PIlot project proposal

Name of Project: Gigaprinter: Development of a large-scale inkjet DNA synthesizer

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Background: Custom oligo DNA synthesis is performed using the phosphoramidite chemistry method. Early DNA synthesis machines were column synthesizers, producing a limited quantity of unique DNA molecules. Inkjet synthesizers have been constructed for the purpose of oligo arraying at a much larger scale than afforded by column synthesizers. These machines place (at least) thousands of spots on a surface and build the oligonucleotide molecules layer-by-layer during rounds of chemical reagent dispension from the inkjet printhead. However, the scalability of this regime has not yet reached its limits.

Technical idea: The goal of this pilot project is to build inkjet DNA synthesis machines. The first version will be a basic prototype not intended to push state-of-the-art performance. Rather, it will be a basic platform on which the GP-write community can freely innovate (or even use). Following the initial version, large-scale DNA synthesis can be achieved by optimizing the system components, including reagents and material choices, as well as scaling up the inkjet printhead capacity by custom engineering of inkjet printheads with thousands (and eventually millions) of nozzles, to increase the total throughput and synthesis capacity of the machine.

Utility: The initial prototype of the inkjet DNA synthesizer will have limited synthesis utility, as it will not be expected to improve on state-of-the-art performance. However, it can provide a valuable platform for further innovation in the GP-write community. Following the validation of the initial prototype (including all chemical parameters), scale-up can proceed and within a few years it is feasible to be printing billions of base pairs per day.

Fit for GP-Write: This project directly relates to the need for high-throughput, large-scale oligonucleotide DNA synthesis in GP-write. To build an entire chromosome, millions of fragments of DNA will be needed. A platform specific to GP-write is also of interest because it decreases the cost of further development of related technologies. Ultimately, with the successful completion of a large-scale machine, genome synthesis could be performed in-house in GP-write facilities.