Towards the smart structure by nature
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An On-Line Interview with MARTIN HEMBERG, formal teacher in the Architectural Association (AA), London, part of the current staff for Master Programme in Emergent Technologies & Design (EMTECH: http://www.aaschool.ac.uk/et/) and the creative mind behind the GENR8 research in the MIT.

Saying that I'm the "creative mind" behind the Genr8 research is probably giving me too much credit. I developed an idea (and filled in a lot of details) that was conceived mainly by Una-May O'Reilly and Peter Testa.

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QUESTION nº 1

After the inclusion of plug-ins like GENR8 to the modelling phase this has acquired a multiple potential (related to matter, design, and structure as a single way of thinking) by combining transversal disciplines into the generation process of a given project, the collaboration between different disciplines its a must. In the AA you have professional guides like Wolf Mangelsdorf actual engineer of Buro Happold and George Jeronimides, an expert in biomimetics. So, How or in what way are you introducing "biomimetic-enginieering" dimensions to the actual formation of your students so that they can recognize in the modelling phase this multiple potentials and the same time recognize possible restrictions that models bring with them? Are you using some kind of CAE software in the step before the actual prototyping?

I'll start by giving you a brief summary of the development of Genr8. Both me and my principle advisor (Una-May O'Reilly) are mainly computer scientists/mathematicians without much of a background in structural engineering.

Thus, we decided to focus solely on form and not care about structural or material properites at all. Needless to say, the first thing architects ask about are the aforementioned. Now there are two ways one can think about this issue. On the one hand it can be seen as a short-coming of the tool and that there is a serious aspect of design missing in the form generation process. The second, more constructive view, is to take this as an opportunity. Since the tool does not impose any constraints on the structural considerations, the user can impose his own ideas. Achim Menges of the AA pioneered the idea of using other softwares (Rhino) to perform an external analysis. Later he was able to use the results of the analysis to modify the parameters of his Genr8 runs. This is quite a difficult procedure, but in my experience it is a very rewarding way of working with the tool. So far, the students keep surprising me when they come up with new ways of using Genr8. I don't think that there is "the best" way of using it and I prefer to have them explore new methods rather than telling them up front about what people have done before.

In the current curriculum the Genr8 studio comes before the structural analysis/biomimetic stuff, so the students haven't covered those fields in depth. Instead I try to focus on teaching them about evolutionary algorithms and growth models (since that's what I know best).The goal is of course that the students should integrate what they learn from all the modules but for the moment, there are no obvious connections (such as joint teaching sessions) between these two aspects of the programme. It would of course be great to have, but there is only a finite amount of time for each module. If I were to become more involved in the field of architecture, one of the first things I'd do would be to learn more about structural and material engineering so that I could integrate those aspects better in my teaching and future design tools.

QUESTION nº 2

When working with a plug-in like GENR8, that incorporates languages of growing surfaces in an organic way, as a consequence (not finality) of a combination of 3D map-L systems extended to abstract conditions of physical environment, Would it be possible to assure the gestation of surfaces that are structurally optimal from the very beginning taking as a base these languages of adaptative evolution?, And if so is the case, Would it be possible to edit these surfaces (trim, cut, project) without compromising neither loosing their structural integrity towards a possible transposal into a physical model?

Well, optimality is quite a tall order. But in principle you are correct. I think that the it would be quite hard to introduce structural considerations in the growth

language. It would be easier to incorporate it on the level of fitness evaluation. In practice it means that in addition to the form-related fitness criteria there would also be parameters determining the structural and material properties of the evolved surface. Unfortunately, I can't give any more details at this point as I would have to read up quite a bit on structural engineering first.

Due to the complexity of the mapping from genotype to phenotype (growth specification to actual physical form) it is all but impossible to reverse the process. That is, there is no way of finding the L-systems specification of a surface in general. Having said that, there is no way of allowing a user to directly interact with the output and have those changes mapped back into the evolutionary system (you can do that with the evolved re-write systems).

But if one chooses to put the structural considerations at the fitness evaluation stage as suggested above, then it should be possible to use the same evaluation criteria for surfaces that have been hand modified. Thus it would be possible to search the space of possible surfaces ' by hand'. This would of course be very time-consuming, but also very useful to put the final touch on an evolved surface.

QUESTION nº 3

The surfaces generated using GENR8 are of a highly “heterogeneous nature” based in its own adaptable structure morphology to these abstract conditions of physical environment. How does this “heterogeneous nature” faces a phase of cheap, massive and low energetic-impact production in regards to the chosen material, the production method and its utter mounting process?, Or is this heterogeneity solved from the beginning using robotic processes like CNC or laser-cutters as the only choice?

As with the structural aspects that I discussed above, there was not much considerations of physical production when we developed Genr8. We knew about CNC milling and laser cutting but we did not pay much detail to those aspects and instead we focused on the form generation. Some of the students have tried to manufacture surface and as with the structural analysis; the solutions are typically very creative.

