our green terminal building: ‘t’. The use of the lower case emphasizes the low impact the terminal buildings are to have on the environment.

Looking at Schiphol today, T1 and T2 were built in 1967 and T2 was renovated in 1974, while T3 defines a period in 1990. In this sense, the names T1, T2 and T3 are highly appropriate as this is also how engineers denote points in time[4].

Why do we stress the factor time? To make our point, we assert that in order to think ambitiously about green terminal buildings, one should think ‘greenest’. However, reflecting on the analogy with ‘tallest’ we encounter a problem. The tallest building is only the tallest until a new, taller building arrives. For example, due to fears of being overtaken by competitors, the height of the Burj Khalifa in Dubai was kept a secret in the final construction phase, in order to maximize the period during which it actually was the tallest building[5].

Any definition of a green terminal would therefore need to include an element of time. In this paper we propose the following definition:

Definition 1: The greenest buildings are conceptually designed to remain green in an unknown future.

4. Refer to ISO 8601 standard (source: Wikipedia). **5.** It is still the tallest today (dec 2011), courtesy international economic turmoil; Nakheel Tower was scheduled to sur- pass Burj Khalifa, but the project was abandoned in december 2009 due to financial problems (Source: Wikipedia).

SEVEN PRINCIPLES

It is a common misconception that simply adding a range of new measures or technologies to an existing situation can create sustainability. Instead we believe we should incorporate principles right into the conceptual design phase. We have established seven principles to form the basis for creating our future terminal.

1. Every traveler is VIP

Travelers are the key to Schiphol’s business model. Since the emphasis of Schiphol’s turnover is the direct or indirect revenues from shopping, Schiphol needs the traveler to spend time in the terminal as long as possible. The traveler needs to be at ease in the terminal lounges. Therefore the traveler needs should be carefully mapped.

In the green terminal of the future goods and services are offered dynamically, according to the needs of travelers due to arrive, this can be known from real time information obtained from the registered or public profiles from travelers.

Lounges are dedicated to specific groups of travelers and dynamically fitted to their needs and customs. Travelers are offered food that fits with their bio-rythm and matches the time zone they come from. Everyone is VIP.

Making time less critical or more flexible for passengers in this sense is an appealing thought. This involves offering many other services and facilities in addition to transport, all of which will form an integral part of the travel experience of the future.

But to really feel like a VIP, users will have to be able to shape and re-shape the terminal and the services it offers according to their needs. Only a building that remains relevant to its end-user is truly sustainable.

2. Sustainability is self-evident

This sounds like a no-brainer, but it isn’t. To create a green terminal, or any other green building for that matter, everyone involved in the creative and operative phases will have to have an open mind. This attitude is the common denominator throughout the design process. For one thing, all partners, shops and companies involved need to have a contributing vision as well - a vision that matches or surpasses our own.

In practice, we should avoid too many explanations. There is no need to highlight the fact that there are specific organic food shops, nor does everything that is organic or sustainable need to be labeled as such. Too much overt promotion of greening measures will reduce the image of the building to that of a marketing tool with a temporary shelf life.

3. Creating a perpetual biotope

Being sustainable means benefitting from something without reducing its value for future generations in any way. Nature itself is organized that way. Birds eat fruit and their droppings provide nutrients for new plants. Every biological and technical cycle of our terminal building needs to be an integral part of nature. As soon as passengers enter the terminal, they become an integral part of this biotope as well.

Passengers can be looked upon as people who do not just take goods from the airport, but they also bring valuable assets. Garbage and human waste can be turned into energy. Waste from planes and restaurants can be converted into biofuels. Warmth released by people and planes can be captured and stored for heating the terminal building in winter.

Seasonal food for restaurants could be grown as locally as possible; one option being a greenhouse on the roof of the terminal itself. The batteries in electrical cars left at the long-term parking lot may be used as a low-maintenance energy buffer for Schiphol, earning parking customers money or airport benefits.

4. A performance-based business model

In the new terminal building, ownership is a thing of the past. Usage is what matters. It will be necessary to shift from a linear to a circular economy[6] to create this performance-based terminal. This can be achieved using new and innovative business models.

Following Cradle to Cradle's idea of 'waste equals food' the terminal building of the future can be seen as food in architectural form. Everything from columns and beams, light bulbs and ducts, chairs and tables to tiles and carpet are the ingredients to be used for building a new terminal or a school or any other construction. When the terminal building needs to be changed, there will be no waste and no debris, but only valuable resources that are dismantled or disassembled and can be turned into raw materials for new production processes.

Partners are chosen on the basis of their 'overall best' green performance rather than for having the lowest price. Companies with better performance track records will be given a chance to contribute.

5. No single element dominates

In designing sustainable, no single element should dominate. The only way to ensure that real balance can be maintained over an extended period of time is to ensure that not too much focus is placed in one area.

No one item is more important than another and nothing should be labeled as a specific goal. Carbon reduction does matter, but being energy-positive, expelling toxic materials, generating local revenues and providing for a healthy indoor climate matter too.

6. Informed decision making uses 'cloud' thinking

The creation of a perpetually green terminal building will not have a fixed completion date. It remains a work in progress – an ongoing search for the perfect balance. Performance throughout the terminal's lifetime is what will become important.

Informed decision-making will mean that all data are open-source and innovation is a continuous and collective process. To make this more specific and to again emphasize principle 5, we care to state that all partners are equally important.

7. A 'greenprint' for the future

In our vision on the terminal of the future we need to first come up with a model before we can start to design. This model will function as a script or scenario[7] for new green terminals worldwide.

6. In a circular economy products function as a 'resource bank'.

7. A nice term in Dutch for such a script would be 'GEENPRINT' to emphasize its is never fixed (printed).

A FIRST LOOK AT THE TERMINAL

When a project for a new terminal building is launched, one has the chance to start with a clean slate and grasp the chance to re-think and determine what is really needed and what is led by convention. So, what is really needed?

Schiphol's present business model focuses on revenues from the shops. As a consequence Schiphol wants to keep travelers in the terminal lounges as long as possible, giving them time to spend money at their leisure. Once they have finished, they just walk along the corridor to the plane.

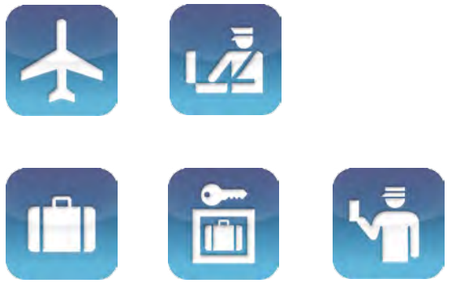
However, building piers is spending money and resources on large building parts that are in fact meant for pedestrian transport only. This immediately brings up the question whether building a terminal with dedicated piers would be still the best solution.

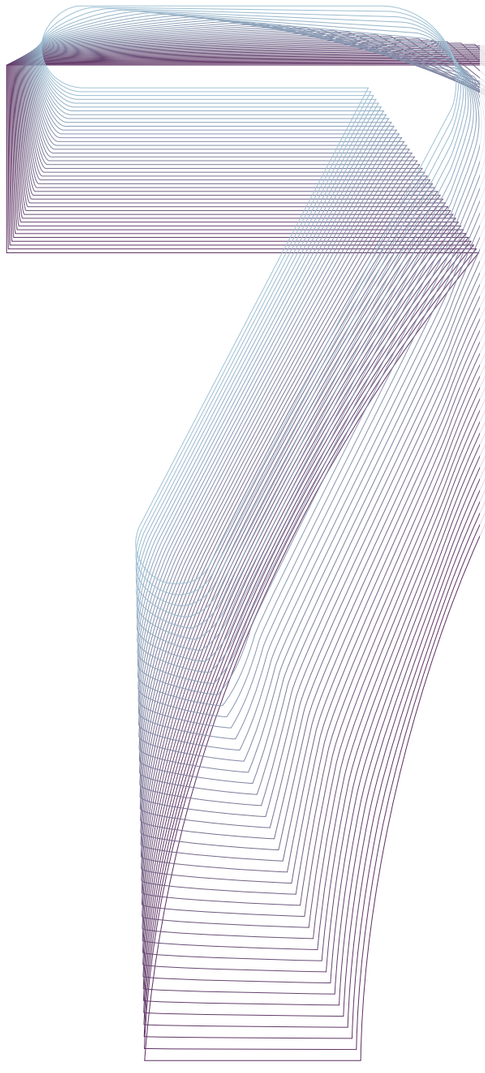
Instead of making people travel to catch planes, why not bring planes or airports closer to the people?

