Research Overview of Intelligent DEsign Automation Laboratory

何宗易

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Motivation for Microfluidic Biochips

- Clinical diagnostics, e.g., healthcare for premature infants, point-of-care diagnosis

- "Bio-smoke alarm": environmental monitoring

- Massive parallel DNA analysis, automated drug discovery, protein crystallization

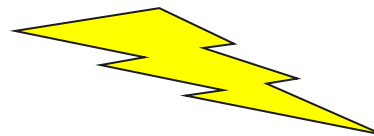- *Functional diversification, More than Moore*

Hemophilia

CLINICAL DIAGNOSTIC APPLICATION

Lab-on-a-chip for CLINICAL DIAGNOSTICS

Shrink

Microfluidic Lab-on-a-Chip

20nl sample

Conventional Biochemical Analyzer

Higher throughput, minimal human intervention, smaller sample/reagent consumption, higher sensitivity, increased productivity
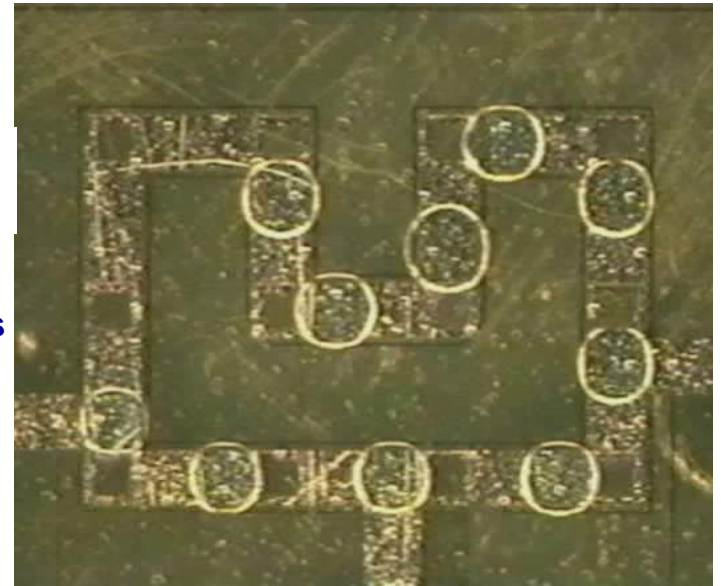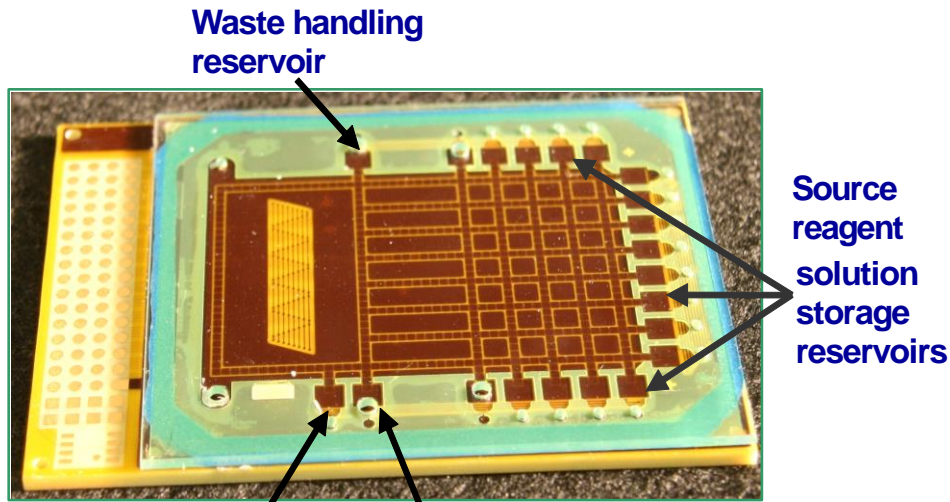
Microfluidic Device market and forecast from 2011 to 2018

