BEM Next lab

The Next Generation of the Built Environment Modelling

BEMNext lab

BEMNext stands for the next generation of Built Environment Modelling (BEM). Built Environment Modelling deals with all forms of computation, modelling, analysis, simulation, optimisation of the built environment in its broadest form during the entire lifecycle. The aim of our lab is to research and develop integrated systems for the complete lifecycle of objects in the built environment. The key is that they will serve the user's processes in the best way possible.

The BEMNext Lab is being led by dr.ir. Jeroen Coenders (assistant professor). ir. Anke Rolvink performs a PhD research on Structural Safety Tools as a PhD candidate.

Mission Statement

Our proposition is that the world of the future can greatly benefit from a new type of (use of) digital technology and computing in the built environment. Our mission is to let the world (the built environment) benefit from these technologies.

The research programme

The future promises great challenges and promises to become evermore complex: space and resources are running out and humanity keeps increasing in number, leading to an increase in density and subsequent problems: housing, mobility, energy; new challenges for reuse, recycling and renovation exist. The world is becoming more complex by greater interconnectivity and interdependence in the physical, virtual and digital world. Computing and especially a smart use of computing might be able to provide solutions and benefits by making use of greater control over large quantities of information, learning from the information, communication, optimisation. The Quantified Self is a great example of people benefitting from digital devices to measure themselves and learning from this information, eventually leading to changes in behaviour and increase of personal health. The built environment can similarly benefit from technology..

Prospectus

Why BEMNext?

Our vision describes a complex and dense world with many interrelationships. Although human-beings are good at solving both small, detailed problems and large, abstract problems by identifying patterns, humans are not very good at overseeing, controlling, managing and communicating large numbers of detailed interdependencies. Unfortunately, this is the characteristic design, engineering and construction is all about: the processes we use to modify our built environment.

Fortunately, digital technology and computers are good at holding and processing large volumes of complex data. So there is an opportunity to bring these two worlds together: human beings can potentially use digital technology to assist their own design, engineering and construction processes to overcome some of the challenges. Furthermore, digital technology has recently proven (such as the 'Quantified Self') to be beneficial by changing human behaviour in the right direction. We only have to find out how to address these challenges.

How BEMNext?

Our mission states that we believe that technology provides us with answers to these challenges for our planet. For example, optimisation can lead to smarter design with less material and therefore more sustainable solutions suitable for the future. Or, parametric and associative logic can help to map and break down complex relationship in order to come to a deeper understanding of design.
Below we will list some additional areas and explain how we envision digital technology, in a new 'BEMNext form', can help.

Connected world

Almost nothing in our current world can be seen as independent anymore. The world around us has changed and will continue to change by for example the interdependence that the built environment has in time and the fact that it is shaped through construction. Objects including the built environment are becoming more and more connected in realtime. Initiatives and concepts such as Smart Cities, the Internet of Things, the Internet of Everything, Quantified self, Quantified cities, etc. proves this point. On the one hand this might look like a challenge because digital technology and IT is impacting our lives in every facet. The fact that data and interconnected devices are constantly around us, perhaps even are partial autonomous, gives opportunities for new forms of optimisation, changes in behaviour, better understanding through more measurement opportunities (and available data) and real-time (or delayed) feedback on our decisions.

BEMNext takes 'the connected world' as a starting point for further research into the technologies available, how to exploit them, but also how to make sure that they can interconnect on a more fine-grained level.

What does BEMNext look like?

We envision a new generation of software that will be comparable with the move from personal computing to the internet. The vision is for software that is continuous, contains all data about the environment and is real-time and connected to the physical reality, which will be modelled, simulated and analysed in parallel. Next to the physical reality, many alternative virtual realities can exist in parallel which can be utilised for a variety of purposes. Time is variable on these realities. Time can be played backwards to observe data from the past or can be played forward in order to obtain predictions about the future potentially in multiple scenarios. Project-based modeling will no longer exist, but will be dealt with as an 'alternative reality' that will be analysed and/or simulated in parallel to the physical reality and can provide predictions about the impact a 'project' will have on its environment and how the design will function in its context.

The transition from BIM/BIMNext and BEM towards BEMNext

Our roadmap, shown on the next page, ends with the transition from BIM, BIMNext and BEM technology to the BEMNext technology of the future. Below table summarises the changes from the future state of BIM/BIMNext/BEM to the BEMNext generation of software.

