Institute for Complex Engineered Systems

Carnegie Mellon

University-Industry Research Partnerships

Our experience and observations

Connecting People with their Physical and Information Environments

Nature of the Partnership

- It is a contact sport
- It takes time
- It requires management of expectations
- Multi-year focused projects are better than one year projects or charity grants.

A Contact Sport

As any contact sport, the rules of interactions and commitment to the game period is critical.

- Summer internships
- Short stays of faculty at site
- Short stays of your personnel at the university

Time

- Building relationships
- Ensuring that that both sides understand the problem
- Understand each others expectations

Management of Expectations

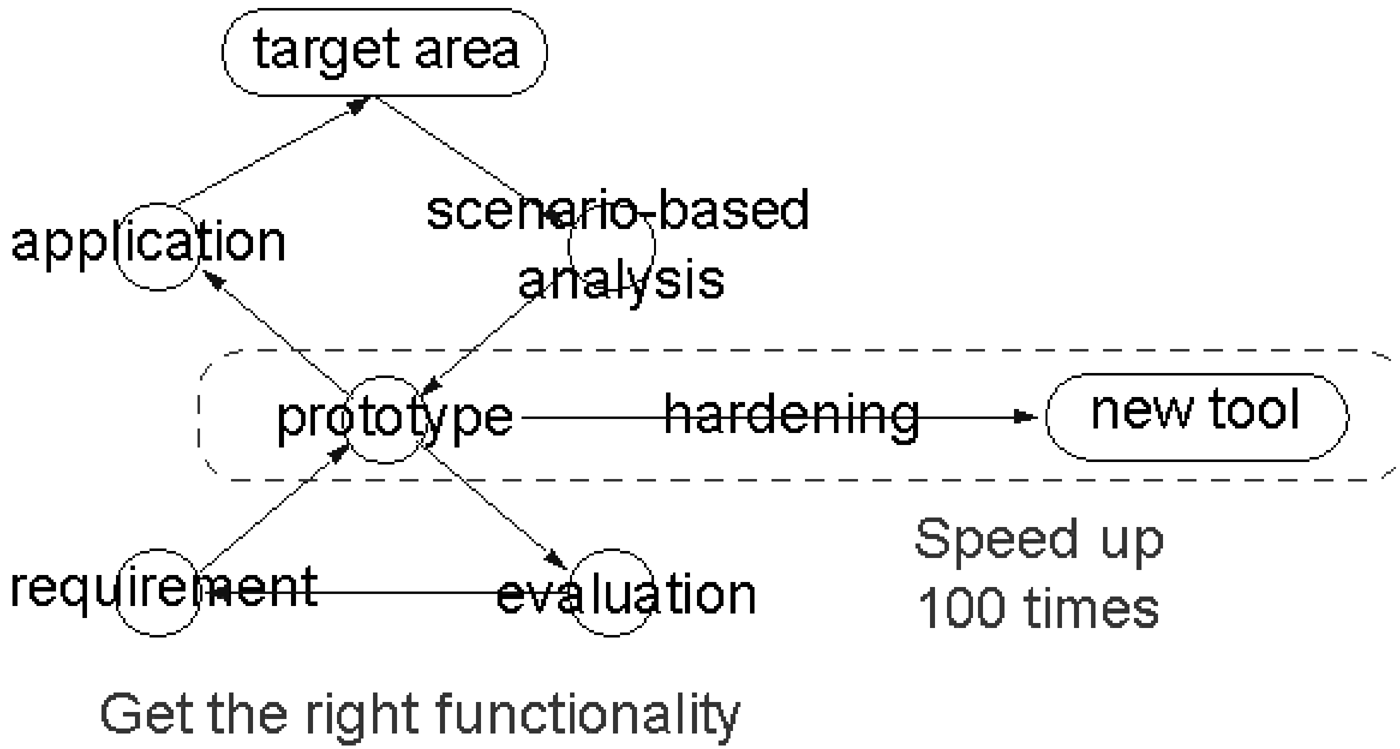
- Universities are not production shops
- Software will not transfer, only people with knowledge will
- There are specific types of projects that work for a university setting
- Professors and students should understand company strategy to place work in context.

