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FINAL DECLARATION OF THE "1ST WORKSHOP ON BIODESIGN AT THE INTERSECTION OF CREATIVITY AND BIOENGINEERING"

("YARATICILIK VE BİYOMÜHENDİSLİK ARAKESİTİNDE 1. BİYOTASARIM ÇALIŞTAYI"NIN FİNAL DEKLARASYONU)

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ABSTRACT

This paper contains the final products and ideas of "1st Workshop on Biodesign at the Intersection of Creativity and Bioengineering" organized within 7th Bioengineering Congress.

Keywords: Bioengineering, Architecture, Biodesign

ÖZ

Bu yazı, VII.Biyomühendislik Kongresi bünyesinde gerçekleşen "Yaratıcılık ve Biyomühendislik Arakesitinde 1. Biyotasarım Çalıştayı"nda üretilen fikirleri ve atölye sonuçlarını kapsamaktadır.

Anahtar Kelimeler: *Biyomühendislik, Mimarlık, Biyotasarım*

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1. INTRODUCTION

This pioneering multi-disciplinary workshop was organized as the first of its kind in Turkey to create collaborative, hands–on projects at the intersection of bioengineering and design, materializing artworks, prototypes and architectural concepts that harness living materials and bio-processes, presenting bio-integrated approaches to achieve sustainability and innovations enabled by biotechnology.

The workshop was held on 19-21 November 2015 in Izmir Architecture Center in conjunction with 7th International Bioengineering Congress (BEC2015). An interactive and creative platform was built by the group of participants of 6 architects and 11 bioengineers: Aylin Şendemir Ürkmez, Özge Andiç Çakır, Suphi Öncel, Didem Akyol Altun, Gülden Köktürk, Ayça Tokuç, Irem Deniz, Tuğba Keskin-Gündoğdu, Bahar Aslanbay, Eyüp Bilgi, Burcu Filiz Demirci, Aslıhan Kazan, Bora Örgülü, Pelin Sağlam Metiner, Umut Doğu Seçkin, Atakan Tevlek and Selma Uzunoğlu.

The facilitators of the workshop were from various professions that deal with the built environment and biodesign. On the first day, the facilitators made presentations that included both the basic subject matter and their state of the art research.

Assoc. Prof. Dr. Özge Andiç Çakır presented the problem of cracks in concrete buildings, and self-healing systems for restoring these cracks using biological interventions inspired from the vascular system of living organisms and encapsulation of biological healing agents, i.e. bacteria. The main challenge in this method is to find the most appropriate bacteria with $CaCO_3$ precipitating characteristics, which is resistant to extremely high pH of cement hydration products. Mechanism of action is that the bacteria produce calcium carbonate due to its metabolic activity with urea, thus the selected bacteria should be able to perform long term viability inside the high pH concrete pore solution. Growing concrete (also called bioconcrete) was defined as a layer of calcite precipitating bacteria which allowed to grow by supplying more nutrient from the outside. The calcite precipitation was shown to continue and grow while forming different shapes depending on the outside effects; moisture, temperature, etc. Application of that technology was discussed to be applied to durable roads, bridges, buildings, and also hard-to-reach areas, such as powerplants. She also gave ideas of green roofing which is a layer of mosses allowed to grow due to the nutrient media provided by biological concrete.

Assist. Prof. Dr. Aylin Şendemir Ürkmez gave her speech on bioinspiration and biomimetics in biomedical applications. Bioinspired and biomimetic materials were identified. Examples to how nature achieves various microstructures through exceptional levels of complexity were presented with the ideas of how we can use these samples inour daily lives with brain storming. Dictating cellular responses and cell-to-cell communication with engineered micro-environment were shown to have enormous implications for cell biology, regenerative medicine and tracking the fate of transplanted cells in cell therapy, as well as biosensor applications. A combination of hierarchical topographies could be used to differentially functionalize implants for distinct applications, or demarcate particular “zones” within a single device. Patterned differentiation to produce functional devices was highlighted as crucial.

