

# Manifold: a Language and Toolchain for Microfluidic Circuit Design

**Program:** Software Engineering

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Manifold is an open-source high-level language for systems engineering. Our capstone team has been extending a prototype language initially developed by a team from the SE 2015 cohort. We have focused mainly on expanding Manifold's support for describing microfluidic circuits and devices. Our project is not about using an analysis tool, but instead we have created an analysis tool for other engineers to use.

The field of microfluidic circuit engineering currently suffers from a lack of accessible software tools for design and analysis. Engineers currently need to develop systems of equations that represent their circuits by hand. They must then manually solve these equations to determine the system's viability. With Manifold, engineers will be able to describe their microfluidic systems with a functional programming language. Manifold compiles the code into a schematic that can be analyzed with the dReal satisfiability solver and the MapleSim simulator, allowing engineers to test designs without needing to physically construct the devices.

At this time, Manifold is capable of expressing simple microfluidic devices in its high-level design language. Users do not need to specify all of the device's design parameters; they can leave some parameters blank and let Manifold help find suitable values. Manifold is currently able to do a single analysis pass on the design and provide an initial validation result with the help of dReal and MapleSim. In the future, Manifold will be able to use the results from the initial validation to refine the design's parameters, eventually creating a design that meets the user's requirements.

The goal of Manifold is to allow microfluidics engineers to easily find faults in their designs that would otherwise be uncovered only after a device's physical construction. With the aid of an automated analysis tool, engineers will be able to iterate on their designs more quickly and more efficiently.