Where do they work?

- Sponsor cannot easily create multi-disciplinary teams for exploring new areas.
- Testing an idea/technology for a product.
- Ideas and inputs that better the product.
- Practices and methods that make the operation more efficient.
- Proof of concept prototypes on sponsors software and hardware.
- Needs are clearly felt at sponsors grassroots level and university level.

How have we worked before?

Example: Design support tools



In Conclusion

- A research partnership is successful if:
  - a product organizations feels a contribution has been made from input from the partnership.
  - A sense of ownership of the research and its contributions for both sides is critical for long term partnerships and effective tech transfer.
  - Multi-year projects and processes are necessary for any substantive results.

Some Projects …..

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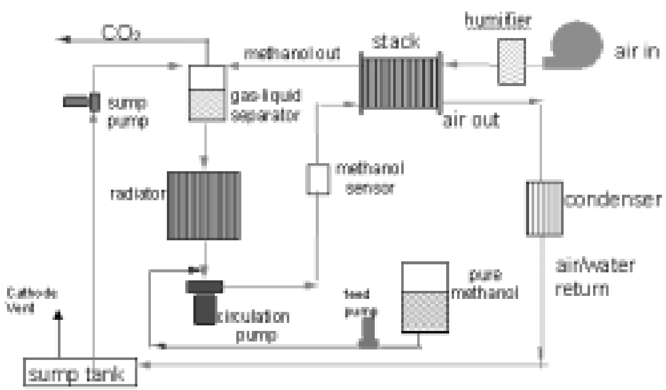
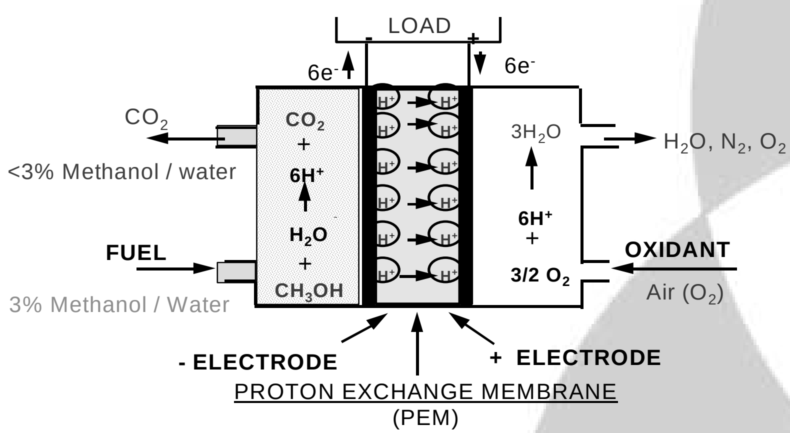
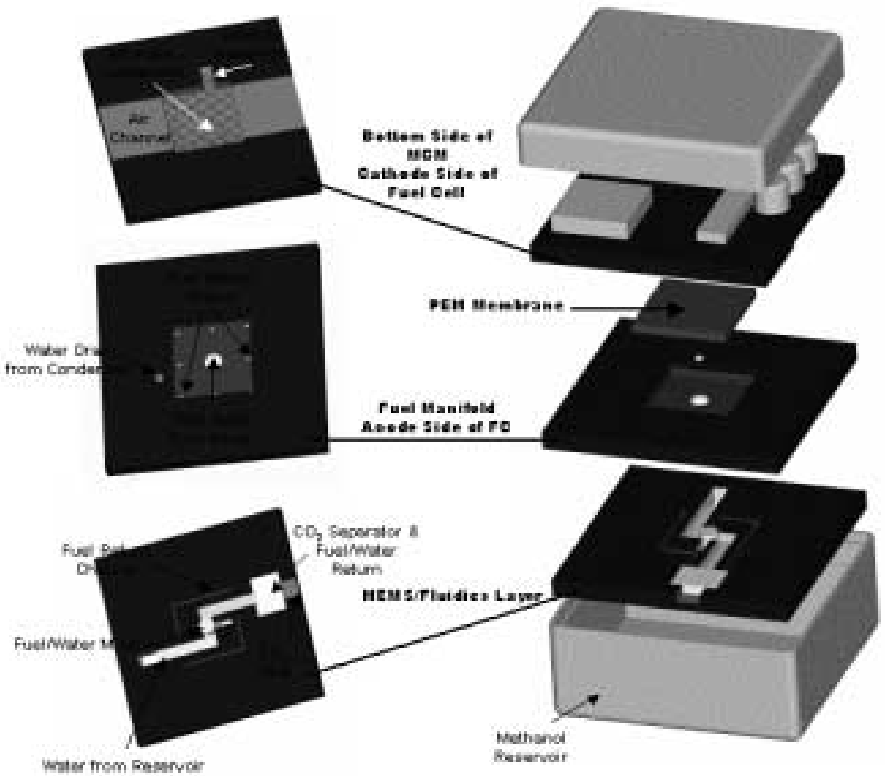
Direct Methanol Micro Fuel Cell for Powering Micro Sensors