Assoc. Prof Dr. Suphi Öncel made his presentation titled "From photobioreactors to green walls: Microalgae as a green volunteer for energy efficient buildings and a design element in architecture". Microalgae was identified and then production techniques of algae were discussed. Photobioreactors used for microalgae production were classified. Real life building applications of microalgae were given from different countries.

Assoc. Prof. Dr. Didem Akyol-Altun presented her speech on responsive environments and living architecture. The term of biomimetic was discussed again with the idea of inspiration from natural shapes, processes and ecosystems, in order to innovate in a sustainable way. The early studies at the intersection of biology and architecture were defined and computer programming for parametric designs were presented. Some examples of biomimetic studies (such as Biostructure Game Park and Genetic Barcelona Project by Alberto Estevez, Digital Botanic Architecture by Dennis Dollens, Fab tree Hab by Mitchell Joachim) were also given. Nanotechnology and new biomaterials used in architecture were described. The responsive architecture was defined as a class of architecture or building that demonstrates an ability to alter its form, to continually reflect the environmental conditions by adapting their form, shape, color or character responsively. These example were discussed in possibility of a living architecture that could generate by itself in the future.

Assist. Prof. Dr. Gülden Köktürk's presentation was on protocells which can be described as small peptides that can be placed on RNA to vesicle membranes by electrostatic interaction. The generation of the protocell hypothesis was defined and several videos were shown to make the participants understand the subject. The development of the Amoeba shoe has been shown which is thought to be produced as a tangible protocell shoe for 2050. The effect for the athlete that use Amoeba shoe was shown to synchronize to the individual foot exploiting protocell responsive and reconfigurable properties, adapting in real time to the current activity of the runner by adding extra support in high impact areas. On the other side Venice Projects, developed by Rachel Armstrong and partners, were given as a promising sample for protocell applications of the living architecture in the future.

After the brainstorming on the first and second days of the workshop, more than 10 different ideas discussed and among them, 3 projects were found to be promising and applicable. These ideas were developed furthermore to be presented.

1.1. A Biopolymer Bench/Arbour Structure

The first idea was on using biopolymers as furniture, interior decoration or landscape architecture. A creative design can be used as a sitting bench or an arbour in a park (Figure 1). The scaffolding material of this creative structure can be build by PBS (Poly Butylene Succinate). PBS and its copolymers are a family of biodegradable polyesters synthesized from succinic acid. Succinic acid can be produced through fermentation by bacteria isolated from ruminant animals converting glucose to succinic acid. Biotechnologically produced PBS is replacing the chemically produced PBS. PBS can be substituted by many plastic products such as PET (Polyethylene tetraphtahalate), PP (Polypropylene), PS (Polystyrene) etc.