In such an airport, the layout can be entirely different and the terminal building much more compact. Instead of organizing hotels, car parks and piers horizontally resulting in lengthy walking distances and a wasteful use of plot space, a vertical organization is the future we envisage. Shopping floors, hotel floors, business floors, entertainment floors, restaurant floors, parking floors, garden floors and departure and arrivals floors. Travelers would simply switch between floors within this all-in-one concept, instead of having to walk long distances to reach a boarding gate.

A vertical organization would require a much smaller physical footprint than a terminal in the present airport layout. Ongoing expansion of airport grounds in the future could come to a standstill; the future growth of the airport could be catered for within the existing premises. Talking of sustainability! Contraction instead of expansion will imply less instead of more. Less surface area to be built on, less connecting infrastructure between terminals, less strollers or shuttles, less impact on the environment and also, as a consequence, less cost. And last but not least, happy passengers that are not burdened with stress of traversing huge distances to reach their planes.

To take a modular terminal one step further, one can even imagine a terminal where all spaces are dynamic in terms of function, size and shape, depending upon actual demand.





SHAPING TERMINAL t

Is this compact and dynamic terminal then perhaps the way forward? Our approach should be to avoid making choices that we sooner or later would start to question. Instead, these choices should be replaced with a range of options that become available to us as we proceed in time.

If a green terminal building is to remain green over time, the question is how this will influence its conceptual and structural design. In order to evaluate this properly, it seems wise to reflect on the status of the public debate on several interrelated topics including sustainability, environmentalism, climate change and social responsibility.

This field is not yet a ‘hard’ science and we should be aware that there is little we know for sure. The one thing we can agree on is that our ideas are likely to change over time.

For our terminal ‘t’ this implies that the way we calculate, assess and judge the environmental impact of a building is likely to change over time. In addition, available technology options will change. The commercial availability of sustainable or ‘green’ solutions is a relatively new phenomenon. We anticipate that further innovations will become available to us at an increasingly rapid pace.

To provide for these dynamics, the structure and all its infrastructure should be modular (for flexibility), parameterized (for offline modeling) and metered (for real-time control and verification). To take sustainability still further, one needs to organize products and building elements in a way that ensures that their overall performance is distinct and intelligible at all times (cyclical). Consider a shop, a corridor / floor / façade element, a point of sale, a check-in desk, a lounge, etcetera. If its data is retained in a mathematical model, its performance can be monitored and by running updates, potential new scenarios can be evaluated.

Moreover, in addition to the performance, the model provides information on the product's economic value in the form of the natural resource used to build it. After the operational life of a product or building component, it will be de-assembled and its resources up-cycled into new products. At all times, the product's share in the new production in terms of its value, is known and retained in the model.

A granular, metered and cyclical infrastructure requires a sophisticated backbone for its inputs and outputs. The bare inputs are data and power, while the ideal outputs would be limited to power and data as well, with every module reworking everything it needs (water, air, …) in a perfect balance. Theoretically, any module could be fitted to such a backbone. An analogy: a spaceship hooks up to power (solar panels) and data (a satellite link with earth) and all its components link into this backbone. In this new modern world a traveler could be seen in a similar way - requiring power (food) and being connected, the data being his or her digital self.

In this sense, our concept for a green terminal building is a model, and our ambition for both its completeness and its granularity are infinite[8]. Actually, we could take this a step further and state that such an approach is implicitly compatible with designing a building based on an identity – the model itself would be its identity.

As we learn and as the model grows in completeness, the building will change continuously, growing into something better and more balanced, like all things green and living in nature. And then, even after such a building is demolished, everything that has been learned from it will remain in the model, so one could say that its identity will live on. This is an extremely exciting architectural and infrastructural opportunity.[9,10]

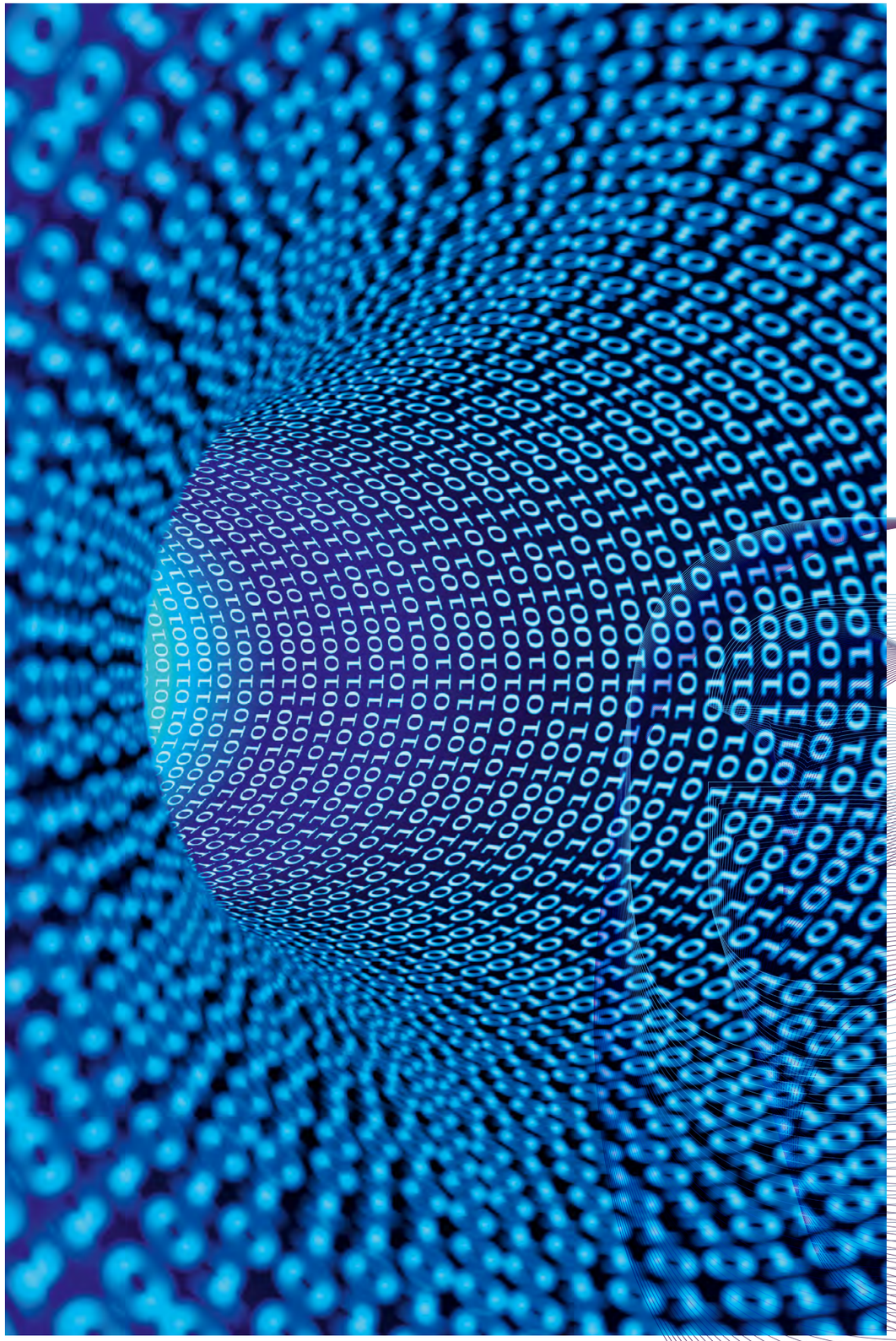
There will be a shift to an entirely new world of creating, designing and building. Nowadays we tend to fully take the future into account and try to foresee how in time demands will change. We try to make a design as flexible as possible. In the end however, products often lose their economic value once their operational value is gone, despite the money and effort that have gone into making them flexible enough to cope with an unpredictable future.

