Industrial Outreach

Edited and Presented by
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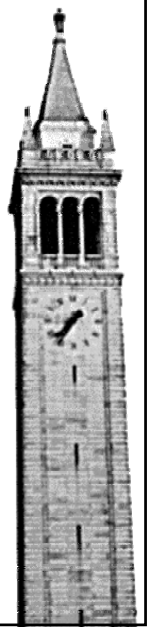
Co-PI
UC Berkeley

Chess Review
November 18, 2004
Berkeley, CA



Industrial Advisory Board

Integrated Circuits
- Ivo Bolsens (CTO, Xilinx)
- Theo Claasen, (CTO, Philips)
- Andrea Cuomo (Senior VP Strategy and General Manager, Advanced System Technology, ST)

Systems
- Clas Jacobson (Director, Systems Department, United Technologies Research Center)
- Patrick Popp (Director, Electrical, Control and Safety Systems, GM Research Center)
- Fabio Romeo (VP, Cable Technology Division, Pirelli)
- Tariq Samad (Principal Scientist, Honeywell)
- Patrick Scaglia (VP of Research, Internet and Platforms, HP)
- Masaaki Tsuruta (Deputy President of S&S Architecture Center, Sony Corporation)

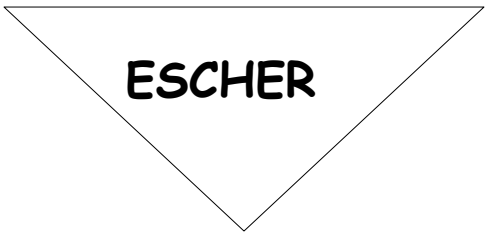
Tools
- Cleve Moler (Chief Scientist and Founder, Matworks)
- Bran Selic (CTO, Rational Technology (IBM))
- Ted Vucurevich (CTO, Cadence)

Overview

- Escher
- Industrial use of Metropolis
  - Automotive (Daimler-Chrysler, GM, Toyota)
  - Multi-media and Wireless (Infineon, Intel, Sony, ST, Xilinx)

Corporate Customers

Government



Research Groups

Mission: Non profit organization to provide services that promote the transition of government-funded Information Technology research and Development results to industry Contact:

Contact: Norm Whitaker
nwhitaker@alum.mit.edu

Strategic Objectives

- **Preserve, maintain and maturate** the fruits of government research investments
- Build a **research infrastructure for** selected technology areas (initial focus has been distributed embedded systems)
- Enable l**everaging** of the technological infrastructure across industrial sectors (such as automotive, aerospace, space systems, medical devices and manufacturing automation)
- **Identify research needs**, serving as a "voice of the customer" (VoC) to researchers and government agencies funding research
- **Identify development needs** and requirements, serving as a "voice of the customer" (VoC) to providers of solution technologies and tools
- Be available as a **resource** for knowledge and other share-able resources to American researchers, developers and users

Business Model

Stage 0:
- Road mapping and other consulting services

Stage I:
- Participation in government program to work with specific performers – funded by program
- Quality standards create goal and possible corporate follow on for performers create positive incentives
- Software is not lost if not transitioned at end of program, but becomes "GFE" for the next stage
- Escher helps with license issues
- Funding credit tag remains with technology for future tracing