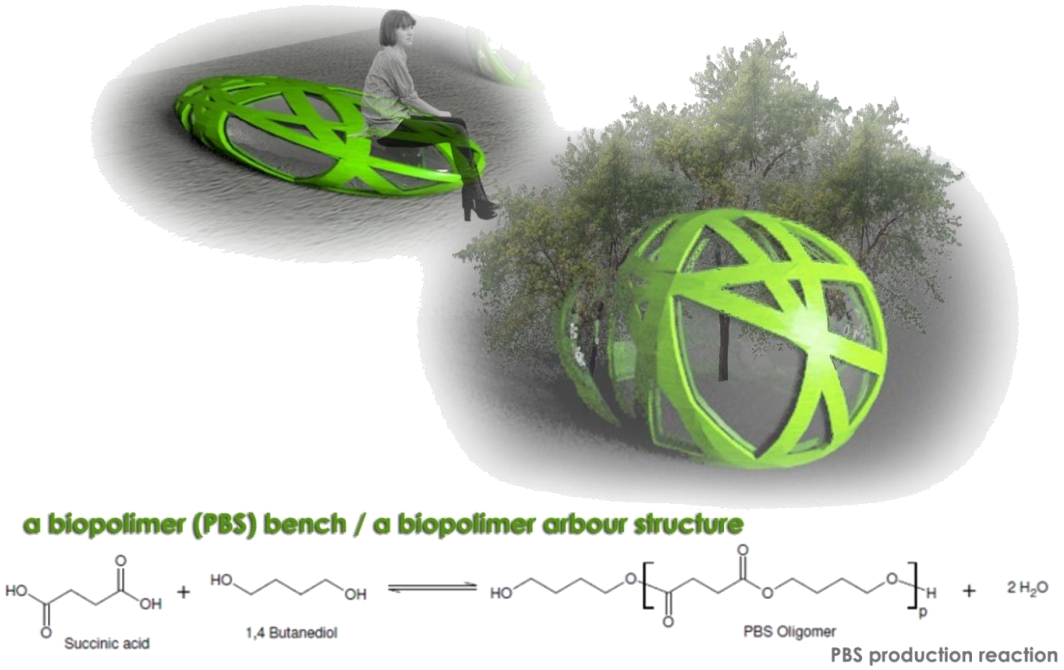

Figure 1. A PBS based sitting bench or an arbour

1.2. Illuminating Izmir Railway Map/Illuminating the Urban Areas with Slime Mold/Illuminated and Living Facade with Slime Mold

Slime mold is an informal name given to several kinds of unrelated eukaryotic organisms that can live freely as single cells, but aggregate together to form multicellular reproductive structures. Although not related to one another, they are still sometimes grouped for convenience within the paraphyletic group referred to as kingdom Protista.

More than 900 species of slime mold occur all over the world. Their common name refers to part of some of these organisms' life cycles where they can appear as gelatinous "slime". This is mostly seen with the myxogastria, which are the only macroscopic slime molds. Most slime molds are smaller than a few centimeters, but some species may reach sizes of up to several square meters and masses of up to 30 grams.

Physarum polycephalum, literally the "many-headed slime", is a slime mold that inhabits shady, cool, moist areas, such as decaying leaves and logs. Like other types of slime molds, it is sensitive to light; in particular, light can repel the slime mold and be a factor in triggeringspore growth.

The third group of ideas is based on using this strain for illuminating Izmir Railway (Figure 2) and the urban areas such as cycle path, pedestrian path and roads.