Report includes detailed breakdown: General dispensing, drug delivery, accurate dispensing, analytical devices, clinical and veterinary diagnostics, point-of-care testing, industrial and environmental testing, pharmaceutical and life science, microreaction technology
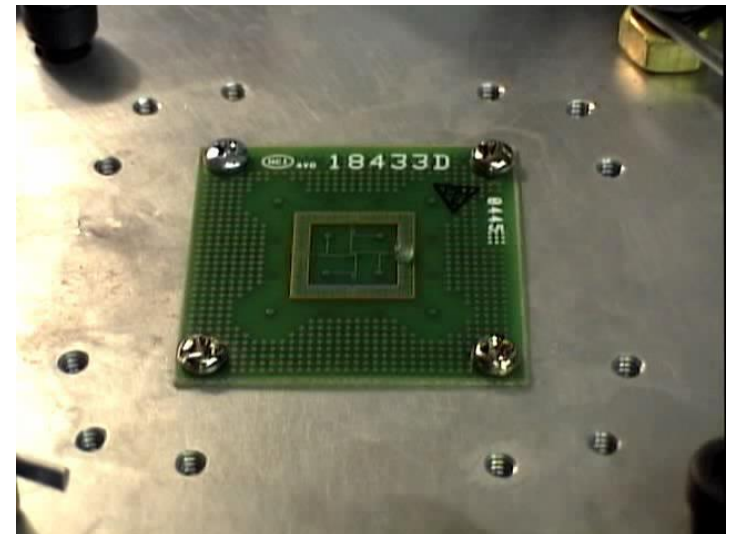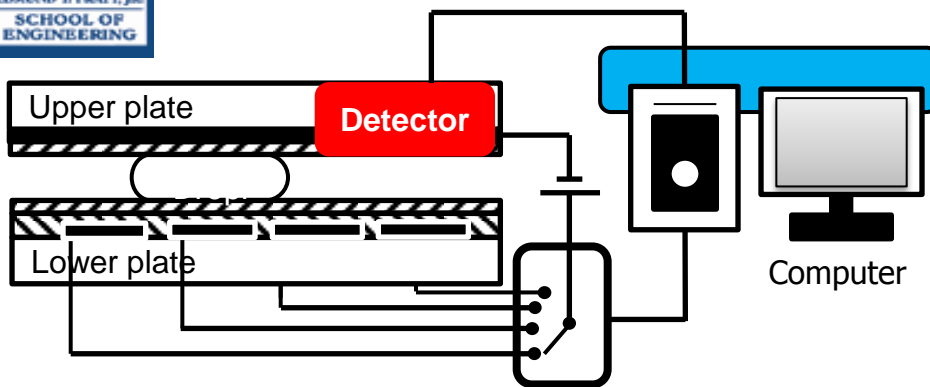
$CAGR_{2013-2018} = 28\%$
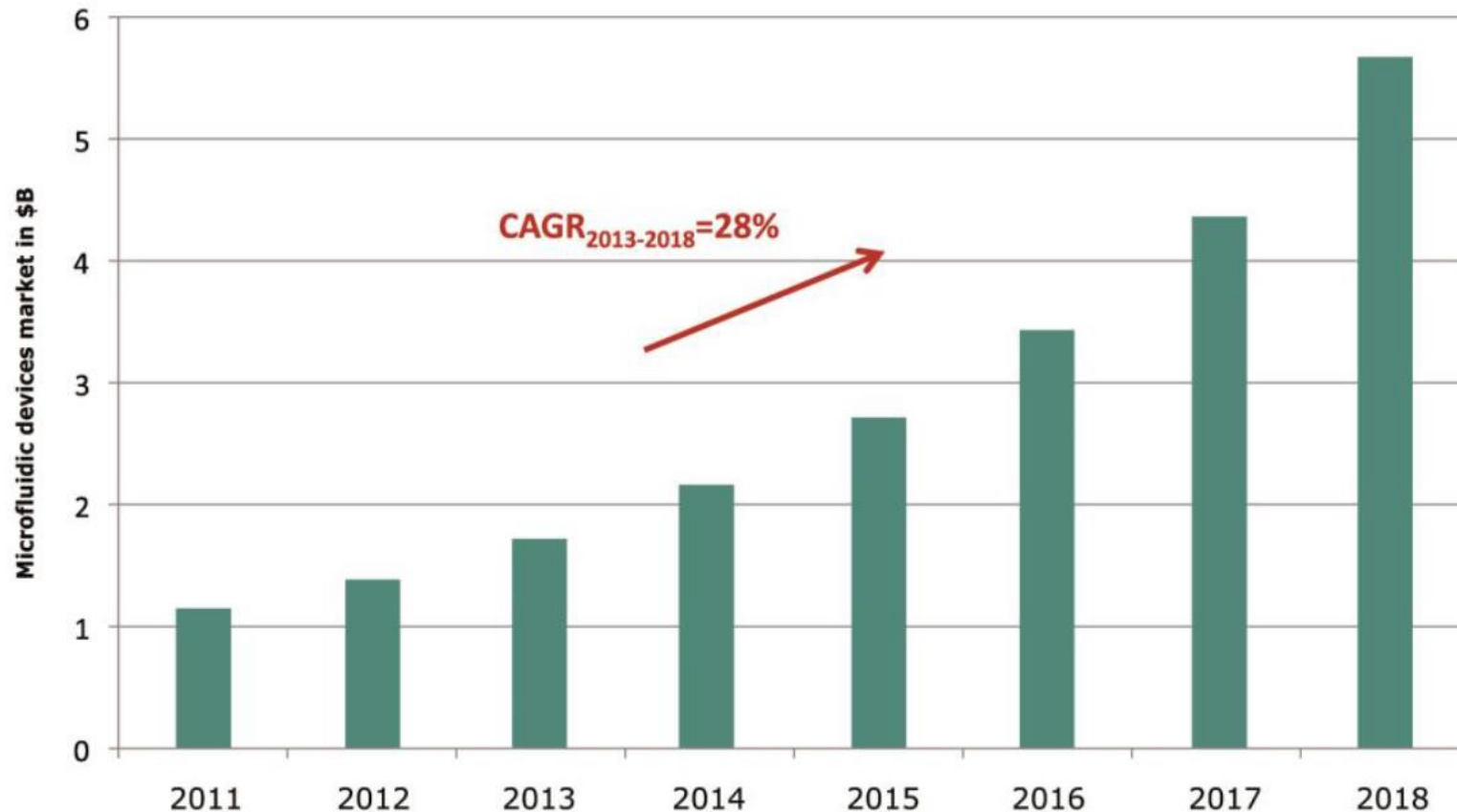
"The microfluidic device market will grow swiftly, from $1.4B in 2013 to $5.7B by 2018".