8. Obviously, in any practical implementation, both completeness and granularity will be limited [but open to discussion, modification and extension].
9. In his book 'De LEGOlisering van de bouw' Prof Dr. Ir. Hennes de Ridder argues that one of the key problems in our current approach to creating buildings is that the lack of a learning mechanism causes us 're-invent failing solutions' again and again, wasting value and resources. A modular (componentized building blocks) approach is proposed as key to solving this problem. **10.** The Greek Philosopher Heraclitus (c. 535 – c. 475 BCE) is famous for quoting Plato with "Panta rhei" which means 'everything flows' or 'everything moves'. He argued the impossibility to cross the same river twice, simply because the water refreshes. Our model is like this. In a way, it is never used the same way twice. For these reasons, we propose Pantarai as the name for the model.

The concept of capturing value through product resources gives a different point of departure and consequently ultimate freedom of design. Not the future, but the present will determine any list of requirements. We will only design and produce what we need today, even if is trendy or very fashionable and thus has a limited lifespan. The notion that we can revise its shape or functionality as soon as demands or ideas change will free humanity and it forms the perfect solution for coping with the incredible pace of change in technology and fashion today[11].

Concluding: to be green or sustainable over time we need to dream, invent, learn, also from mistakes, and develop. Because we cannot afford to make any major mistakes once operational we need substantial proof that new ideas, concept or modifications will perform the way we want them to before we really implement them. This can only be achieved when all relevant impact aspects are verified in a mathematical model.

11 http://www.youtube.com/watch?v=NbFEaSUSR9U and http://vimeo.com/17358934



HOLISTIC MODELLING

So what will our mathematical model look like? In its very essence, such a model is holistic, delivering a balance over time by applying the principles used in a circular economy. We have found a perfect analogy for this in the form of a space station. By definition, a space station has to exist in a state of balance and everything on board has to be self-sustainable.

For a space station, air, water, humidity, temperature, position, speed, course, weight, fuel, electric power, food, CO_2, biorhythms and many more aspects all have to be in perfect balance for the duration of its life in space. Any imbalance whatsoever could lead to severe problems, with the space station ultimately veering off into space or crashing down to earth.

It is of course possible to add, remove or replace items, but even such basic activities require insanely complicated missions and are extremely expensive. You cannot open the window[12], you cannot put out your garbage – in fact garbage itself is actually impossible. On top of this one property may never be managed at the expense of another[13]. Imagine refreshing the air by draining the batteries: not an option.

Consequently, much can be learned by looking at how this balance is achieved over the lifetime of a real space station. It was promising to see[14] that this is achieved by applying extensive modelling[15] during the design, planning and operational phases.

12. Space station MIR, during its last years of operation had severe problems with moulds living of wiring and composites and producing bad smells, leading to health issues and structural damage to the space ship. **13.** Water, available for drinking, cannot be used to clean out moulded panels. Well, yes actually it can, but then you have another problem. Also the problems are in balance! **14.** We interviewed Prof. Dr. Ir. J. Dam from the Technical University Eindhoven and Mr. Christophe Lasseur and Mr. James Etchells from the European Space Agency (ESA) in Noordwijk, Netherlands. **15.** We will spell 'modelling' with a double 'l' as common in UK English to specifically distinguish it from 'modeling' (US English) with one 'l' and a strong connotation to appearance, which we associate more with 'greening' - not being the topic of this paper.

If all things are truly considered equally important, it will be necessary to combine knowledge from divergent fields of interest by ‘connecting brainpower’, leading to an explosion of data. Fortunately, developments in computing power and modelling tools have increased significantly in recent years, which makes multi-parameter optimization considerably more straightforward. These technical possibilities allow us to simulate different scenario’s (what if … ?) to rule out unwanted surprises and optimize our operating strategy throughout the future.

We will use a virtual computer model to predict the outcome (the collective evaluation of all balances). After implementation we can verify the real performance using a real-time version of the model, which allows us to interpret the enormous quantity of signals that are collected in the terminal building to learn from reality and improve our building.

By comparing this information with our virtual forecast we gain a better understanding of the different processes involved and can make improvements in both the real world and the virtual model - a continuous loop of learning and improving. Collecting and studying this data also enables us to share knowledge with other people who can help make a contribution to our model (virtually and in reality). By implementing the virtual model as a cloud, improvements can be offered from all over the world, which will ‘super boost’ the innovation process.

Long duration missions

Long duration missions, such as the establishment of permanent bases on the lunar surface or the travel to Mars, require such an amount of life support consumables (e.g. food, water and oxygen) that direct supply or re-supply from Earth is not an option anymore. Regenerative Life Support Systems are therefore necessary to sustain long-term manned space mission to increase recycling rates and so reduce the launched mass.

The architecture of an Environmental Controlled Life Support System widely depends on the mission scenario. Even for a given mission scenario, different architectures could be envisaged which need to be evaluated and compared with appropriate tools. As these evaluation and comparison, based on the single criterion of Equivalent System Mass, was not considered comprehensive enough, ESA is developing a multi-criteria evaluation tool: ALISSE (Advanced Life Support System Evaluator).

The main objective of ALISSE is the definition and implementation of a metrics system, addressing the complexity of any ECLSS along its Life Cycle phases. A multi-dimensional and multi-criteria (i.e. mass, energy, efficiency, risk to human, reliability, crew time, sustainability, life cycle cost) approach is proposed through the development of a computing support platform.

Each criterion being interrelated with the others, a model based system approach is used. ALISSE is expected to provide significant inputs to the ESA Concurrent Design Facility and, as a consequence, to be a highly valuable tool for decision process linked to any manned space mission.

Source: The Smithsonian/NASA Astrophysics Data System

Knowledge from data and partners

In order to take a closer look at the holistic mathematical model we need, we will have to define what it is, what it does and how we measure its success.

In order to focus on the right parameters, we should respect the interests of all parties involved (stakeholders, government, environmental groups, society and customers), because these are the people that will eventually define our success.

Relevant operational and design specification data for Schiphol can be obtained from its ERP[16], FMS[17] and BMS[18] systems for the current terminals, or from departmental systems, ERP or from the departmental systems[19] of the service providers with whom they work.

Service providers like Imtech also have further available data on installation, management and maintenance of the operational equipment in a terminal. These data sets and tools are typically departmental, sometimes integrated to form sophisticated bid preparation tools. These tools may need to be adapted but are perfect contributors to our goal.

The same goes for building-companies that possess data relating to both the physical construction (concrete and steel) and the process of construction itself.

Links to external companies/ agencies should also be considered, such as governmental planning agencies[20], preferably those with an international bias for obvious reasons. Changes in politics, national budgets, crises, etc, all affect the needs and dynamics of an international airport terminal.

We should use existing data for benchmarking and build the first model (v.0) based on an existing terminal and start collecting and measuring data now (baseline measurement).

In addition, it would make sense to invite environmental organizations like Greenpeace or WWF, to participate in the debate on the model's inputs, outputs and methods. These may also prove to be better sources of data in certain areas.

In short: after establishing the right parameters, we will use existing data for benchmarking, build the first model (v.0) based on an existing terminal and start collecting and measuring data to establish a baseline.

We will consider our approach to be a success if we end up with a practical model, which is ready for further development and implementation, based on input from a wide range of people and with their ongoing commitment to make it work. Further proof of our success will be when other parties and building projects start using our model.

16. Enterprise Resource Planning system, vendors include SAP, J.D. Edwards, BAAN, Exact, Oracle, etc. **17.** Facility Management System, vendors include Planon, Ultimo, Topdesk, etc. **18.** Building Management System, vendors include Honeywell, Siemens, Priva, etc. **19.** Includes tools like spreadsheets, local databases, or other non-company wide systems. **20.** For example: the Dutch Central Bureau of Statistics, CBS.

The history of modelling

Modelling is as old as science itself (e.g. for engineering and economics): it's nothing more than a simplified projection of reality. It helps us to understand what we can expect in the real world from certain phenomena, processes, behavior etc. By understanding we learn, try to improve and eventually evolve. Over the centuries our models have become more sophisticated and have had a far-reaching effect on the way we obtain our knowledge.

Computer technology has boosted this technique even more and enhanced our understanding of for example physics and the environment. This is actually what started making us think 'green' in the first place. Now that we have become more mature we have become more aware of the big picture on this planet and have started to model this process too. It is in fact the logical next step.

If we look at how modelling has evolved over time, we see some interesting changes. Besides natural development (more sophisticated) modelling has started dealing with the use of resources (materials and energy) in a different way.