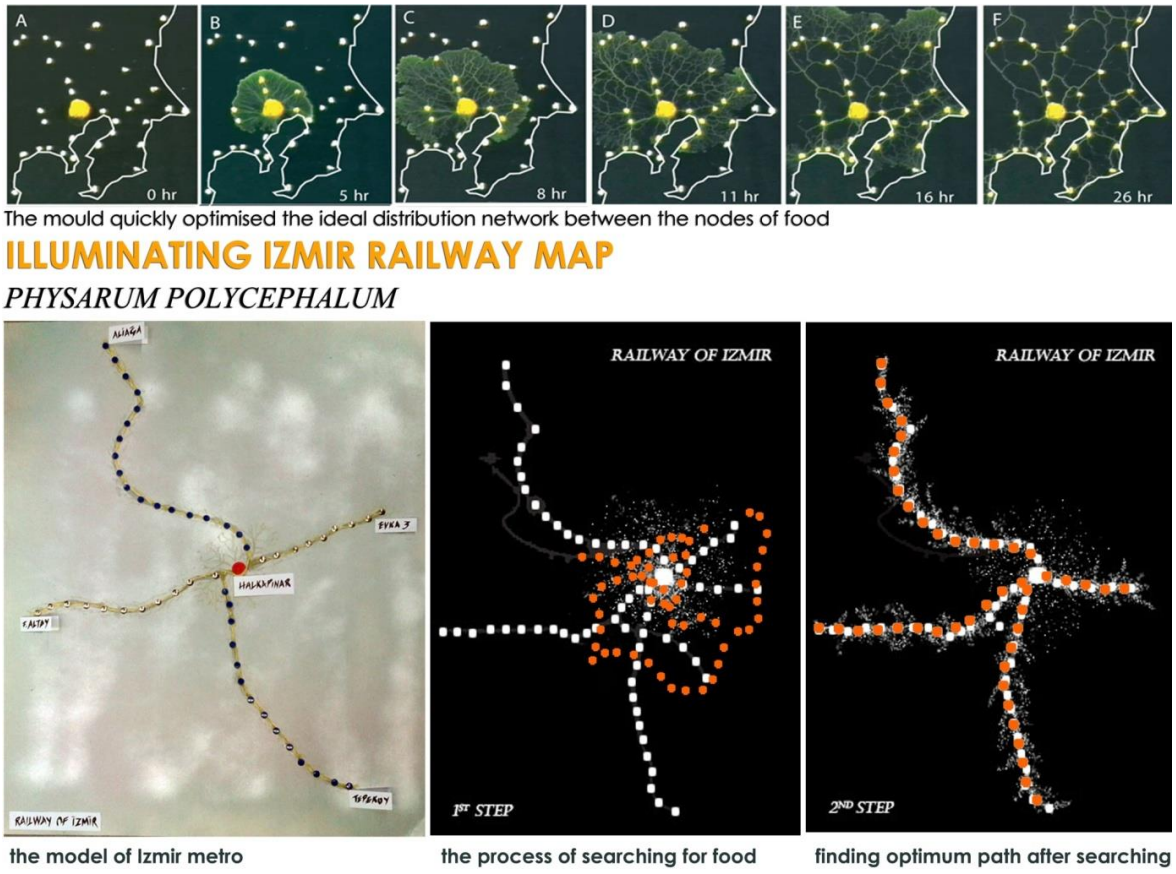

Figure 2. Illuminating Izmir Railway Map

An illuminating gene from lightening bug can be isolated and transfected to ***Physarum polycephalum***. The feeding medium for this strain will be distributed through stations of Izmir metro and the pathway will be illuminated by the growth of this recombinant strain. Or the same idea will be used for illuminating the urban area in dark times of the day (Figure 3).

Figure 3. Illuminating the urban area with slime mold

The last feasible idea was based on using slime molds on buildings to create living façades and decorations (Figure 4).