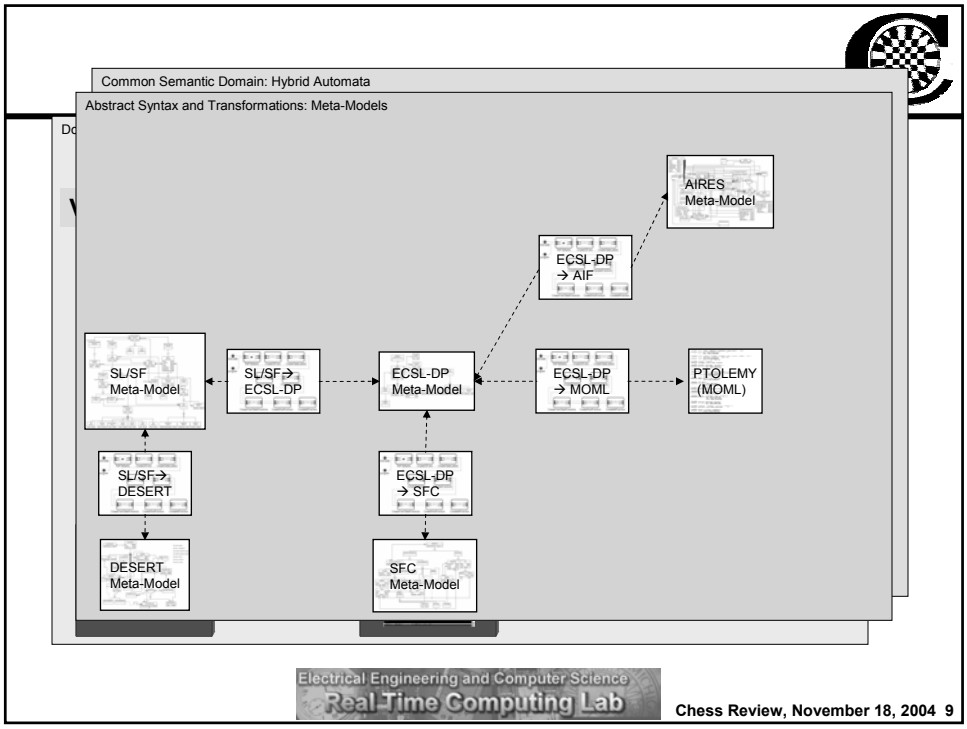
Stage II:
- Corporate funding to mature/harden/complete/customize research results
- Escher coordinates the project – pooled funding and joint performers
- Feedback to government funding agencies