YOLE
Développement

© June 2013

Demonstration of Droplet-Based Microfluidics

Waste handling reservoir

Source reagent solution storage reservoirs

Target solution generation

Intermediate dilution reservoir

EWOD: Electrodewetting on Dielectric

Upper plate

Detector

Lower plate
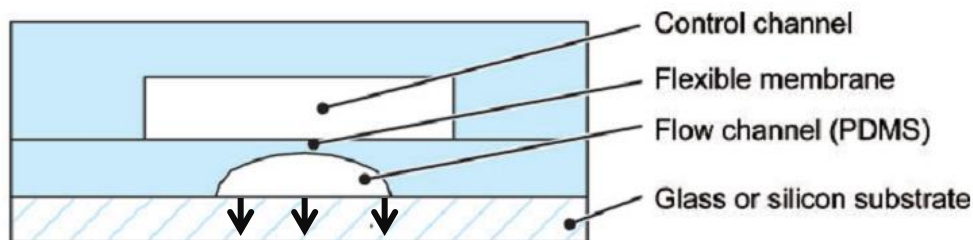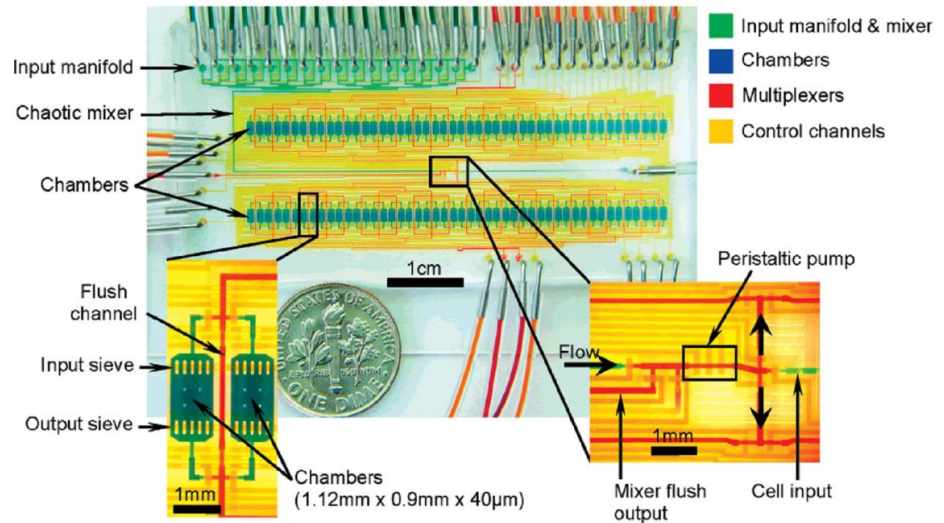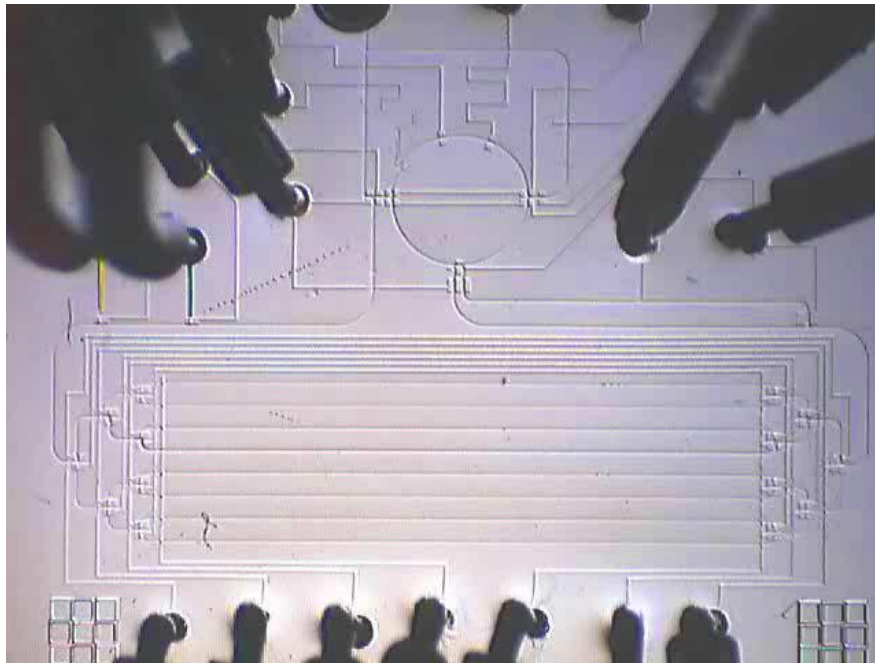
Computer

Source: Advanced Liquid Logic (now Illumina) and Duke Univ.

