MECs: Microfluidic "Building Blocks" for Custom Bioinstruments

D. Hill[1], L. Anderson[1], C. Hill[1], and W. Grover[1]
[1]University of California, Riverside, Riverside, CA

Introduction: The spread of microfluidic technologies into new application areas has been slowed by two main deficiencies. First, most existing microfluidic chips are single-purpose, and creating a new microfluidic tool for a new application typically requires that a whole new chip be designed and fabricated, a time-consuming process. And second, making microfluidic chips requires specialized training and access to specialized fabrication equipment. As a result of these deficiencies, many scientists and engineers may recognize the need for a microfluidic instrument in their research but be unable to adapt an existing instrument or build a new one. To address these deficiencies, we have created a set of "building blocks" which any scientist or engineer can literally "snap together" to create custom microfluidic instruments. We call these building blocks *Multifluidic Evolutionary Components* or MECs. "Multifluidic" indicates that MECs operate on *multiple volume scales* (from nanoliters to milliliters) and include functions from *multiple fields* (not only fluidics but also electronics, optics, and mechanics), and "evolutionary" conveys the ease with which new components can be designed and added to the library of existing MECs.

Materials and Methods: MECs are designed to connect to each other using a standardized three-dimensional interface. The regularly spaced circles on the MECs shown in Figure 1 can contain fluidic, optical, mechanical, or electronic connections. MECs can be made using a variety of different processes; our prototype MECs were mostly made using rapid prototyping (3D printing).

Results and Discussion: Figure 1 gives an overview of the process of designing a custom instrument using MECs. Each MEC performs a fundamental function in a fluidic instrument, like controlling fluid flow, storing fluid, pumping fluid, or mixing fluid (we have developed over 60 MECs thus far). By arranging MECs symbolically into a schematic, then using the schematic to guide assembly of the MECs, a complete functional instrument can be built. For applications that require a custom microfluidic component, the socket MEC (Figure 2) allows virtually any microfluidic chip (made using any process) to be packaged into a standard "shell" and plugged into other MECs. This enables custom microfluidic chips to easily leverage (and eventually be integrated into) the large library of MECs.

Conclusions: By enabling researchers without specialized training or access to fabrication equipment to build custom fluidic instruments, MECs can enable applications for microfluidics throughout the biological and health sciences. MECs may be particularly valuable in resource-limited settings, where physicians or nurses could use MECs to build custom instruments to address their own unique challenges.

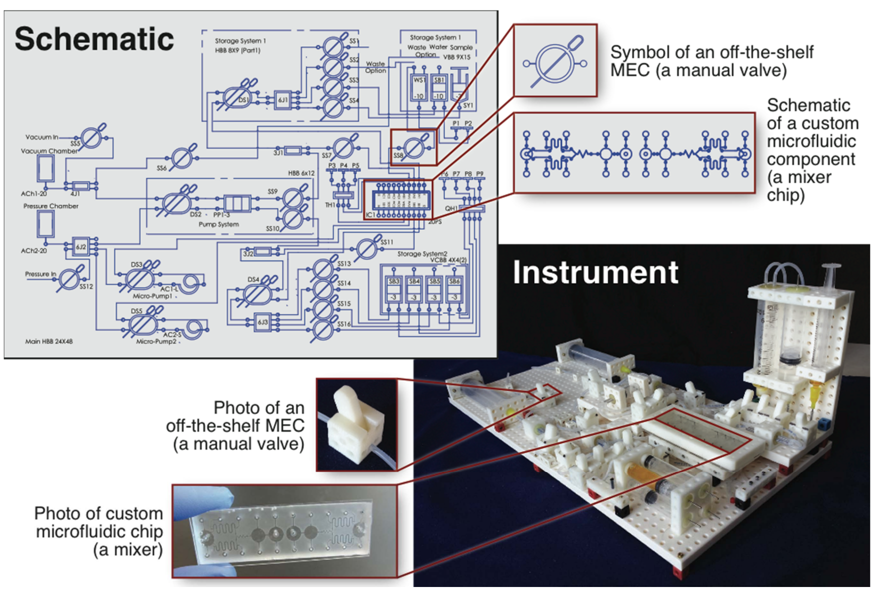

Figure 1. Using Microfluidic Evolutionary Components (MECs) to design and build a custom instrument. MECs are first arranged symbolically in a schematic, then connected together to create a functional instrument (in this case, a mixer capable of combining fluids in volumes from nanoliters to milliliters).

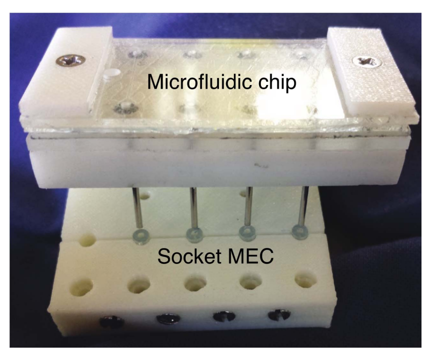

Figure 2. The Socket MEC allows any custom microfluidic chip to interface to the MEC library of parts.