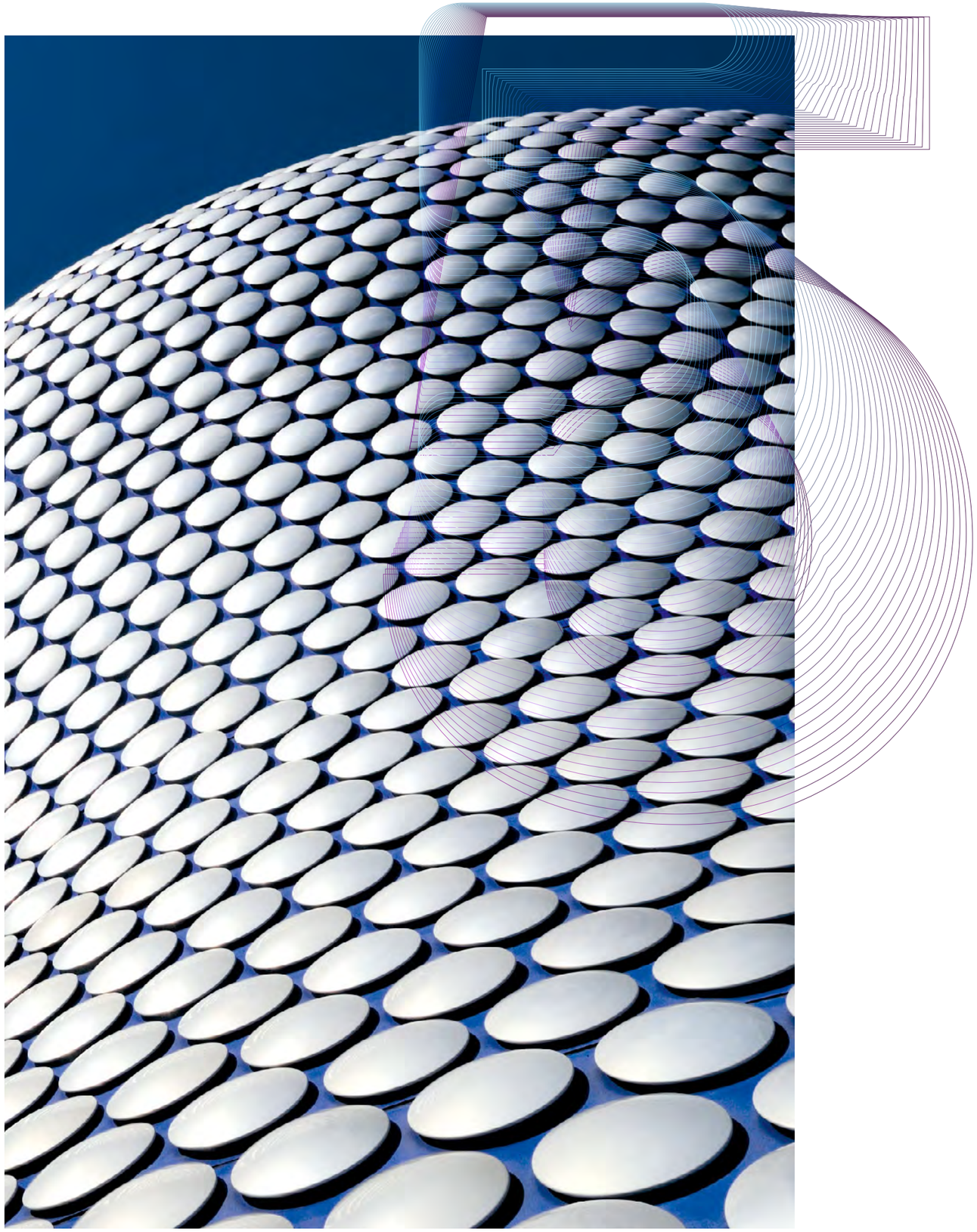
In the early days resources were not an issue. You just took what you needed to fulfill demand and then wasted it at the end of the lifecycle. In recent times we have started trying to minimize the use of resources, at least when it comes to energy. In some cases we are even trying to recycle something at the end of the lifecycle.

Nowadays we realize that our resources are not infinite and we that we need to abandon this linear approach and implement some degree of balance over time and a circular economy in our design principles.

The table below shows how modelling evolved over time.

Period	Complex-ity	Level of integration	Calculation	Resources and approach	Target	View	Social involve-ment
Past	Low	None	Static	Linear*	None	Micro	None
Now	Medium	Low	Static	Linear* / balance	Min. use of recource	Local	CSR
Near future	High	High	Dynamic	Circular**/ balanced	Max. reuse of recources	Holistic	Active

* Based on an unlimited supply of resources and wastage after use.
** Based on the reuse of materials by closing the technical or ecological cycle.



HOW TO START

Just as in the case of the space station, preparations for the green terminal should start with an activity plan for the building, resulting in a list of activities, required resources, produced outputs and produced wastes that cannot be recycled. The next step is to collect an overview of available technological options. Only those systems that support modelling in some way will be considered in the overview.

The task for Schiphol will be to define those data sets, formats and supply methods that are of interest. We will immediately address the argument that ‘this will get way too complex’ by stating that we can start with a model that is limited in both completeness and granularity. For now, the method (getting a grip on managing understanding) is more important than the quality. Once the model works, iterating it (in a Darwinist manner) will be very manageable.

As in our space ship analogy, our model has a holistic view. This is quite new, because nowadays, models are mostly focused on one area. However, this new model needs to take ‘everything’ into account. From financing, building information, logistics, passengers and energy to climate control, social intermediation and environmental issues. There is certainly a longer list of relevant issues.

A first reaction might be to think that this will be very complicated, but most of these elements are in fact already included in several existing models. A look at the IBPSA website (International Building Performance Simulation Association), for instance, shows us that virtually every process related to a building or its environment has already been modulated. We just have to link them to each other and synchronize their input/output. This will involve a considerable amount of work but can certainly be achieved.

Now we can see how this project will have benefits that extend beyond the horizon of Schiphol. As Schiphol is a high profile project, companies will make an effort to produce the necessary tools (or data) to guarantee their involvement in certain scenarios. Many product vendors already maintain detailed models for their products. Sometimes, these models are used in R&D departments, sometimes they are also available as sales tools for commercial departments. These tools can be adapted to meet an interface standard, so that they can be included in scenario calculations. Again, confidentiality can be managed.

What we need is an umbrella or model that acts as the main interface to manage all the I/O's produced by different individual sub models that can be connected to or disconnected from the main model. There will be a main version for both the virtual and real-time models. This approach makes the expansion and evolution of the main model very flexible, as sub models can be added or replaced. Exchanging data between the sub models will ensure calculations become more accurate, because assumed fixed parameters can be replaced by (real) calculated values.

Any operational changes to the terminal building will also be updated in both models. All data will be stored in databases of a Building Information Model (BIM)[21]. The exact content has yet to be determined, but it will have to match the interests of the parties involved.

Because it will be constantly updated, the model can also be used as an information database for the whole terminal building. It can provide drawings, images, technical specifications etc. As it will also enable elements to be labeled with microchips, any information can be automatically accessed real-time on location without a time consuming search through the database archives.

As Schiphol is the operator (not the owner) of the building, it seems logical that Schiphol should be the specifier, owner and operator of the model's inputs and outputs. Management and operation of the model may be outsourced to service providers.

21. Building information modelling covers geometry, spatial relationships, light analysis, geographic information, quantities and properties of building components (for example manufacturers' details). BIM can be used to demonstrate the entire building life cycle, including the processes of construction and facility operation. Quantities and shared properties of materials can be extracted easily. Scopes of work can be isolated and defined. Systems, assemblies and sequences can be shown in a relative scale with the entire facility or group of facilities. Dynamic information on the building, such as sensor measurements and control signals from the building systems, can also be incorporated within BIM to support analysis of building operation and maintenance.