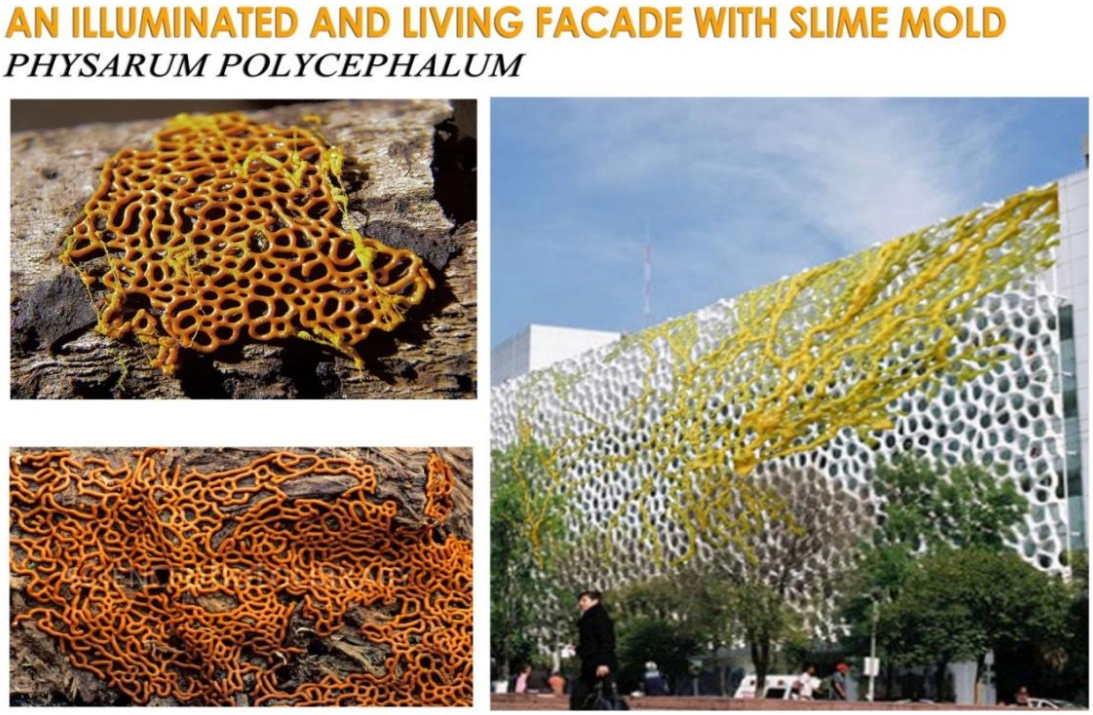

Figure 4. Illuminated and living facade with slime mold

The three days provided an interactive platform for bioengineers and architects for brainstorming and bridging the gap between the two disciplines in pursuit of creating innovative, biotechnology based solutions for architectural challenges. In conclusion, 3 main projects were created and 3 prototypes were presented in this workshop: a playground area for children, a biopolymer bench and illuminated creative designs with slime mold. The works from the workshop was presented during the closing session of the BEC2015. These projects were found to be applicable and industrializable to be commercialized. Thus, the members of this group are eager to gather and discuss more about the applicability and product development necessary for commercialization of these promising projects.

Note:

This multidisciplinary creative platform will be preserved and flourished for future collaborations and contemplated fruitful endeavors. Moreover, the preperations for the "2nd Workshop on Biodesign at the Intersection of Creativity and Bioengineering" has started. You can contact us at iremdenz@gmail.com and keskin.tugba@gmail.com

ÖZGEÇMİŞ/CV

İrem Deniz; Research Assist. (Ar.Gr.)
She was graduated from Ege University Bioengineering Department in 2008. She took her MSc degree in 2011 from Ege University Bioengineering Department and she is continuing her PhD program since 2012 at the same department. She is currently working as a research assistant at Ege University Bioengineering Department. Her research interest mainly focuses on Bioprocess, Bioethanol Production, Enzyme Applications, Bioengineering and Purification Technologies.

Lisans derecesini 2008'de, yüksek lisans derecesini 2011'de Ege Üniversitesi Biyomühendislik Bölümü'nden aldı. 2012'den beri aynı bölümde doktora çalışmalarına devam etmekte ve aynı kurumda araştırma görevlisi olarak çalışmaktadır. Çalışma alanları biyosüreçler, biyoetanol üretimi, enzim uygulamaları, biyomühendislik ve saflaştırma teknolojileridir.

Tuğba Keskin Gündoğdu; Research Assist. Phd (Ar.Gr.Dr.)
Dr. Tugba Keskin Gundogdu
She was graduated from Hacettepe University Chemical Engineering Department in 2004. She took her MSc degree in 2007 from Ege University Bioengineering Department and she completed her PhD degree in 2013 at same department. She is currently working as a research assistant at Ege University Bioengineering Department. Her research interest mainly focuses on Environmental biotechnology and bioenergy applications such as biogas production,biohydrogen production and also bioengineering.

Dr. Tuğba Keskin Gündoğdu 2004yılında Hacettepe Üniversitesi Kimya Mühendisliği Bölümü'nden mezun olmuştur.2007yılında Ege Üniversitesi Biyomühendislik Bölümü'nden yüksek lisans derecesini almış ve aynı bölümde 2013 yılında doktora derecesini tamamlamıştır. Halen Ege Üniversitesi Biyomühendislik Bölümü'nde Araştırma Görevlisi olarak çalışmaktadır. Araştırma konuları daha çok biyogaz üretimi, biyohidrojen üretimi ve biyomühendislik olmak üzere çevre biyoteknolojisi ve biyoenerji üzerine yoğunlaşmıştır.

