Guest Editors' Introduction: Synthetic Biology

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Synthetic biology is trending, as evidenced by the recent achievements in biofuels (microbial production of diesel fuels from fatty acids in Escherichia coli (*E. coli*) and yeast) and in biotherapeutics (microbial production of artemisnic acid as a viable source of antimalarial drugs). The International Genetically Engineered Machine (iGEM) competition in 2011 had over 165 teams and 1000+ undergraduate participants from around the world. Synthetic Biology had a global market which generated $233.8 million in 2008. This is expected to increase to $2.4 billion in 2013. Synthetic biology alone had a chemicals and energy segment worth $80.6 million in 2008 with a projected growth to $1.6 billion in 2013. Synthetic biology is here to stay.

Handcrafted genetic circuits and pathways added to well characterized host organisms are one way produce new synthetic biological systems. These circuits and pathways are not easily identified nor readily constructed; they require extensive funding and research efforts spanning multiple years. "Design flows" are *ad hoc*, involving trial and error, and relying heavily on biologists' intuition and experience. Recall "design compilers" that were dreams in the late 1970s or the "napkin-to-chip" concept in the 1990s? The equivalent conceptual dream in biology now is just beginning to be articulated in many bioengineering fields spanning synthetic biology, metabolic engineering, systems biology, and genetic engineering. The buzz phrasing has not arrived yet. "Bio Design Automation (BDA)" or "Genetic Design Automation (GDA)" promises to deliver the software infrastructure and support design methodologies spanning functional specification to manufacturing instructions.

This special section of this issue of D&T brings together four articles and a perspective on software tools that aid in synthetic biological circuits and systems. "Design Automation for Synthetic Biological Systems" serves as a tutorial illustrating two complementary approaches to designing biology systems by either bottom-up, part-based genetic circuits or the modification of metabolic pathways. "Digital Signal Processing with Molecular Reactions" illustrates how biological systems can be abstracted into sets of reactions which can resemble processing systems familiar to the electrical engineering community. "Design and Test of Genetic Circuits using iBioSim" presents a software framework for the simulation of synthetic biological systems. Finally, "Fast Solvers for Biomolecular Science and Engineering" outlines mathematical frameworks which model the dynamics present in biological systems. Together these articles provide background material, modeling frameworks, and examples of software solutions.

In addition to the four outlined articles, the "Last Byte" of this issue provides a humorous and fictitious take on the origins of BDA. "Perspectives" provides an examination of the emerging biodesign automation field alongside the early days of EDA.

While there are many questions that the larger science and engineering community must still answer regarding synthetic biology, EDA professionals can highly contribute to this nascent field. We are grateful to the D&T editorial board and EIC, Krishnendu Chakrabarty, for allowing us the chance to bring this special section to the D&T audience. We

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hope that the articles spark your interest in biodesign automation, and convince you that you *can* apply your skills in this new field. ■

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