# Demonstration of Flow-Based Microfluidics
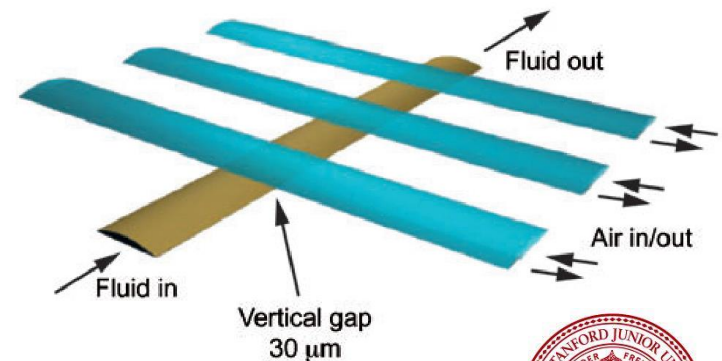
T. Thorsen, S. J. Maerkl, and S. R. Quake, "Microfluidic Large-scale Integration," Science, Oct. 2002.

The Need of CAD Support

- Applications become more complicated
  - Large-scale bioassays
  - Multiple and concurrent assay operations on a biochip

- Design complexity is increased
  - The increasing rate of the valve numbers is four times faster than Moore's Law
  - 25,000 valves for 9,216 PCR[*]
 - 600,000 electrodes for tumor cell analysis[**]

Source: Fluidigm
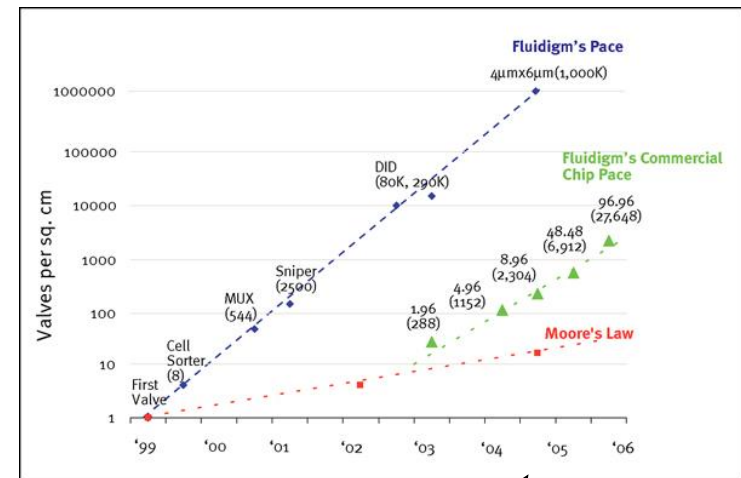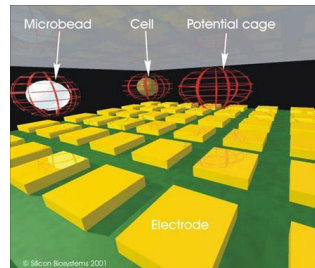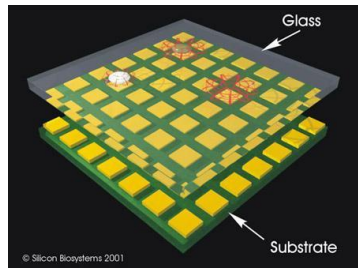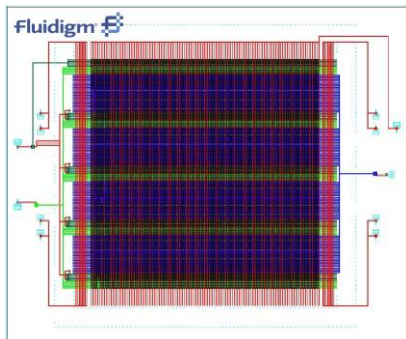
Computer-Aided Design (CAD)

* Perkel, Science, 2008

** Silicon Biosystems, http://www.siliconbiosystems.com/applications/
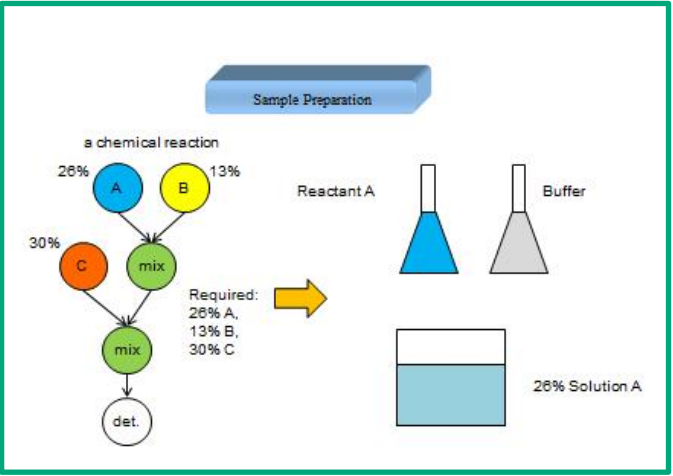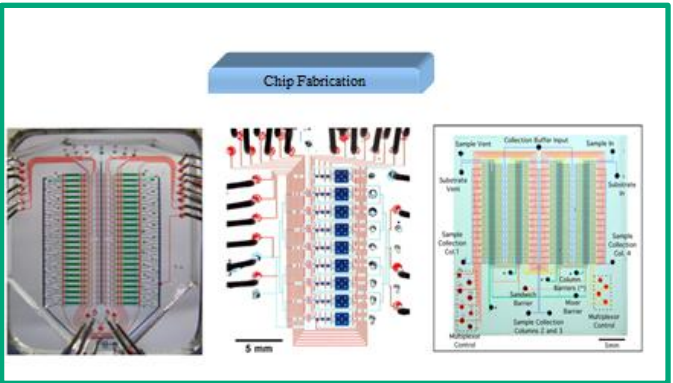
Current Design Methodology