Ayça Tokuç; Assist. Prof. Dr. (Yrd.Doç.Dr.)
Lisans derecesini 2001'de Orta Doğu Teknik Üniversitesi Mimarlık Bölümü'nden, Yüksek Lisans derecesini 2005'de Dokuz Eylül Üniversitesi Mimarlık Bölümü'nden, Doktora derecesini 2013 yılında Dokuz Eylül Üniversitesi Mimarlık Bölümü'nden aldı. Halen Dokuz Eylül Üniversitesi Mimarlık Bölümü'nde öğretim üyesi olarak görev yapmaktadır. Temel çalışma alanı sürdürülebilir tasarımın bina ve toplum ölçeklerini de içeren farklı ölçeklerde kavramsal ve uygulamalı araştırılmasıdır. Diğer ilgi alanları arasında Düşük Enerji Mimarisi, Yenilenebilir Enerji, Enerji Etkinliği, Isıl Enerji Depolama, Karbon ve Yenilikçi Tasarım bulunmaktadır.

She got her bachelors' degree in the Architecture Department at Middle East Techical University, Ankara/Turkey in 2001, her M.Sc. degree in the Architecture Department at Dokuz Eylül University, İzmir/Turkey in 2005, PhD. degree in the Architecture Department at Dokuz Eylül University, İzmir/Turkey in 2013. She is still an academic member of the Department of Architecture at Dokuz Eylül University. Her research examines sustainable design as both a concept and in implementation in various scales including building and community scales. Her other areas of interest are: Low Energy Architecture, Renewable Energy, Energy Efficiency, Thermal Energy Storage, Carbon, and Innovative Design.

Aylin Şendemir-Ürkmez; Assist. Prof. Dr. (Yrd.Doç.Dr.)
She has received her B.S. degree at Mechanical Engineering (1994), M.Sc. degree at Biomedical Engineering (1997) from Bogazici University, Turkey, and PhD. degree at Materials Science and Engineering (2006) from University of Illinois at Urbana-Champaign, USA. She has been working as an assistant professor at Ege University Faculty of Engineering, Bioengineering Department since January 2009 and currently the principal investigator at Ege Research Group of Animal Cell Culture and Tissue Engineering (EgeREACT). Her research interests include interactions of animal cells and biomaterials, tissue engineering, mechano-transduction, stem cells, cancer stem cells and biocompatibility testing. She is also interested in design and production of novel *in vitro* disease models in order to minimize animal testing. She has co-authored more than 20 scientific papers, 2 patents and 3 book chapters. Assist. Prof. Dr. Aylin Şendemir Ürkmez is a member of the Editorial Board of Challenges in Regenerative Medicine.

Lisans derecesini Boğaziçi Üniversitesi Makine Mühendisliği (1994), Yüksek Lisans derecesini ise, Boğaziçi Üniversitesi, Biyomedikal Mühendisliği (1997) bölümlerinden almış olup, doktorasını Illinois at Urbana-Champaign Üniversitesi, Malzeme Bilimi ve Mühendisliği (2006) bölümünde tamamlamıştır. 2009 yılının Ocak ayından itibaren, E.Ü., Mühendislik Fakültesi, Biyomühendislik Bölümü'nde Yrd. Doç. Dr. unvanıyla çalışmakta olup, Hayvan Hücre Kültürü ve Doku Mühendisliği Araştırma Grubu (EgeREACT)'ın yürütücülüğünü üstlenmektedir. İlgi alanları arasında, hayvan hücreleri ile biyomalzemelerin etkileşimleri, doku mühendisliği, mekano-transdüksiyon, kök hücreler, kanser kök hücreleri ve biyouyumluluk testleri yer almaktadır. Ayrıca, hayvan denemelerinin minimize edilmesi amacıyla, in vitro hastalık modellerinin dizayn ve üretimiyle ilgilenmektedir. 20'den fazla bilimsel makale, 2 patent ve 3 kitap bölümünün eş yazarlığına sahip olmakla birlikte, Yenileyici Tıp'taki Zorluklar (Challenges in Regenerative Medicine) adlı derginin editörlüğünü yapmaktadır.