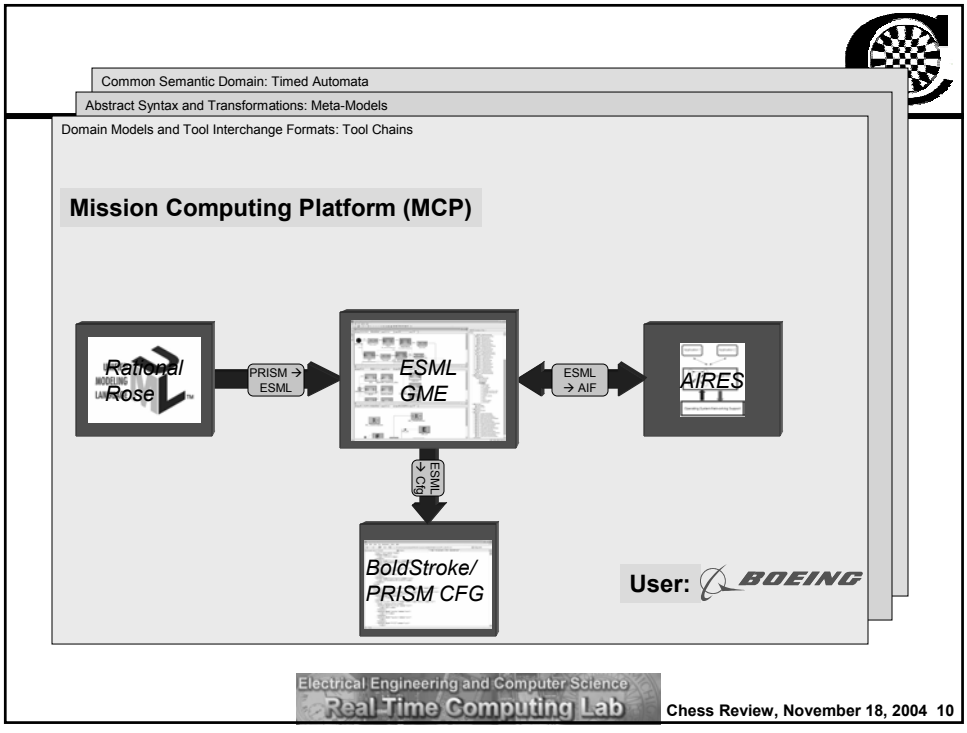
Escher Structure

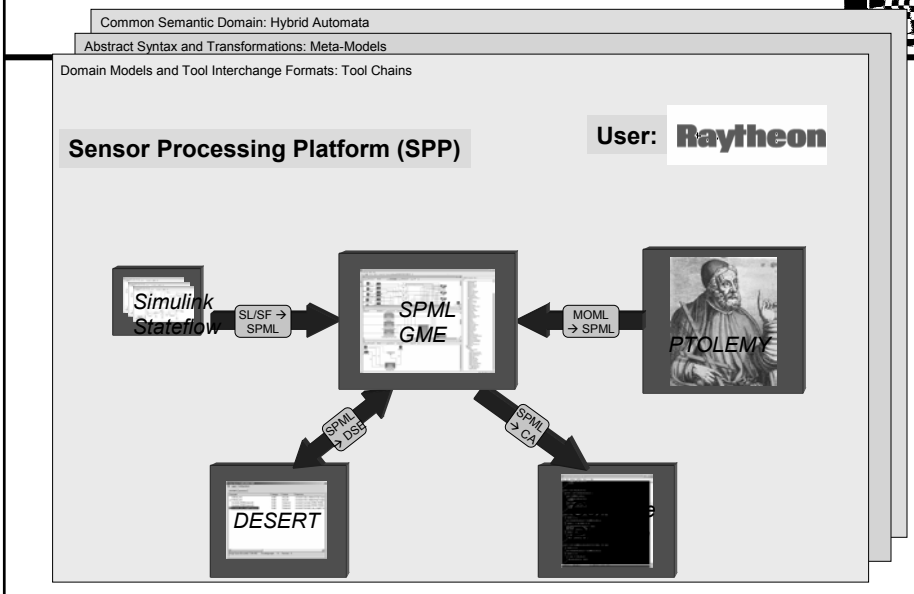
- **Structure**: 501(c)(3) Non-profit Research Institute
- **CEO**: Dr. Norm Whitaker
- **Initial Funding**
  - **Corporate**: General Motors, Raytheon, Boeing
  - **Government**: National Science Foundation, DARPA,
- **Initial Focus**: Infrastructure for Embedded System Design
- **Initial Board of Directors**
  - Prof. Janos Sztipanovits – Vanderbilt U
  - Prof. Shankar Sastry – UC Berkeley
  - Prof. Doug Schmidt – Vanderbilt U

Status

- Incubation completed, ESCHER has been incorporated in February 2004
- VU-ISIS span out ESCHER an independent entity in March, 2004
- Year 1 work progresses under direction of the Technical Advisory Board (TAB) (Boeing, GM, Raytheon)
- In May, 2004 the Tab finalized FY04 technical schedule, which includes:
  - Initial Repository Setup
  - Three tool chains using U. Michigan, Berkeley and VU-ISIS tools
  - Training programs for industry
- **In November 2004, TAB gave the "go-ahead" for Year 2**


Common Semantic Domain: Hybrid Automata
Abstract Syntax and Transformations: Meta-Models
AIRES Meta-Model
ECSL-DP → AIF
SL/SF Meta-Model
SL/SF→ ECSL-DP
ECSL-DP Meta-Model
ECSL-DP → MOML
PTOLEMY (MOML)
SL/SF→ DESERT
ECSL-DP → SFC
DESERT Meta-Model
SFC Meta-Model


Common Semantic Domain: Timed Automata
Abstract Syntax and Transformations: Meta-Models
Domain Models and Tool Interchange Formats: Tool Chains
Mission Computing Platform (MCP)
Rational Rose
PRISM → ESML
ESML GME
ESML → AIF
AIRES
ESML → CFG
BoldStroke/ PRISM CFG
User: BOEING



Overview

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  - Automotive (Daimler-Chrysler, GM, Toyota)
  - Multi-media and Wireless (Infineon, Intel, Sony, ST, Xilinx)

Metropolis: an Environment for System-Level Design

- Motivation
  - Both design complexity and the need for verification are increasing
  - Semantic link between specification and implementation is necessary
- Platform-Based Design
  - Meet-in-the-middle approach
  - Separation of concerns
    - Function vs. architecture
    - Capability vs. performance
    - Computation vs. communication
- Metropolis Framework
  - Extensible framework providing simulation, verification, and synthesis capabilities
  - Easily extract relevant design information and interface to external tools
- Released Sept. 15th, 2004

Metropolis Contributors

Industry

- Cadence Berkeley Labs (Design Methods and Tool Development)
- General Motors (Distributed subsystems)
- Infineon (Platform-based cell phone design)
- Intel (Wireless platforms, Imaging-Video subsystems)
- National Semiconductors (Analog Platforms)
- ST (Set-top box, Automotive, Sensor Networks)
- United Technologies (Air conditioning, Security)