- CAD tools are in their infancy
  — Bottom-up design methodology
  — Most groups use Matlab or AutoCAD
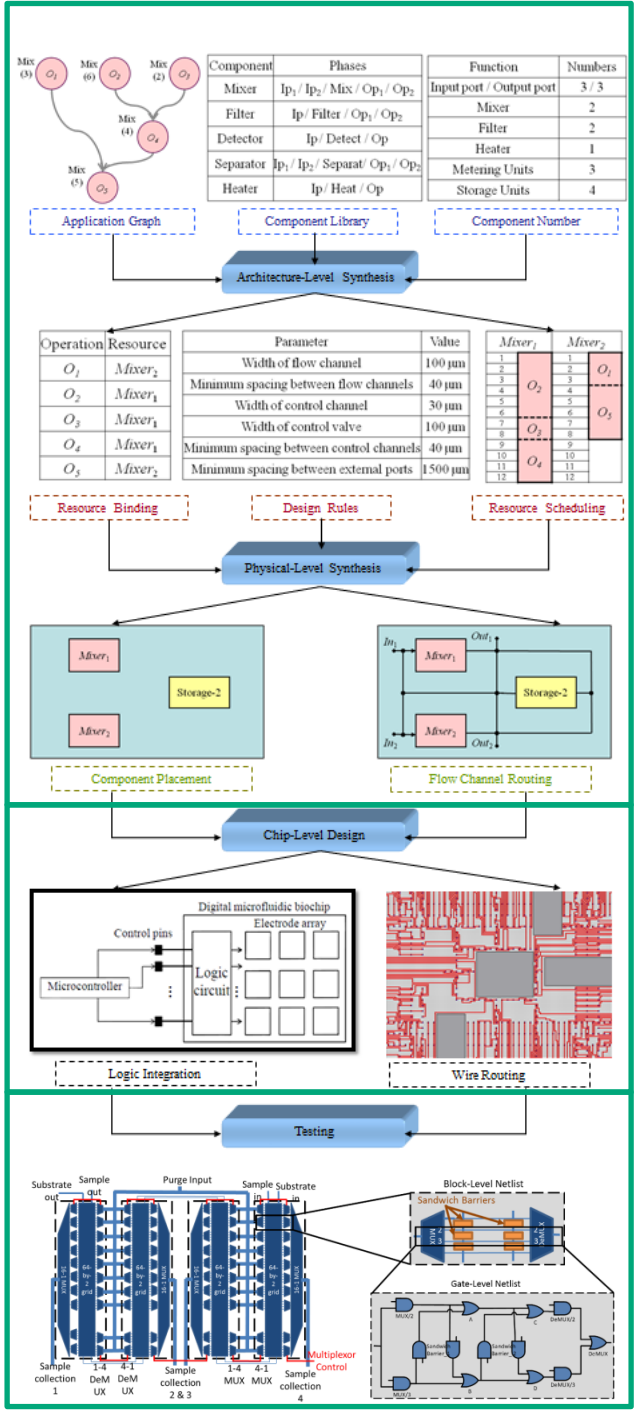 — Limited automation; every line drawn by hand; manual control