Characteristics	BIM/BIMNext/BEM	BEMNext
Modeling scope	Project-based modeling	Continuous model
Analysis scope	Ad-hoc project-based analysis	Continuous analysis
Data scale	MB or GB	Big Data: TB, PB, etc.
Data	'Dead data'	Realtime data
Hardware	Desktop	Cloud
Knowledge	Project-specific	Project-overarching

Table 1.1 The technology transition from BIM/BIMNext/BEM to BEMNext

Continuous models with continuous and real-time analysis and simulation

We envision that BEMNext models 'exist' rather than 'are created' meaning, that there is an (IT) infrastructure that runs somewhere in "the cloud", potentially centralised, potentially distributed, that contains the data and models of realities and real-time analyses and simulates these realities. This will require a new type of infrastructure that will need to be researched and developed.

From the earliest stage (optioneering) towards the physical environment

Although we envision that project-based modeling will have no relevance anymore, we foresee that project-based working will still exist as new buildings and other objects in the environment will need to be conceived in the physical reality. As stated, these 'projects' will be seen as alternative realities that simulate an intervention in the current (or future extrapolation of the) physical reality. The BEMNext systems will need to support these interventions from the earliest inception/conception stages when designers are optioneering all the way to the point in time when they merge data from the physical reality.

Big Data

The data involved in BEMNext will be Big as in Big Data. Currently, models in the Architecture, Engineering and Construction (AEC) industry often span MegaBytes or perhaps GigaBytes in case of GIS or laserscan-data, but BEMNext will produce and handle TeraBytes, PetaBytes or perhaps even bigger. This will require new technology to store and handle this data, new types of analysis and simulation

Exploiting optimisation

At BEMNext we utilise optimisation for two purposes: mainly for its searching, finding and exploring capabilities, but also to find 'real' optima in multi-disciplinary problems.
There are great opportunities in this technology to help solve some of the challenges we face: we can minimise materials, energy, but also search for solutions that provide a good trade-off between design aspects. This, in turn, leads to better design solutions that might last longer and waste less. However, we can also utilise this technology to explore: we might not be seeking purely for the 'most mathematically optimal solution', but for knowledge to base our decisions on. BEMNext technology will be able to help designers in the future to explore ideas and directions of reasoning by providing them data of their performance. Not as optimisation is now, often an academic exercise of a few preconceived aspects, but as an exploration on the scale of many aspects based on many performance analyses and simulations of many alternative realities.

User-centric design

What many current software applications for the design and engineering industry are still lacking is user-centric design. The software applications have often been built around the invention of a new method of solving a problem (e.g. matrix solution methods in case of Finite Element Analysis modeling or the single-directional solution graph processing in parametric and associative design systems). However, for successful and large-scale adoption of technology it is essential that users (designers, engineers, but also contractors, workers, etc.) can make the transition to the new technology. BEMNext technology therefore aims to be designed in a user-centric manner, meaning that the user and his or her processes are studied and translated to software instead of the other way around.

Is it a system? Infrastructure? Software? Or the cloud? Will it work on my iPhone?

We don't know exactly what it will look like, but that is what the research is all about. We know our vision, we know some of the key characteristics of the technology, but the research we will perform over the coming years will prove which form the technology will take.

Research focal areas

The BEMNext lab research programme focusses on a number of key areas ('the four pillars'):

1. Design and Engineering Computing
2. Information Management
3. IT Infrastructure Technology
4. Open-source

It needs to be noted that our focal areas do not span the entire roadmap towards the vision of BEMNext: we cannot do everything at the same time. We need to focus. The roadmap combined with our past experience guides this focus. These are the first steps we are taking towards our goal.

The roadmap in time

This table contains the roadmap and the envisioned time frame in steps of 5 years.

Roadmap	Technology transition
2011 - 2015	From BIM to BIMNext
2015 - 2020	BIMNext maturity
	The rise and broadening of BEM: from BIMNext to BEM
	The first light of BEMNext
2020 - 2025	BEM maturity
	The rise of BEMNext: from BEM to BEMNext
2025 - 2030	**BEMNext maturity**

Table 1.2 The roadmap in years