Universities

- University of California at Berkeley
- Carnegie Mellon University
- Politecnico di Torino
- Scuola di Sant'Anna (Pisa)
- Universita' de L'Aquila
- Universita' di Trento
- UCLA
- UC Riverside
- Universitat Politecnica de Catalunya

Consortia

- BWRC (Cadence, HP, Ericsson, Infineon, Intel, Nokia, Qualcom, ST, …)
- PARADES (Cadence, Magneti-Marelli, ST, *UTC*)

Highlights

We studied **36** different architectures for IFX-3 Concept Car (HyWire System) within the context of differing:

- Network architectures
- Software architectures
- Node architectures

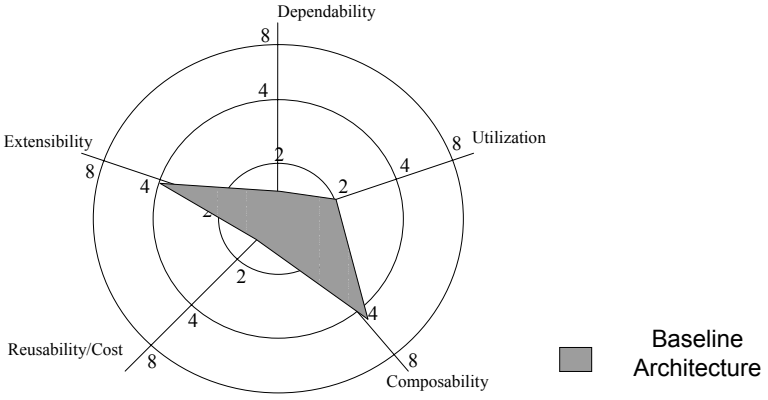
- Entire design cycle completed from March 26th to May 15th
  - Static analysis tools can return results within minutes
  - Bottleneck is preparing format for entering the tool chain

- Three people involved on a part-time basis (< 50%)
  - Sri Kanajan
    - GM Researcher
  - Claudio Pinello
    - PhD student at UC Berkeley (now at Quantech GM Berkeley Labs)
  - Paolo Giusto
    - SysDesign Expert (now at Quantech GM Berkeley Labs)

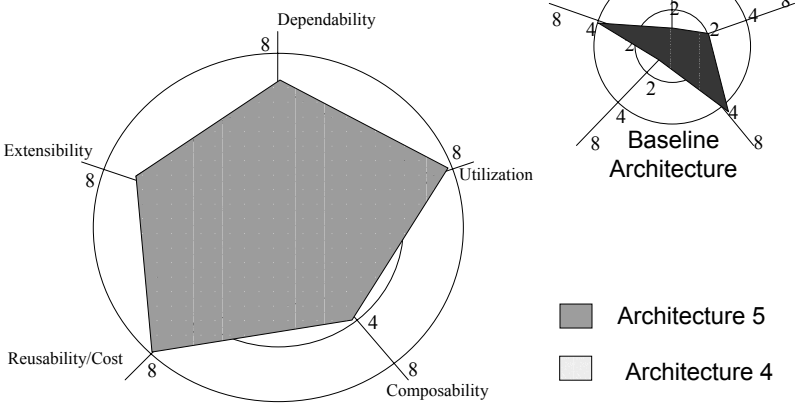
SBW Architecture Development: Metrics

- Dependability/Fault Tolerance [failures/hour]
  - Reliability and availability -> failure rates
- Utilization [% of resource bandwidth usage]
  - Processor and bus utilization
- Reusability/cost [number of unique components]
  - This is defined as how much of the architecture can be made common.
- Extensibility [% of remaining "space" for future extensions]
  - This is defined as the ability to extend the current architecture in terms of functionality or hardware configuration without causing "coordinated" change.
- Temporal Composability [Degree of synchronization between components]
  - This is defined as the ability to integrate components together without loss of the original properties of the individual components.