Bottom-up design method
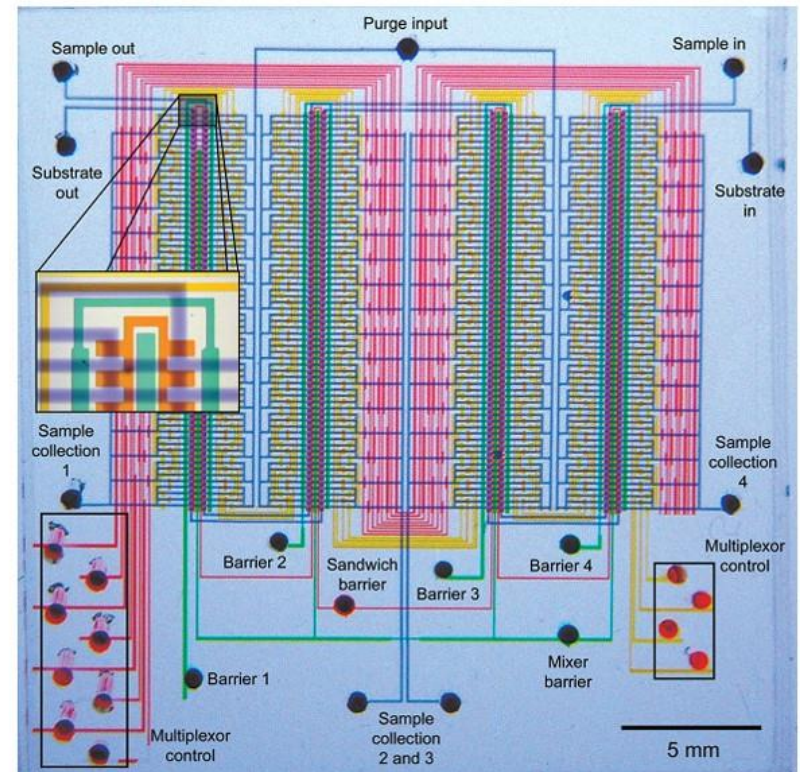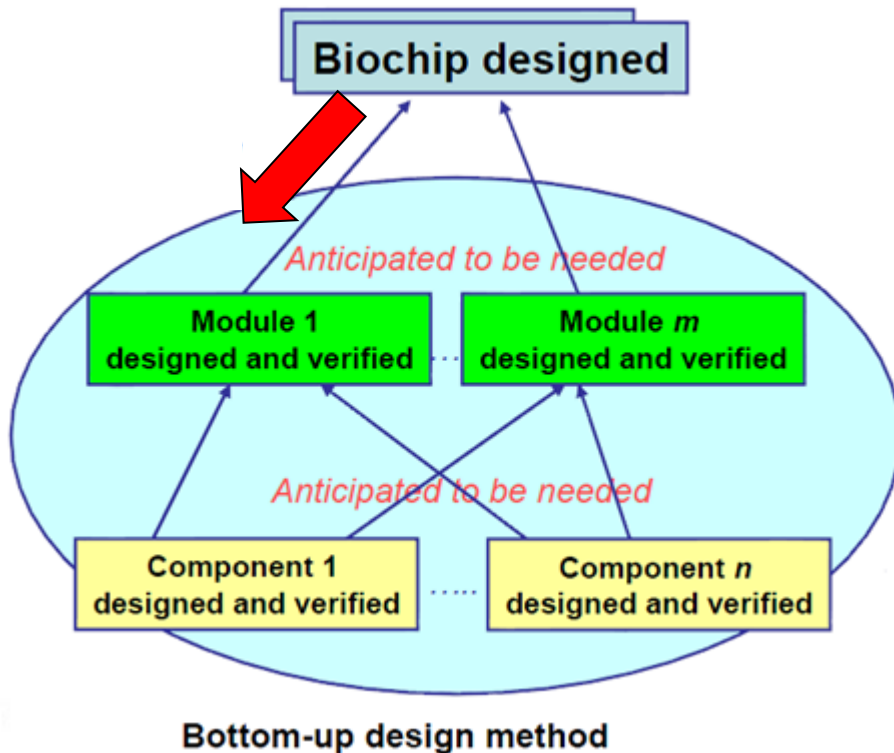
應用於微流體生物晶片上之生化反應樣本製備流程
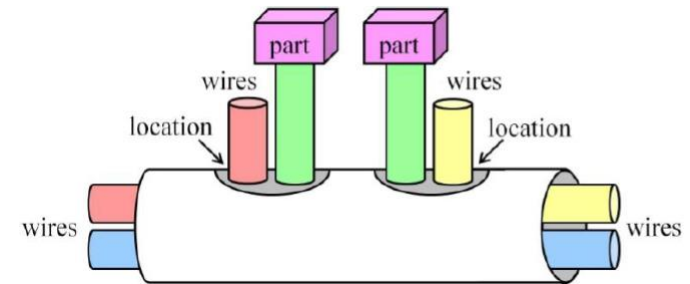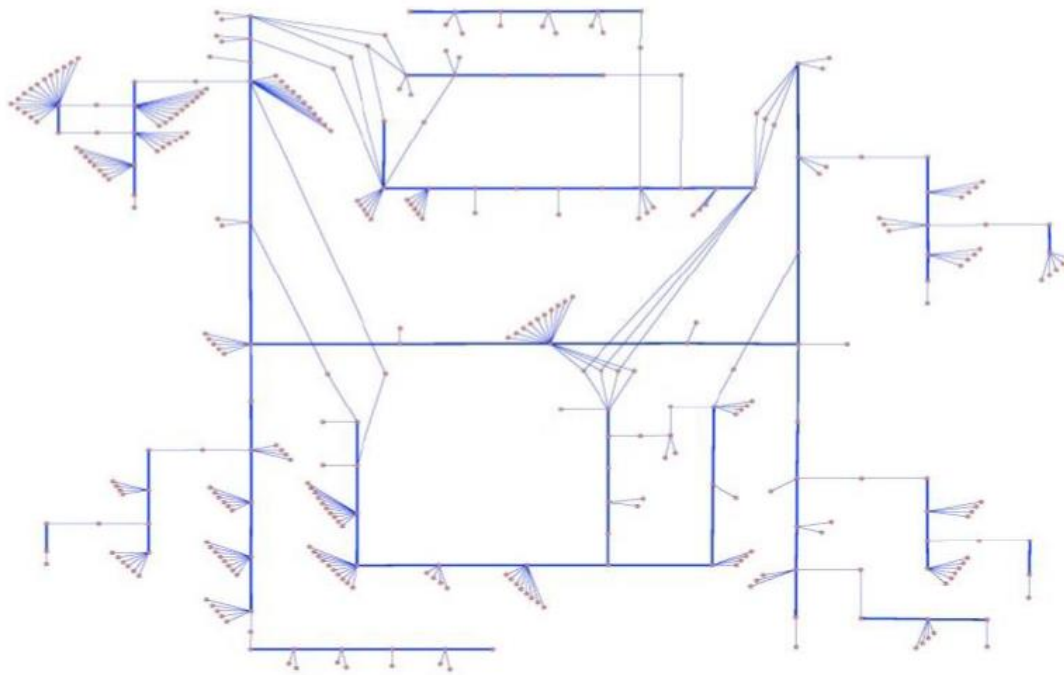
高整合度微流體晶片的製程、設計規則和元件驗證