QUESTION nº 4

What construction methods and performative criteria would you recommend in order to understand the pure morphology of this highly heterogeneous models?. I’ve been reviewing the models done using

GENR8 , like the ones of Jordi Trucco (2001) and Elisa Simonetti (2002), where there is an intention of keeping in the material translation the heterogeneous density informed by the digital models, but to my opinion, they were reducing ways of translating all that morphologic intensity because they used typical commands like rebuild, cross section and lofting, in softwares such as Rhino or Studio Tools. Much more than “adding material where is needed”, the techniques used in these cases are the same as used in a general tectonic translation of digital models as we are used to, more in a “mechanical way”, not in a “machinic way” mentioning to Greg Lynn. Do you think that all this new possibilities of form-finding should go along with new methods of translation, like for example, the potential of subdivision surfaces found in Alias/Wavefront´s MAYA 6 or another ones that encapsulate this intensive manipulation in a design process?

I find it hard to give general advice about choosing performance criterion. Moreover, my experience from the studios at the AA is that it's an important decision. The most successful projects tend to be the ones where the student has a goal in mind an agenda when he or she starts using Genr8. It is important to choose your performance criterion in relation to the goals of your project. If you just let Genr8 run, it will create more forms than you can ever analyze. Thus, you must come up with a strategy of how you want to use the tool and figure out a way to analyze the output and feeding the result back in to Genr8 (by changing parameters or the environment). In that way you can set up a creative feedback loop between yourself and the software. The important leap of faith that many students are reluctant to take is to give up some of the control of the design process and leave it in the hands of Genr8. On the other hand, you must make sure that you prod the tool in the right direction as it is unable to find good designs on it's own without proper guidance from the user.

QUESTION nº 5

Today it is GENR8, and it seems that the future relies in the generation of solids under evolutive logics. Do you know if there is any plug-in being developed for a software such as Solid Works, that allows the design of solids in this “Organic Fashion”, (i.e. often related to Boolean operations) and that allows the finite element analysis and the linkage with material properties in the process?

As far as I know, there are no other plug-ins in the spirit of Genr8 being developed. As far as the EDG at MIT is concerned, it is no longer active since the head of the group, Peter Testa has left MIT to take up a practice in LA. I know that there are still people (eg Axel Killian) at MIT developing tools, but as far as I know, they are not collaborating as intensly with computer scientists anymore.

I don't know of any commercial endeavours that are related to Emergence in design softwares (well, there's a flocking algorithm in MAX which is a start at least). It's probably something of a gamble for a big company, but I believe that such methods are going to become more mainstream in the future. I think the main problem is that there is no coherent theory for how to create shapes using evolutionary/generative techniques and thus I think that the development is going to be in the form of plug-ins for a few more years. This is not as bad as it sounds, writing a plug-in is comparitively easy and the API of Maya provides the developer with a lot of functionality.

QUESTION nº 6

All this revolution around the use of the genetic algorithm in design processes it seems to point in a quite near future to the design of buildings that are integrally optimal, as a consequence, light and of a maximum performance. The concept of Lightness in the architecture field, mucho more than minimizing the dead loads of a certain structure, makes us think in the use of new materials and production technologies, in new ways of minimizing the energetic consumption and to a pre fabrication light as well, environmentally friendly.
Under this perspective, What potentials do you see in the *Emergence* concept in order to be in tune with the *Lightness* concept?

The driving notion of Emergence is that the global behavior of a system should the result of local interactions. This implies that one should think in bottom-up terms rather than the more traditional top-down way. The way I see it, Emergence is more a mindset than an actual technique for design. Thus, I don't see any problems combining Lightness and Emergence, on the contrary it sounds like an interesting marriage of notions.

QUESTION nº 7

Have you thought in new features for a possible upgrade of GENR8?
I ask you this, because the own growing nature of the plug-in, involves evolution, meaning a great time leap and so a change in the

morphology of the surfaces in each evolutive step, a Typologic variation. I was asking myself if its possible to think on a way to adapt this optimization potential and fitness criteria that GENR8 has, also for a branch of time more immediate, in a smaller fluctuation of time (in effect, real-time); that allows a Topologic variation of a surface, maybe using the timeline in Maya, so one could animate the intensity of attractors, repellors, boundary conditions and gravity, or another variables and be able to monitoring their immediate changes in this abstract environment conditions. Something like the “SOFT BODIES” in MAYA6, that link the dynamic handle of surfaces in relation to force fields in a respective time lapse. All this in order to link self-organization with self-generation in a even closer way.

Let me try to rephrase your questions:
1)Would it be possible to change Genr8 so that one can alter the environment during the growth to make the growth more dynamic?

I have thought a bit about this issue and it's something that I'd like to explore further. I call this concept a dynamic reactive growth environment and it's something that I'd like to explore and try out in a design tool (although I can't fathom when I'd have time to sit down and do it). I have a list of possible extensions and future developments of Genr8, but I haven't got any plans for actually implementing them. At the moment I don't think it's necessary since there's untapped potential in the current version of Genr8. Furthermore, it would probably be more rewarding to develop something completely from scratch in order to make quantum leap rather then an incremental development.