Architecture 1 Baseline: Result Representation



Architecture 5: Result



Summary

- Steer-by-Wire Sub-system analysis
  - Qualitative and quantitative metrics introduced
  - 36 fault tolerant architectures analyzed in 1.5 months
  - Significant architecture improvements in comparison to baseline
- Automotive Architecture Exploration Tool Chain
  - Metropolis (UC Berkeley)
    - Specify, analyze, and synthesize systems at several levels of abstraction
  - SysDesign (Cadence)
    - Simulation tool that bridges pure functional modeling and architecture design
  - SCRAPE (UC Berkeley)
    - Fault Tolerant Design Exploration and Synthesis
    - Worst case static analysis tool

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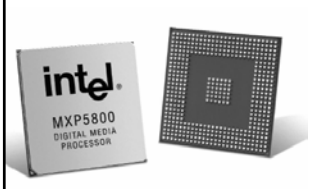
Metropolis in the Multimedia Domain



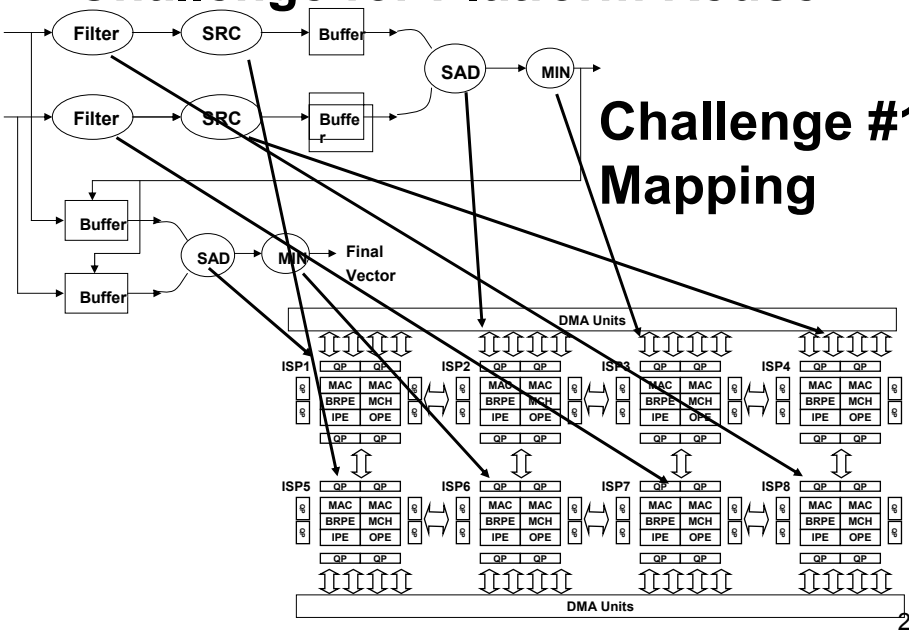
(Intel MXP5800 and Xilinx Virtex-II Pro)

- Case studies involve concurrent, heterogeneous, and reconfigurable architectural platforms
- Applications are typically data intensive streaming applications
  - Kahn Process Networks is a common model of computation
- Mapping must take into account:
  - Computation (due to heterogeneous arch. platforms)
  - Communication (due to application characteristics and platform concurrency)

Typical Application: The Intel MXP5800

- **Complete Solution for high performance Digital Imaging Applications**
  - **Multifunction Printers**
  - **High End scanners**

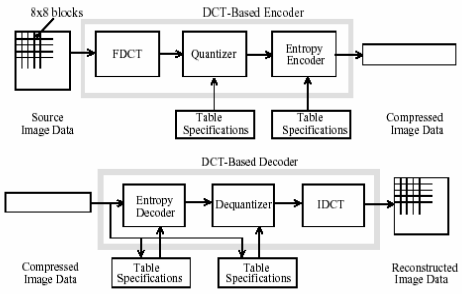
Challenge for Platform Reuse



Challenge #1 Mapping

Intel Project Overview

- Initially explore mapping of JPEG encode/decoder application
- Choose the abstraction level and mapping strategy such that results correlate with actual implementation