國際合作

針對大型微流體生物晶片之合成與最佳化

生物微流體晶片之繞線自動化與設計整合研究

針對大型微流體生物晶片之測試與診斷

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Design Automation for Emerging Technologies
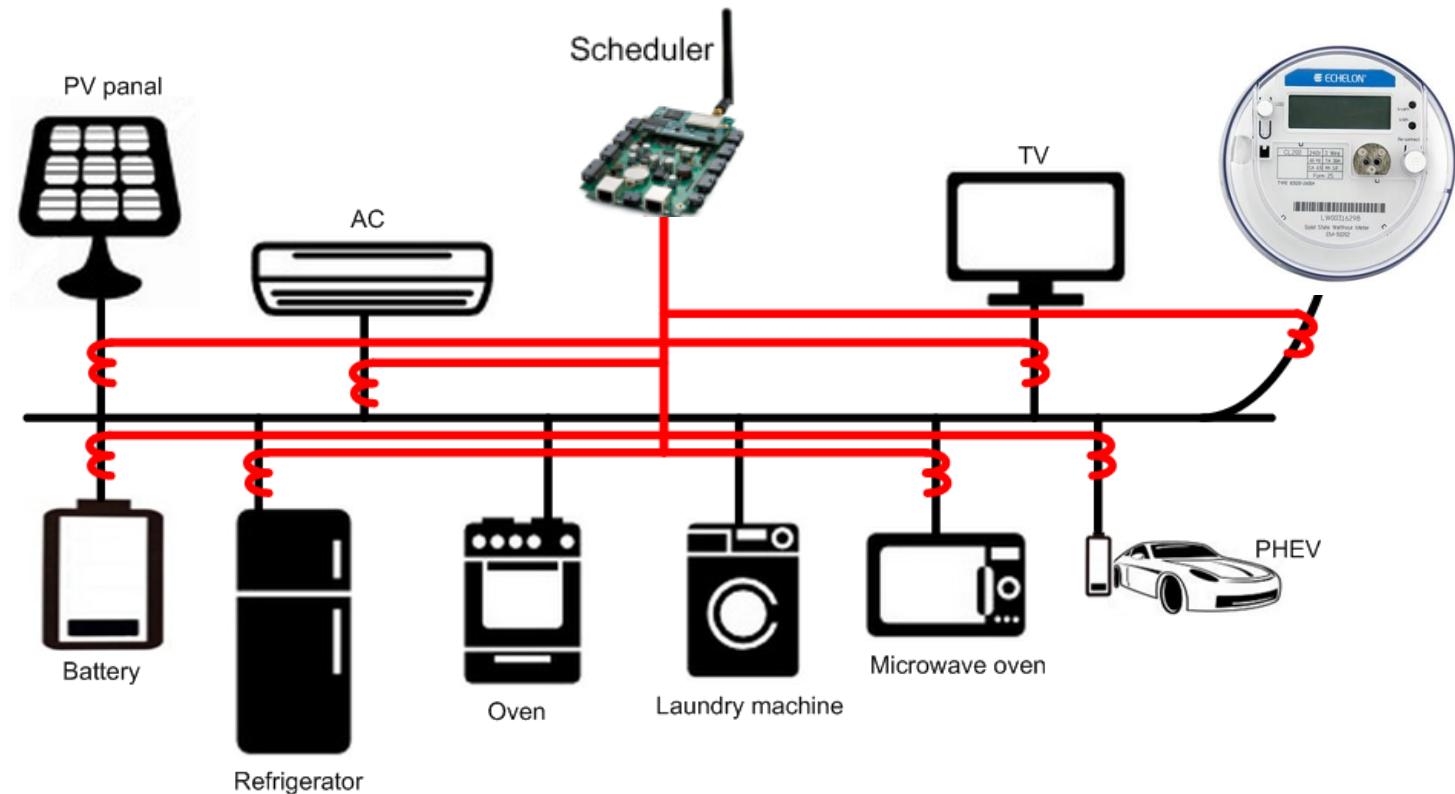
Ex: Wire Routing for Automotive System

