# Systems Biology Research Symposium
# Oral Presentation Session

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## Enabling Effective Design, Construction, and Optimization of Synthetic BioSystems

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The rich genome sequence information being generated from the diverse microbial world presents us with a golden opportunity not just to learn from nature, but to build upon it – to forward engineer better synthetic biosystems, including novel biomolecules, metabolic pathways, or even new genomes and organisms, for the purpose of creating alternative or more abundant sources of nutrients, energy, medicine and materials. Today we are still at an early stage of deciphering nature's programming language; our forward engineering skills are even less sophisticated. The goal of our research is to develop such skills and use them in forward engineering to create beneficial biological systems. Outlined here are some crucial capabilities which we are developing, including high-throughput gene and genome synthesis technology, precise protein expression control techniques, as well as new protein design and optimization platform.

High-throughput gene and genome synthesis technology is needed to eliminate the bottleneck of testing the deluge of hypotheses generated by genomics and systems biology, and to enable the field of synthetic biology to take off. To reduce the cost and increase the throughput of gene and genome synthesis, we integrate oligonucleotide array synthesis with microfluidic gene assembly using new material, chemistry and fabrication processes.

Precise protein expression control is critical for any designed gene circuits or metabolic networks to function properly. Promoter control is one approach but may not be sufficient. We develop ways to systematically modify the gene sequence in order to modulate the expression of each individual component in a designed system.

Another challenge for synthetic biology is to cerate new proteins and enzymes with novel or improved functions. Increasingly sophisticated design algorithms are being developed, including our ensemble-based program; yet the computation, testing and optimization cycles seem to be a limiting factor in reaching an optimal design. We favor an approach which integrates computational design, high-throughput synthesis, high-throughput functional screen and optimization to accelerate the process.

It is our hope that the combined power of these technologies will lead to more efficient microbial engineering and assist the development of synthetic and systems biology in general.

Key words: synthetic biology, gene synthesis, gene design, protein design, protein expression, metabolic engineering