Gülden Köktürk; Assist. Prof. Dr. (Yrd.Doç.Dr.)
She graduated as an electrical-electronics engineer from Dokuz Eylul University (1988), received her M.Sc degree (1992) and Phd degree (1998) in same department. She is still an assistant professor at Dokuz Eylul University, Department of Electrical and Electronics Engineering. Her research interest include photobioreactors, biomedical applications, sustainable technologies and architecture and she have many national and international papers about this topics. She also works as reviewer and as an editor in different international academic journals.

Lisans derecesini 1988'de, yüksek lisans derecesini 1992'de ve doktora derecesini 1998'de Dokuz Eylül Üniversitesi Mühendislik Fakültesi Elektrik ve Elektronik Mühendisliği Bölümü'nden aldı. Hala aynı kurumda öğretim üyesi olarak çalışmakta ve farklı ulusal-uluslararası dergilerde editörlük görevlerini sürdürmektedir. Çalışma alanları fotobiyoreaktörleri, biyomedikal uygulamaları, sürdürülebilir teknolojiler ve mimarlık ilişkisidir.

Özge Andiç Çakır; Assoc. Prof. Dr. (Doç.Dr.)
She is currently associate professor at Ege University Civil Engineering Department with degree of PhD in materials of construction. She has been Vice Director of Ege University EBILTEM-TTO since 2013. She has been the supervisor of many national projects in the field of building materials and sustainable materials technologies for eight years and has more than 50 publications. Her research interests are functional concrete design and technology, aggregates, bio-inspired materials, energy efficient and sustainable building materials. She has participated in several collaborative projects including ee-WiSE and nEBULA project funded under EU FP7 and ERASMUS+, respectively. She also has valuable experience in technology transfer, organization and development of dissemination activities like conferences, seminars, workshops, etc.

Ege Üniversitesi İnşaat Mühendisliği Bölümü'nde öğretim üyesi olarak çalışmasının yanı sıra 2013'ten veri Ebiltem Teknoloji Transfer Ofisi'nin müdür yardımcılığı görevini sürdürmektedir. Yapı malzemesi ve sürdürülebilir malzeme teknolojileri alanında pek çok ulusal proje yürütücülüğünün yanı sıra 50'yi aşkın makalesi mevcuttur. çalışma alanları işlevsel beton tasarımı ve teknolojileri, agregalar, biyo esinlenmeli malzemeler, enerji korunumu ve sürdürülebilir yapı malzemeleridir. Bunun yanı sıra ee-WİSE, nEBULA gibi Avrupa 7.Çerçeve Programı ve Erasmus + kapsamındaki çeşitli işbirliği projelerinde yer almaktadır. Ayrıca teknoloji transferi ve konferans, seminar, çalıştay gibi organizasyon düzenlemelerinde deneyimleri çok sayıdadır.

Didem AKYOL ALTUN; Assoc. Prof. Dr. (Doç.Dr.)
She graduated as an architecture from Dokuz Eylul University (2000), received her M.Sc degree (2003) and Phd degree (2010) in same department. She is still an associate professor at Dokuz Eylul University, Department of Architecture. Her research interest include genetic architecture, protocell, biomorphological design, adapting of bioengineering in architecture. She have many national and international papers about bio-design and related topics. She also works as reviewer and as an editor in different international academic journals and have many prize in architectural competitions.

Lisans derecesini 2000'de, yüksek lisans derecesini 2003'de ve doktora derecesini 2010'da Dokuz Eylül Üniversitesi Mimarlık Fakültesi Mimarlık Bölümü'nden aldı. Hala aynı kurumda öğretim üyesi olarak çalışmakta ve farklı ulusal-uluslararası dergilerde editörlük görevlerini sürdürmektedir. Çalışma alanları bilim ve mimarlık ilişkisi, biyotasarım, dünya fuarları, kapalı konut siteleri olup bir çok mimari proje yarışmasında ödülleri bulunmaktadır.