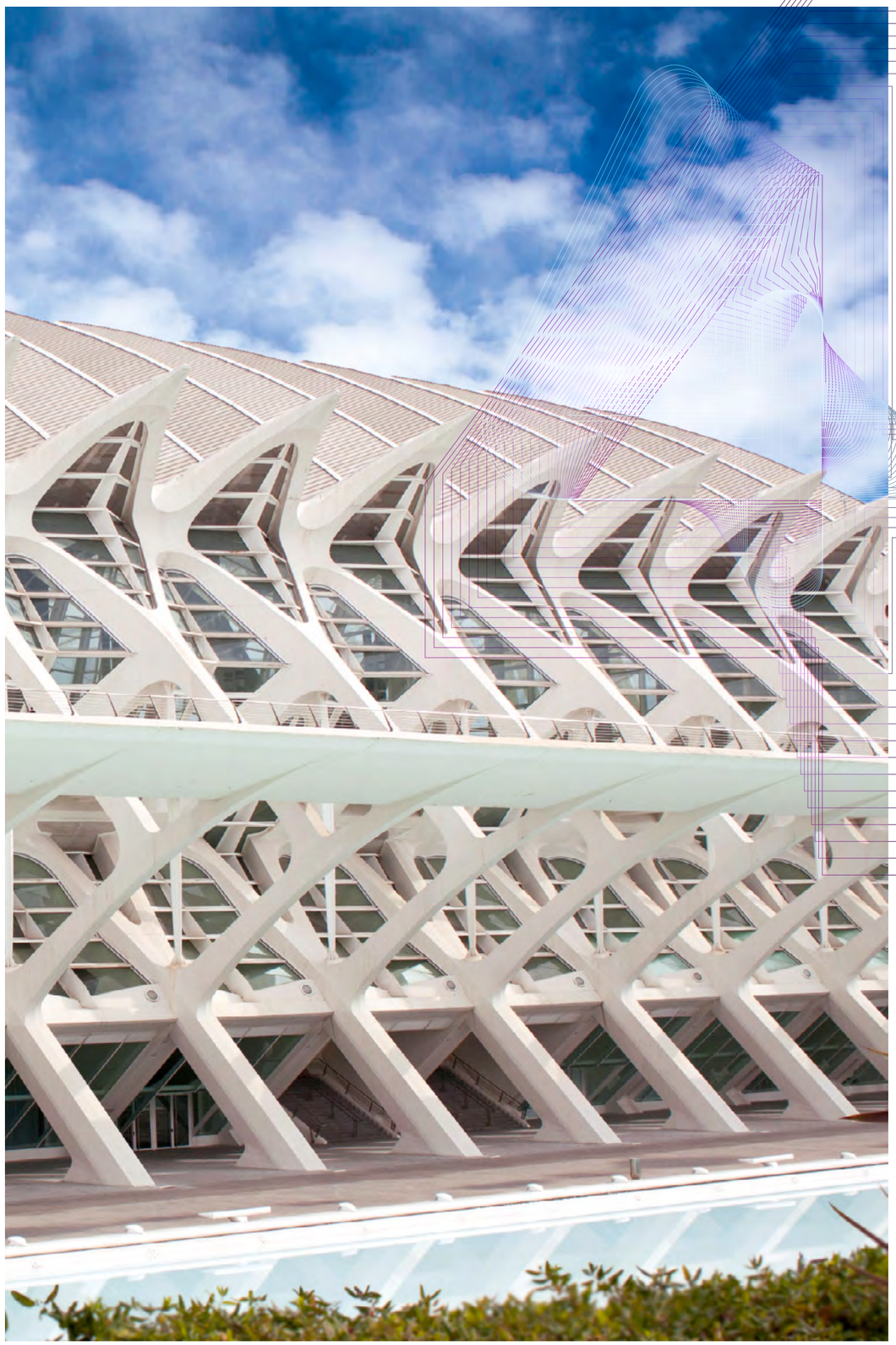
Together with an architect (and the modelling service provider), Schiphol should specify activities and requirements, and drill this down to a list of parameters that are required for evaluation in scenarios. The architect can then retain his/her creative function and evaluate the overall environmental impact of any design. It would be best to define the scope of the model (how to define and calculate environmental impact) with the key stakeholders: owners, local and national bodies, environmentalists and the general public.

For the actual building, parts of the model can be translated to control loops; this way the actual dynamics of the building remain close to its design.

Furthermore, real-time data from all metered modules should be collected and fed to a real-time version of the model in order to assess the actual dynamics of the building and its impact on the environment. In this way actual knowledge on the building can be obtained, which can be used to feed the improvement process.

In the light of the fact that holistic modelling is the key to designing both the most stable space station and the most sustainable earth-based building, we believe it is now time to state the following:

Definition 2: Sustainability is rocket science



A PERFORMANCE BASED BUSINESS MODEL

To meet the image of a performance-based terminal as described by the principles, we need social and economical changes. It will be necessary to change our linear economy into a circular economy in which products function as 'resource banks'.

There are several business models[22] that are specifically designed to lead to the preservation of resources. Their goal is to ensure that production and consumption no longer have a negative impact on the environment and society.

Using these business models, Schiphol would hire-in products based on performance and only pay for what is delivered in terms of the terminal and its products. The producers retain the ownership of their products and will be held responsible for maintenance, innovations and updates of their products. The airport pays for light instead of lamps, heat instead of a boiler, and fresh air instead of a plant room. The producer or manufacturer remains the contractual owner of the product. At the end of the contract period he will take the product back, creating a 'performance cycle'.

Schiphol can fully focus on its core business. The used raw materials will return at the end of its period of usage to the producer. Resources now remain available for new generations of products. This offers the following benefits:

- Schiphol no longer pays for the raw materials in a product, it only pays for the performance.
- Producers continue to own their resources and become less dependent on the commodity market.
- Valuable resources are no longer lost, but kept in a circular economy.

22. One of these models is ®Turntoo. Within this model, consumers no longer own a product, per se, as they only pay for the product's performance. The producer remains owner of the product, at the end of the contract he will take it back, creating a 'performance cycle'. In this way, producers are challenged to approach their products as "resource depots" and the raw materials will remain part of the technical cycle.
The producer remains at all times responsible for his product and thus the consequence of his actions. In addition, by shifting consumer perception from products to performance, manufacturers will start to rethink production paradigms. Information: www.turntoo.com

A new perspective on the value of a building has come into existence. It will be impossible to declare a building or a product economically worthless. The raw materials they incorporate will always retain their value. In this terminal building of the future, ownership will be regarded as a thing of the past and as a burden. Usage will be what matters.

Schiphol will no longer own the terminal building and the products it contains. Schiphol will borrow suitable raw materials in the form of a product from the manufacturer in order to use them. It will only pay for the service that particular product supplies and not for the product itself.

For short, Schiphol will be released from organizational matters that demand knowledge and skills in fields other than its core business. Schiphol will always be in a position to obtain the latest technologies, services and products without having to bear the initial investment costs.

ESA vs Schiphol

In the approach used by ESA on space projects, two essential phases can be distinguished: planning and operation. Each phase has its' own set of tools. For planning, a tool called ALISSE is used. This tool facilitates a selection procedure to evaluate and compare different architectures for on-board systems. The analogy with a green terminal building would be a tool to facilitate a selection procedure to evaluate and compare different building configurations and infrastructure options.

The problem to be solved for space situations is a comprehensive trade-off between technical, safety, cost and strategic considerations. The analogy with a green terminal building would be a holistic trade-off between technical, environmental, cost and strategic options. The way this works for a space project is as follows. Everything starts with the plan for a mission, resulting in a list of activities, required resources, produced outputs and produced wastes that cannot be recycled. The next step is to collect an overview of available technology options. Only those systems that support modelling one way or the other will be considered in an overview. It is important to note that the way modelling is supported for individual systems is not prescribed.

ALISSE as a tool is able to interface with external data systems like SAP, databases, spreadsheets, but also modelling tools like EcosimPRO, Mathematica, Matlab, Hisys, Openfoam, or any other modelling tool for that matter. These tools interface with a solver called ALISSE. The interfacing with ALISSE is open and standardized, so that developers of new systems do not need to share confidential details about the inner workings of their technologies by sharing models. Each supplier simply connects to ALISSE by providing standardized inputs and outputs, so each supplier can run his own algorithms. This way the management, computation and confidentiality is conceptually distributed.

ALISSE itself is a multi-criteria solver based on EcosimPRO that uses all inputs and outputs from the distributed vendors to produce results for various scenarios and configurations. These results are exported to an excel spread sheet, essentially a table where the columns are managed properties, and where the rows are scenarios.

These are visualized using spider diagrams and used as input for meetings to come up with more sophisticated configurations and scenarios. In this process, no item is the most important.

esa

IBPSA

IBPSA is founded in the 1980's and is an international organization with regional affiliate organizations around the world. Its mission is to advance and promote the science of building performance simulation in order to improve the design, construction, operation, and maintenance of new and existing buildings worldwide.