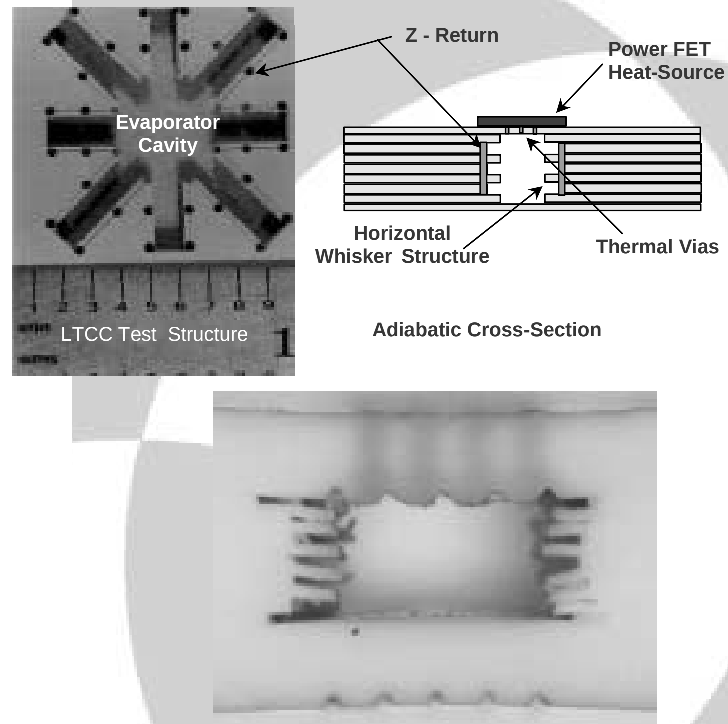


- MPG effort: CMU (ECE, MSE, MechE), JPL and Harris
- *Direct* methanol fuel cell
- Continue output 10 mW for sensing for 5 weeks with overall size of 1 in^3 (~15cc)
- Energy storage for peak power data transmission
- Active control with MEMs pumps, valves, CO_2 separator and temp. and methanol sensors
- Low temperature co-fired ceramic (LTCC) microelectronic packaging