From: G. K. Wallace, The JPEG Still Picture Compression Standard

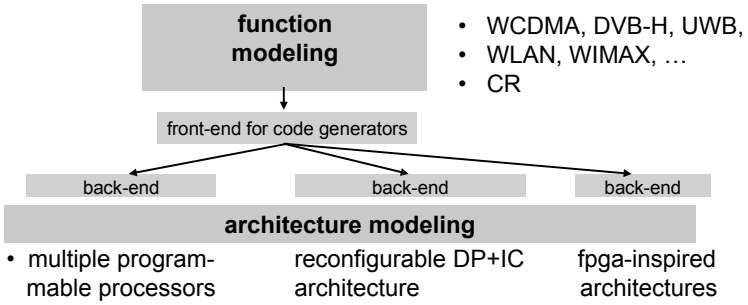
Xilinx Collaboration

- Create a flow to characterize performance of Xilinx designs.
- Create Metropolis Models of Xilinx CoreConnect Components
  - Create models of architectural families based on overall topology of components.
  - Various abstraction levels
  - Tie into the EDK flow for implementation
- Produce Metropolis Functional Model of well examined application using Xilinx HW
  - JPEG2000 strong candidate
- Enhance mapping infrastructure to support the co-simulation of such models.
- Examine the results of the co-simulation and characterization in order to draw conclusion regarding design space exploration of Xilinx based designs in Metropolis.

Infineon technologies

stop thinking Never

Proposal for Common Framework for Cognitive Radios

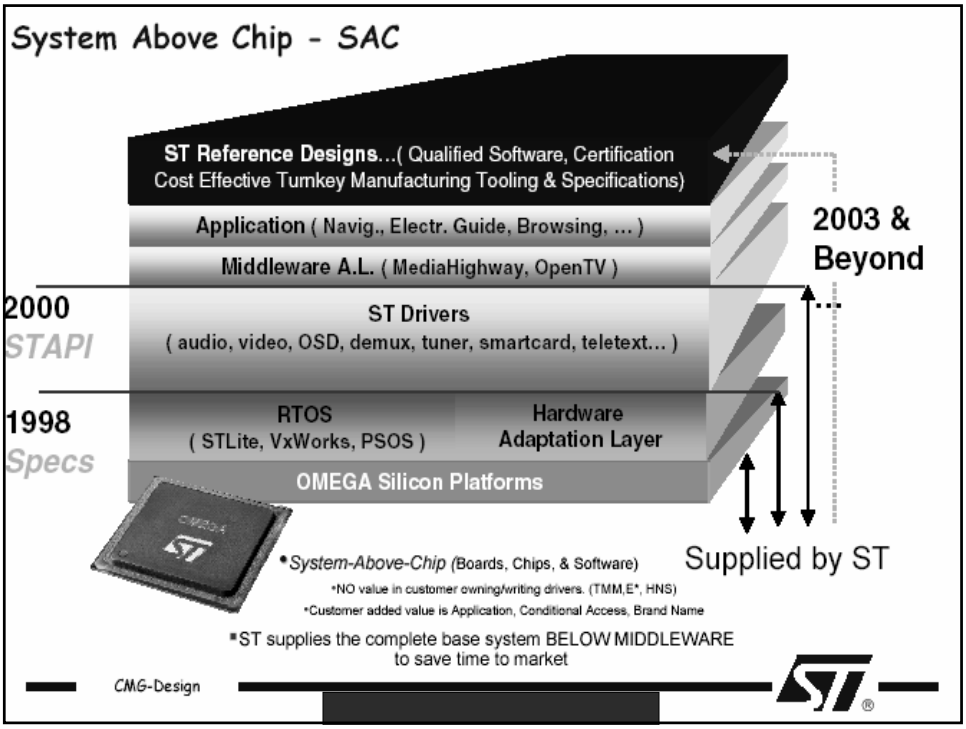


- WCDMA, DVB-H, UWB,
- WLAN, WIMAX, …
- CR

- multiple program-mable processors
- reconfigurable DP+IC architecture
- fpga-inspired architectures

Common Research Agenda:

- benchmarks
- real-time in f&a space
- common rules for modeling
- connection between function and architecture model
- systematic design space exploration
- synergy in designing code generators
- „Future-proof“ framework for Function&Architecture Modeling (Matlab, Simulink, **Metropolis**)



Concluding Remarks

- Rich interaction with industry
- Different domains addressed: IC, Systems (e.g., Automotive, Avionics, Defense, Consumer), Tools
- Impact on research agenda and on product development
- Escher provides a wealthy model to support and distribute results from our research to maximize impact both ways
- Escher complements and extends traditional approach to industrial interaction and tool distribution tested for years at Berkeley