IBPSA shows us that modelling on whatever issue is today's reality. Upgrading modelling to a holistic level is the most logical next step, the step needed for our green strategy.

BUSINESS OPPORTUNITIES

Does our vision create business opportunities for Schiphol? Yes, it does. If we consider the concept of a perpetually green terminal, some opportunities immediately come to mind.

We believe that embracing space technology will be of strategic importance for many other reasons. Commercial space flight is in an exciting development phase. Sir Richard Branson's Virgin Galactic and SXC are just two serious European examples. Spacecraft are becoming more like airplanes - cheaper and more commercial. Although still only affordable for the happy few (ticket prices for Virgin and SXC are USD 200,000 and USD 100,000 respectively, but there are already 430 people on Virgin Galactic's waiting list), we should not forget that this is how many new phases in human development started.

One day, space flight will be mainstream. SXC is even claiming that it is greener since it takes place in the outer atmosphere and so creates less pollution. For a green terminal, such developments are important and they are theme related. It appears that thinking about the next step for an airport terminal, implies thinking about 'space'.

An interesting aspect of Schiphol Airport is its affiliations. Based on unique domain knowledge, Schiphol has been able to establish footholds throughout the world. This offers still more potential opportunities for the green terminal proposed in this paper.

The green terminal we have outlined above will go through continuous waves of innovation, with some modules being replaced with newer ones. These newer modules are an enhanced version of the old module, 'pluggable', modeled, metered and cyclical. The innovation axis for the module is its impact: the new module, using extensive modelling, should have proven lower impact in the factual and anticipated dynamics of the terminal.

One way to deal with an old module is to bring it to the end of its life, the cyclical aspect of the module. If it is a Cradle2Cradle product, its materials will be recovered and reused. But redeploying the module is perhaps a better idea. Since its functionality is self-contained and its interfacing is standardized, it will be possible to ship the unit to affiliated airports, and make them greener as well.

In this way, the impact of the green terminal is not limited to Schiphol, but it will have an effect worldwide. Implemented well, this could create a cascade-effect where Schiphol would be able to establish unique control points in several ways.

First, the connections for the module, are standard and Schiphol owns the designs and specifications. Second, Schiphol owns the protocols for the modelling. Third, the modelling could be offered as a service and be scaled to include evaluations of where to place redeployment modules for overall optimal effect. Airports can then become a series of connected cities and Schiphol an exporter of knowledge – perhaps an interesting thought on a future-proof (sustainable) business model component for Schiphol.

For service providers like Imtech and RAU, new business models certainly are a possibility. Nowadays, an airport is designed, tendered, built, and finally serviced. It is difficult to guarantee complete context exchange between the teams involved in each of these phases. Actually, there is little that links these teams and tasks.

For the terminal concept we propose, the model is the one element that links everything together. It explicitly contains all the information. Anything that happens will be logged, metered and evaluated against scenarios. In this sense, there is no contract specification and no project; there is just a model and a trajectory. The trajectory is the long-term service, where knowledge is continuously being added from all directions, reflecting the essence of the model.

Schiphol will remain flexible with respect to its choice of partners (since it owns all knowledge through the model). The criteria for awarding projects will be ‘the best possible new scenario’ and not just ‘the lowest price’. ‘More work’ methods are replaced with ‘more marginal impact’ proposals.

Obviously, the modelling can be reused for all kinds of other projects and buildings (the commercial redeployment of knowledge), adding to the scope of opportunity we create. It promises to be a fantastic way of being uniquely positioned in the market with a specific competence.

EFFECTS ON COST STRUCTURE

Our perpetually green terminal concept has unique properties that have an arguably positive effect on the cost structure for services that Schiphol charges for handling planes, goods and passengers.

As we have argued before, our terminal building can best be viewed as a service itself as it will continuously evolve into something better and more valuable. Such a service creates a predictable structure for both commercial and flight-related costs[23], built up from the partial costs of many modules. The fact that the activation of these modules is spread out over time, will lower the net service costs charged to customer airlines.

On top of this, the conceptual flexibility of our terminal offers a clear advantage. For example, if we run scenarios against our model and the results indicate that the global economic situation will have an impact on business, changes can be made to the terminal building rapidly. Capacity can easily be reduced or enhanced. As a result, the net charges change in predictable ways, by adding or subtracting the cost portion for the new or decommissioned modules. As stated earlier, the service charge pays for the use of products, but Schiphol does not own them. Raw materials remain the property of the manufacturer and do not influence the costs for usage, which leads to lower overall costs. There are several fundamental benefits here.

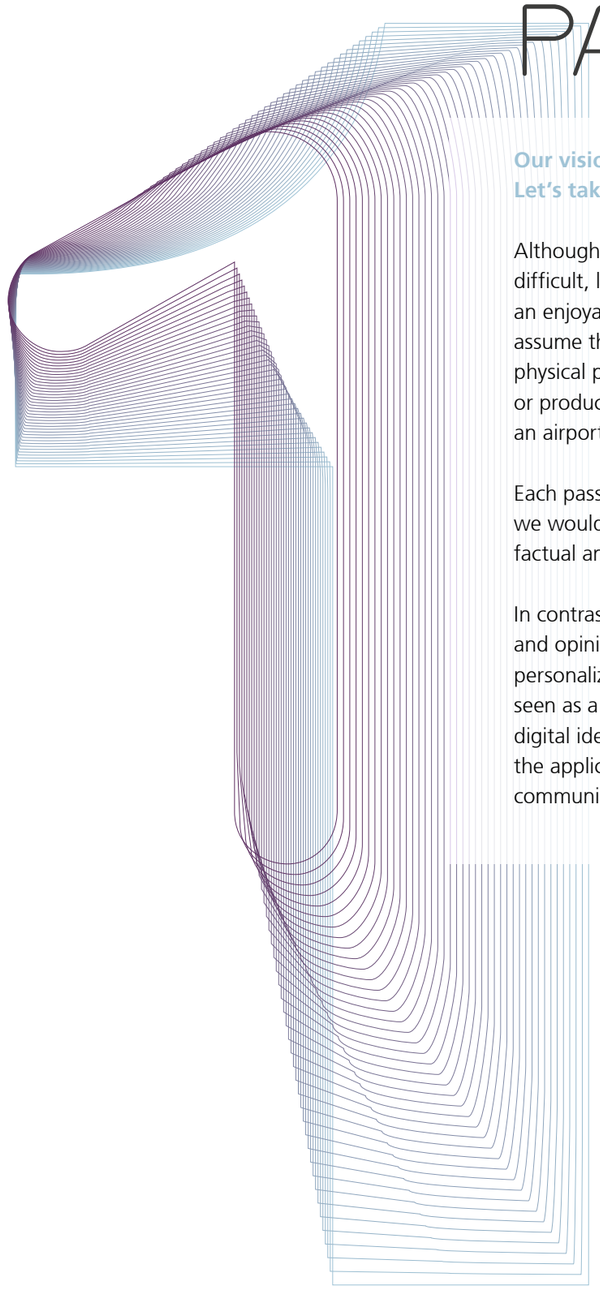
First, in case of economic downturn, modules could be decommissioned rapidly, immediately lowering the net

23. In The Netherlands, taxation of handling related activity and property at airports is different from standard (commercial) taxation. One notable difference is the rate (it is lower) and also the commencement of the write-off period (which is 30 years). The write-off period starts on the date of planned commercial exploitation, and this is not necessarily the same as the start of actual commercial operation. This is why for accounting purposes all assets and activities at Schiphol are split into commercial and handling related.

service fees. The problem of having a hibernating asset which offsets service charges will cease to exist.

Second, in case of economic growth, if new capacity needs to be planned, a much more casual and pragmatic approach may be used. No one will have to take responsibility for impossible decisions based on long-term views of the future, only to be later confronted with unanticipated events. It will be possible to plan for the short term (which we can predict), see what happens and then make any necessary adjustments accordingly. A step in any direction will always be possible. Any change will result in a perfectly clear additional service charge that can be simply cancelled if it becomes obsolete at a later stage.