Direct Methanol Micro Fuel Cell for Powering Micro Sensors



Schematic of 3D Integrated Fuel Cell



LTCC Heatpipe Structure

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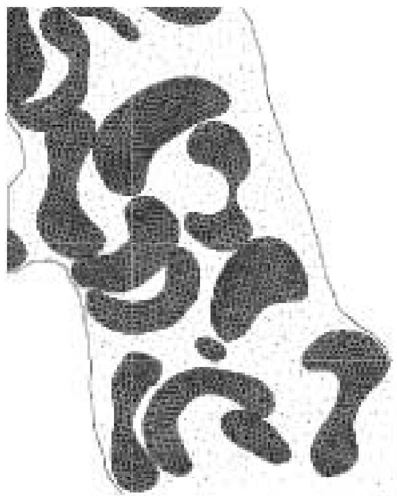
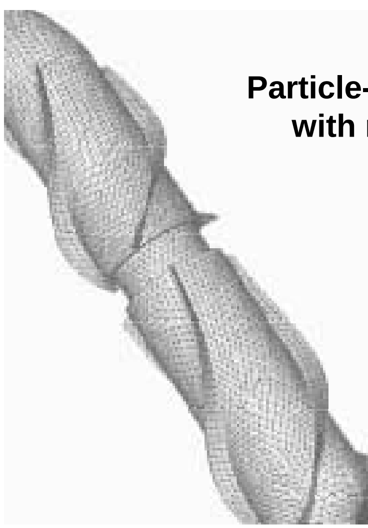
Multiscale Blood Flow Modeling on Teraflops Computers

CIT, MCS and CS & UPMC

Micrograph: red cells with surrounding plasma



Particle-based discretization coupled with mesh-based discretization



Goal

- **Develop mathematical and computational tools for simulation-based design of artificial organs (lungs and hearts)**

Needs

- **Accurate models of blood flow behavior in complex geometries**
- **Constitutive models, damage models, parallel algorithms; lagrangian-eulerian algorithms**

Approach

- **Multiscale blood flow models to resolve phenomena from organ level (cm) to blood cell level (μ)**
- **Teraflop parallel computing**

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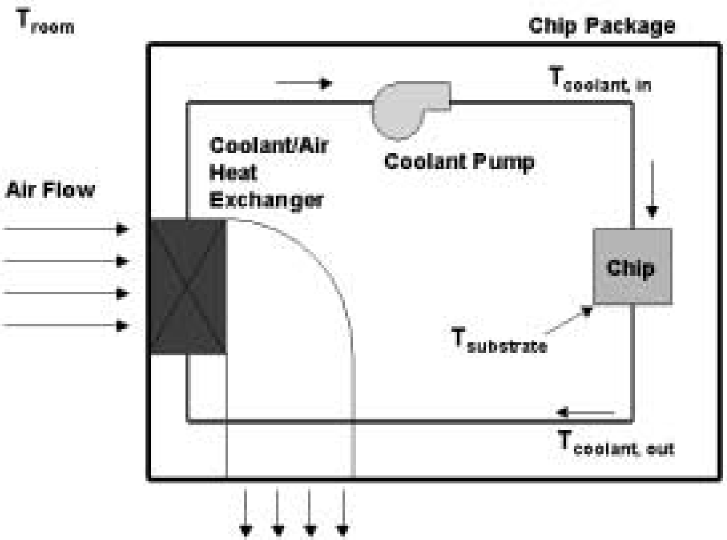
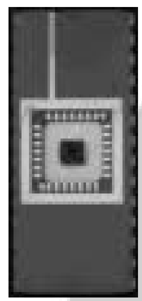
ICESCATE

Integrated Cooling of Electronics using Sub-Circuit Anisotropic Tunnel Etching





Closed-loop fluidic chip cooling system

Post-CMOS fabrication

- Design and demonstrate MEMS-enabled, closed-loop fluidic cooling systems
- Cooling structure aligned with electronic circuitry
- Integrate cooling channels and structures compatible with CMOS for both digital and analog IC chips.
- Integrated circuits using post-CMOS micromachining and sealing
- Remove heat fluxes of 75+ W/cm^2 for high-power electronics, optoelectronics and IR detectors

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