International Collaboration with UC Berkeley

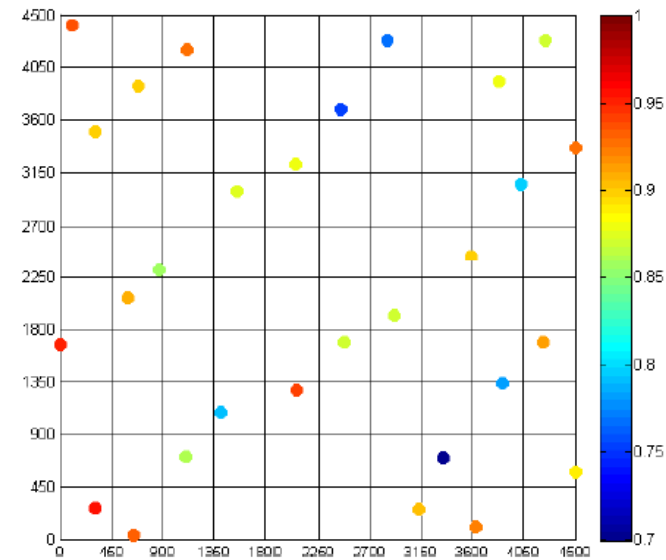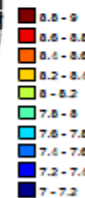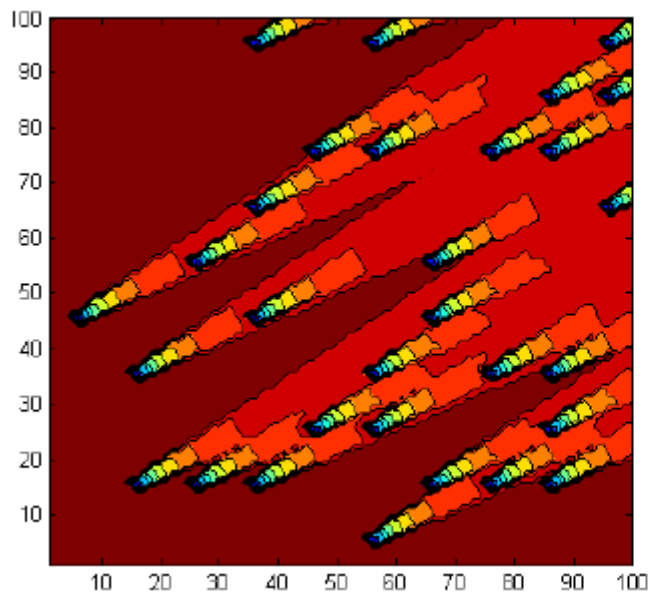# Design Automation for Emerging Technologies

Ex: Design Automation for Smart Home System

International Collaboration with Michigan Technological University

# Design Automation for Emerging Technologies

Ex: Design Automation for Wind Farm Design

International Collaboration with University of Missouri and IBM

International Collaboration

- Collaborators:
  - Prof. Bhargab Bhattacharya (India Statistical Institute)
  - Prof. Philip Brisk (University of California at Riverside)
  - Prof. Krishnendu Chakrabarty (Duke University)
  - Prof. Steven Quake (Stanford University)
  - Prof. Paul Pop (Technical University of Denmark)
  - Prof. Ulf Schlichtmann (Technical University of Munich)
  - Dr. Robert Wille (University of Bremen)
  - Prof. Shigeru Yamashita (Ritsumeikan University)
  - Prof. Hao Yu (Nanyang Technological University)
- Duke University's Microfluidics Research Lab
- Stanford Microfluidics Foundry
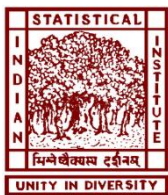
For Prospective Students

- We're recruiting **1 Ph.D.** and **2~3 M.S.** students
  - Please send your contact information with supporting materials (resume, transcript, paper, and etc) to tyho@cs.nctu.edu.tw
- Requirements

動機

English

邏輯設計

EDA

高 EQ/
Integrity

基礎電路學

程式實作
資料結構
演算法
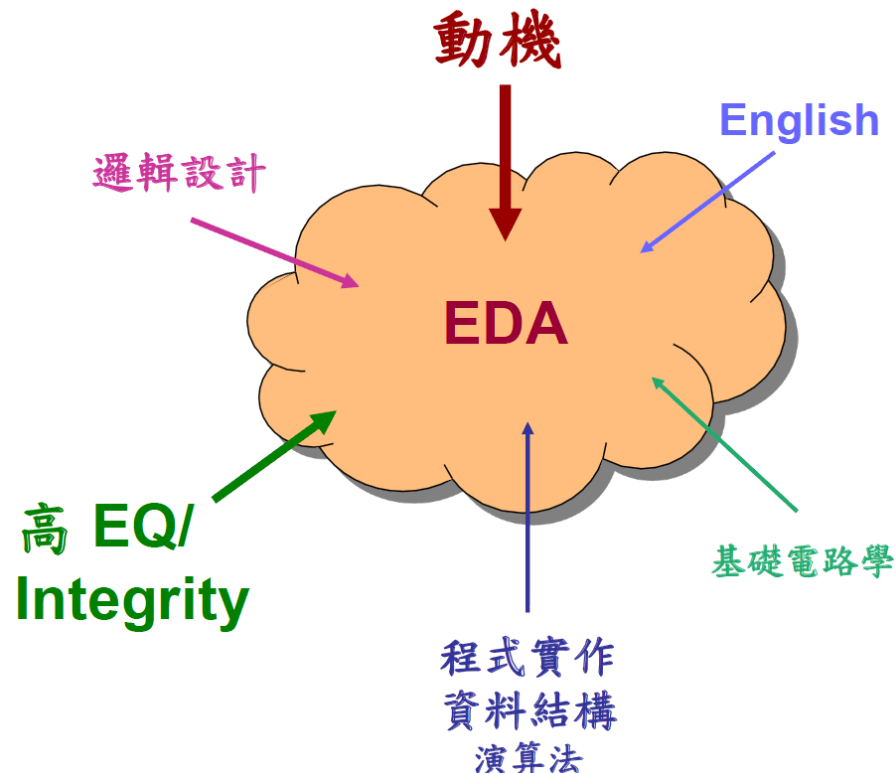
New Blood wanted!

- We desperately eager for talented students joining us to claim challenging and exciting research projects
- Yes, you are one of the talents!