Compare this with the traditional approach. The current building has become obsolete, but it is difficult to take the decision to change, simply because the building 'resists change'. This is compounded by the fact that nobody knows what the future will bring or what changes should be made. The decision is put off to a later date. Things deteriorate; maintenance starts to be given a lower priority because change is 'eminent' anyway. On the eve of the anticipated economic growth the decision is finally taken, but on a grand scale – probably bigger, better, but nothing really new. This inability to fundamentally change leads to overcapacity, irrational fees, complaints and potential business goes to other, flexible airports that do offer a lean and dynamic cost structure based on a conceptually dynamic terminal concept.



PUTTING PASSENGERS FIRST

Our vision also offers next-level benefits to the end-user. Let's take a brief look at the passenger.

Although in the international context of an airport generalizations are difficult, let us assume that it is in the interests of each passenger to have an enjoyable experience while traveling. Looking into the future, we can assume that there is more to a passenger visiting Schiphol, than just a physical person. As we have already established, a passenger is a container or producer of organic compounds and, as such, part of the habitat of an airport-city.

Each passenger also carries data. For the purpose of our discussion, we would like to focus on data that are not travel-related as they are factual and only contain information on this one dimension.

In contrast, our passenger's digital-self is dynamic (Facebook, Foursquare) and opinionated (Twitter). This means there are opportunities for personalized experiences. The passengers at Schiphol should not just be seen as a number (50 million in 2011) but as a dynamic aggregation of digital identities whose needs can be anticipated. The very capabilities of the applications and personal devices people use, will require Schiphol to communicate[24] with them and treat them in new ways.

24. MMORPG: Massive Multi-user Role Playing Game. Examples: Call Of Duty, World of Warcraft, SIMs etc. Involving MMORPG game developers could help us devise sophisticated strategies for an airport visited by people with a digital-self. This may sound rather extreme, but this is how youngsters grow up, and they will be visiting our green terminal building in the future. These game developers understand strategies, they understand the data sets and the dynamics. Their worlds are adaptable - just like our building.

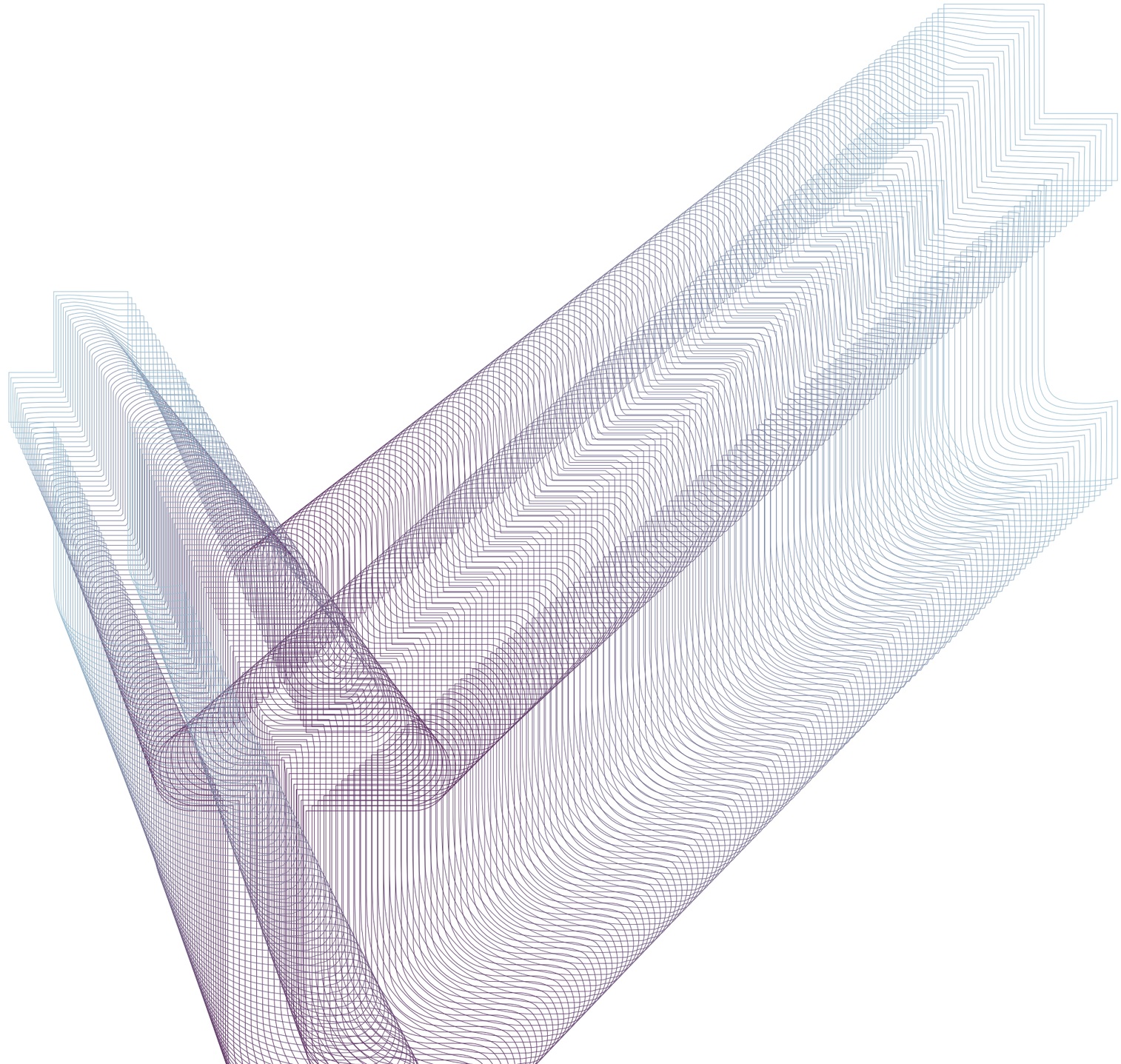
It is here that we can take the dynamics of a building to the extreme. Spaces should be dynamic in terms of size, shape, climate (temperature/ humidity/day/night), culture (sounds/ music/ advertisements), etc. Imagine being able to offer travelers food that complements their biorhythms and the time zone of their country of departure.

Of course it is possible to download a 2D floor plan to prepare for a time-critical connection at an airport you have never visited. However, while walking through the terminal, you have to interpret what you are experiencing (3D) relative to a 2D print. This is not an enjoyable experience and it is probably downright unpleasant in a stressful situation. In contrast, imagine a 3D interactive walk-through with your own holographic guide, anticipating forecasted crowds, weather, lighting, timing etc.

Role-playing software facilitates such functionalities and is already integrated in the gaming-console embedded is some airplane seats. By offering our terminal as a maze to be explored while flying, analyzing how our space is used, we can assess how people experience and perceive our building. During the time they spend in the terminal, passengers can visit shops, find out about special offers and make reservations in restaurants, helped by their guides. If they get lost and they tweet about it in frustration, we can pick up their signal and act on it.

We can anticipate people's activities and demands by monitoring social media. A separate portal could be created just for Schiphol, but a more effective method will probably be to crawl the web for relevant inputs and then feed this data to our real-time models to evaluate space allocation, configuration and decoration.

Walls could be moveable, giving more space to accommodate the group of fans gathered to welcome a champion returning from the Olympics, or to offer a more cozy environment for the female passenger arriving late at night on an almost empty flight. This means that, if usage or opinions change over time, our building will be prepared and ready. For a dynamic building, this is the way to go.



LIFTOFF

We have established that time is a fundamental part of a passenger's experience and a core element in the sustainability debate. Time is an important factor in building a green terminal building: the terminal must remain sustainable over time.

The approach we propose avoids choices that sooner or later become questionable. Instead, we replace them with options that sooner or later become available.
This also enables us to objectively and openly evaluate performance in relation to sustainability.

Management of changes comes down to an evaluation of scenarios based on numerical modelling. Modelling is already practiced on a daily basis in space – where it helps to sustain human life wrapped in a shell of technology. Re-applying space technology to earthly applications is the way forward: a game-changing approach that can deal with Schiphol's sustainability issues. This is a really exciting research challenge.

Organized through an open source data model, the sustainability performance of all individual components can be assessed at all times and improved on by anyone delivering a better performing product. Tendering will shift from 'best price' to 'best performance' within a circular economy.

The shift from ownership to usage as manufacturers retain the ownership of raw materials, will ensure that products have an economic value at all times. This approach will help liberate the design process. Designs can simply respond to today's needs and not have to take future flexibility into account. Once the future becomes the present, raw materials can be re-used and re-shaped into whatever is required at that time.

The traveler is the key element in thinking and re-thinking the future terminal. Putting his needs first is the only future-sustainable approach. By bringing traveler and plane closer together, we can achieve the sustainable and economic benefits that make the difference and keep Schiphol at the forefront of the worlds' high-end airports. This is another interesting research challenge.

To people that are sceptical or intimidated by the apparent complexity of the challenges ahead, we would like to say: yes, you are right, this is complex. Sustainability is like rocket science. But all we know is there are people out there in space, doing their thing, and apparently, it works!

Definition 1: The greenest buildings are conceptually designed to remain green in an unknown future.

ABOUT THE AUTHORS

Imtech and airports

Imtech is the European market leader when it comes to airports. The company offers a package of technological solutions through a combination of electro-technology, ICT and engineering. These are solutions that ensure that primary and secondary processes at and nearby airports operate faultlessly, 24/7.

Imtech is currently involved in the construction of the Berlin Brandenburg Airport, where, as technology partner, it is responsible for all technology, including a high-tech heat recovery system, in all the new terminals, an order worth more than EUR 100 million. Imtech is also involved in upgrading and expanding Frankfurt Airport.

Furthermore, Imtech is technology partner of the GROUNDS, an Airport Amsterdam-Schiphol initiative to become CO2-neutral in a relatively short period of time, and in 2020 to be producing as much as 20% of its energy requirements in a sustainable way. Imtech is currently also active at Heathrow, Gatwick, Birmingham and all the Royal Air Force air stations as technology and maintenance partner.

Our airport solutions contribute to sustainability, CO2 reduction, a better environment or an optimal level of safety. Here are a few examples: project management and total solutions in ICT, telephony, data, software, fire prevention, energy conservation in buildings, building automation, baggage handling, access technology, electrical systems, security, innovative kerosene vapor processing, mobility solutions, traffic systems and a total range of services for runways.

In the recent past, Imtech has been active at the following airports - Schiphol, Munich, Düsseldorf, Hamburg, Berlin, Dublin, Stockholm, Farnborough, Zaventem, Maastricht, Twente en Rotterdam-The Hague.

Imtech Profile

Imtech N.V. is a European technical services provider of electrical, ICT-related and mechanical solutions. Imtech employees around 27,500 employees and has an average annual revenue in excess of EUR 5 billion.

Imtech is active in the buildings and industrial sectors in the Netherlands, Belgium, Luxembourg, Germany, Austria, Eastern Europe, Sweden, Norway, Finland, the UK, Ireland and Spain, the European ICT and traffic markets as well as in the global marine market. In total Imtech serves around 23,000 customers.

Imtech's integrated and multidisciplinary solutions offer added value and lead to better business processes and more efficiency for customers. Imtech also offers solutions that contribute towards a sustainable society, for example in the areas of energy, the environment, water and mobility.

Imtech shares are listed on the NYSE Euronext Amsterdam and included in the Midkap Index and the Dow Jones STOXX 600 index. In February 2011, Imtech was granted the right to use the designation 'Royal'.

About RAU Architects BV

The RAU architectural team, based in Amsterdam, has adopted a particular philosophy, defined by the term oneplanetarchitecture: RAU designs buildings with a strong emphasis on sustainability. Since 1992, the practice has been working for the public and private sectors, maintaining an approach that is conscious of planet earth and uses integral methodology. RAU is actively involved in the current international discussion on sustainability and in developing energy-saving technology and concepts for energy-producing buildings. In a world where so much nature is threatened by human activity, RAU considers it its mission to make a positive contribution through its presence and its work.
Designs by RAU are characterized by a proficient level of sustainability. Some even set new standards, like the head office of the WWF Netherlands. This former agricultural laboratory was transformed into a CO2-neutral and (almost entirely) self-sufficient office building. Provisional calculations for Le Carré de Soie, a CO2 neutral and energy surplus-producing mixed-use office complex in Lyon (to be completed in 2011) show promising results: LEED Platinum, BREEAM excellent, EPBD A++ and German Passivhaus status.

About Tomorrow Design

Building an original brand that distinguishes itself from your competitors is a complex process. This does not happen over night but is a process of innovative thinking combined with a strong awareness of what is going on in the minds of your customers.
To translate this wealth of knowledge into a mind-blowing design is a journey we don't take lightly. Our devotion guarantees a seamless integration of strategic thinking and outstanding design. This will ensure that your brand will position itself in the one place you want it to be, within the hearts of your customers.
We call that 361°. The 1° extra is what we call our 'WOW' factor. Always exceeding the expectations of our clients as well as those of their target group(s). Not only by competing on hard values like price and functionality but also through soft values like emotion and imagination: human values. Tomorrow works for various consumer brands and corporate clients.

Erik de Ruijter

Erik de Ruijter works for the Special Market Solutions division of Imtech Netherlands. He is a business developer and corporate entrepreneur. His past includes similar roles in other large companies as well as 4 high-tech startups (with one currently in the pipeline). His champion is Bjørn Lomborg: which are the priorities we need to set to ensure that like today most things keep improving for most people. Erik can be reached at erik.deruijter@imtech.nl

Eric Voncken

Eric Voncken works for the Building Solutions division of Imtech Netherlands. He is a consultant in energy systems, building physics, sustainability and indoor climate. He was the lead systems engineer on the recently completed Imtech Green Building in Eindhoven, Netherlands (http://imtech.eu/EN/corporate/Newsroom/Press-releases/2011/Official-opening-of-Imtech-Green-Building-in-Eindhoven.html). His inspiration for green engineering and consultancy stems from people like Barack Obama, Harry Schmitz and Jeremy Rifkin. Eric can be reached at eric.voncken@imtech.nl

Evelien Rodenburg

Evelien Rodenburg is an architect at RAU. Her main focus is a holistic approach to projects in order to evolve their sustainable performances as a whole. In her vision a building is to be seen as a living phenomenon, which has an impact on and is influenced by its surroundings and people. Evelien can be reached at evelien.rodenburg@rau.eu

Thomas Rau

Thomas Rau studied fine arts and dance at the Alanus University of Arts in Bonn and architecture at RWTH Aachen University. He has been working as an architect in Amsterdam since 1990. He established RAU in 1992. Social and environmental commitment are at the heart of Thomas Rau's approach to architecture. Thomas Rau is ranked among the Top 100 Dutch key players in sustainability, a list published by national newspaper Trouw and broadcasting corporation LLiNK. He was ranked number one in the 'Green Building' category of the Dutch 'Green.200' ranking by Green.2 magazine. Thomas can be reached at thomas.rau@rau.eu

Sicco Hermsen

Sicco Hermsen is strategic director at Tomorrow. Always thinking from the consumer's point of view is the starting point for every project. The real challenge lies in connecting brands and companies with their target groups by translating a business or marketing strategy into an emotionally-driven concept that always exceeds consumer expectations. Designing is not just about shapes and colors, but also about creating a message that people embrace and then pass on as their own. Sicco can be reached at shermsen@tomorrowdesign.nl

Hans Rietveld

Hans Rietveld is founder and creative director at Tomorrow. Hans supports: sustainable thinking, positive global changes, social responsibility and 361° branding and design. Hans loves: his family, quality, vintage, handcrafts and traveling. Hans dislikes: all bullshit. Hans can be reached at hrietveld@tomorrowdesign.nl

This white paper on creating a perpetually green terminal building has been compiled for Schiphol Group / Climate KIC by Imtech NV, one of the largest European Technical Services Companies, in cooperation with RAU Architecten BV and Tomorrow Design BV.

Authors

Erik de Ruijter and Eric Voncken (Imtech Nederland)
Thomas Rau and Evelien Rodenburg (RAU Architecten BV)
Hans Rietveld and Sicco Hermsen (Tomorrow Design BV)

Contact

For further information please contact one of following people:

Imtech NV
Hans de Groot
Director Key Accounts
hans.degroot@imtech.nl

Imtech Special Market Solutions BV
Luck Westerbaan, Director
luck.westerbaan@imtech.nl

RAU Architecten BV
Thomas Rau
thomas.rau@rau.eu

Tomorrow Design BV
Hans Rietveld
Creative Director
hrietveld@tomorrowdesign.nl