Overview of
BEACON

Center for the Study of Evolution in Action

STC Directors' Meeting
August 30, 2010

Erik Goodman, Director
Michigan State University

BEACON

Center for the Study of Evolution in Action

MISSION:

Illuminating and harnessing the power of evolution in action to advance science and technology and benefit society

HQ: MICHIGAN STATE UNIVERSITY

Partners: UNIVERSITY OF WASHINGTON, University of Idaho, North Carolina A&T State University, THE UNIVERSITY OF TEXAS

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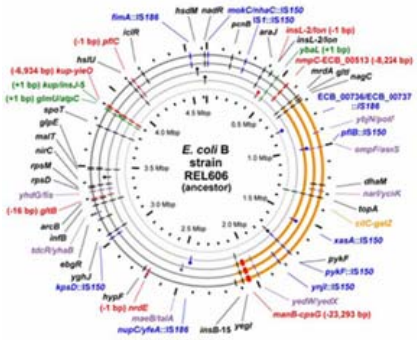
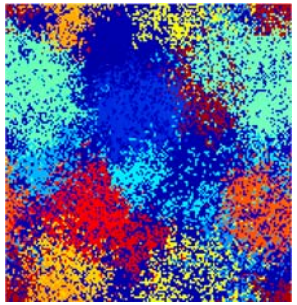
BEACON's Cross-Cutting Themes Span Evolution in Action



Evolution Going on Today in Nature

- **Strong teams, fast-developing collaborations provide many unique resources for lab and field study of evolution in action**

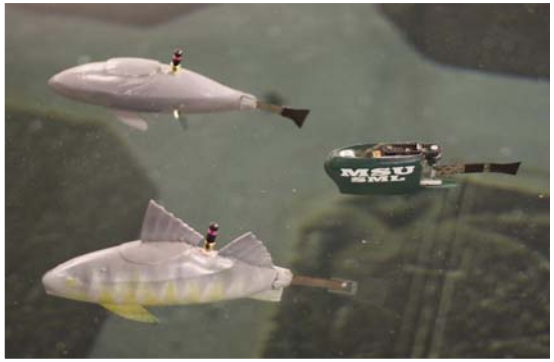


Digital Evolution

- **Avida framework and other software are strong tools for examining evolutionary dynamics, doing experimental evolution, and are being shared across institutions**

Evolutionary Applications

- **Researchers across BEACON are advancing the state of the art in engineering design, computer security, and other applications of evolution principles, using tools developed at multiple partners**



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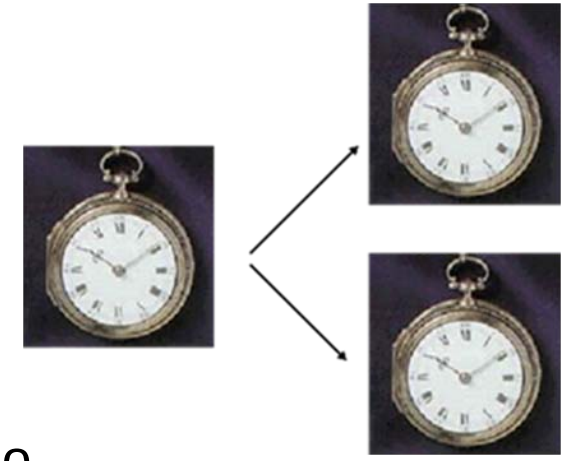
Core Premises of the Crosscutting Themes

- "**The process of natural selection is substrate-neutral** … evolution will occur whenever and wherever three conditions are met: replication, variation (mutation), and differential fitness (competition)." — Daniel Dennett



- **Evolution can be harnessed** to produce useful functions not only in biology but also in software, robotics and other realms.

- Biology and computation often involve optimization with **multiple objectives** leading to mutations with **side effects** (pleiotropy) and **complex interactions** (epistasis).

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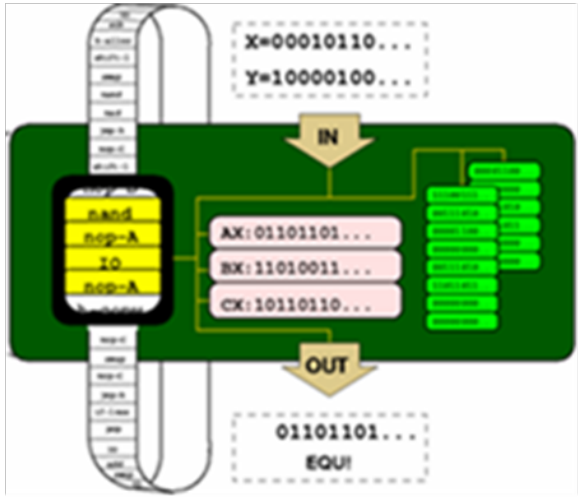
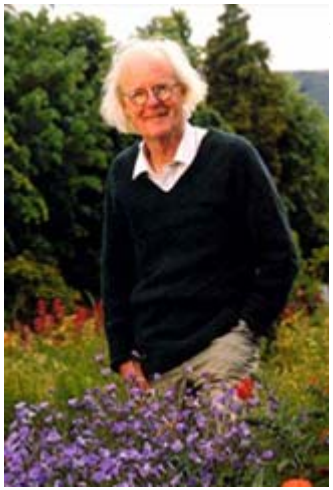
What Can Computer Science Do for Evolutionary Biology?



Claus Wilke
Univ Texas



- **Ideal for Seeing Evolution in Action**
  - *Super-fast* generations, exact environments
  - *Automated* genotypic, phenotypic analyses
  - *Time travel* preserving every intermediate
- **Deep analyses stimulate biology research**
  - For example: "Survival of flattest" in digital organisms (Wilke, Ofria et al., *Nature*, 2001) → now 150+ citations including experiments in viruses, bacteria, yeast
- **Search for universal principles**

"So far, we have been able to study only one evolving system, and we cannot wait for interstellar flight to provide us with a second. If we want to discover generalizations about evolving systems, we will have to look at artificial ones." – John Maynard Smith

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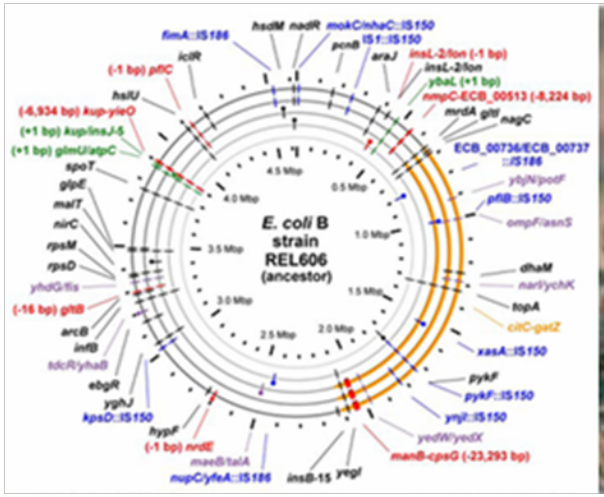
Research Thrust Groups

- Evolution of Genomes, Networks and Evolvability
- Evolution of Behavior and Intelligence
- Evolution of Communities and Collective Dynamics



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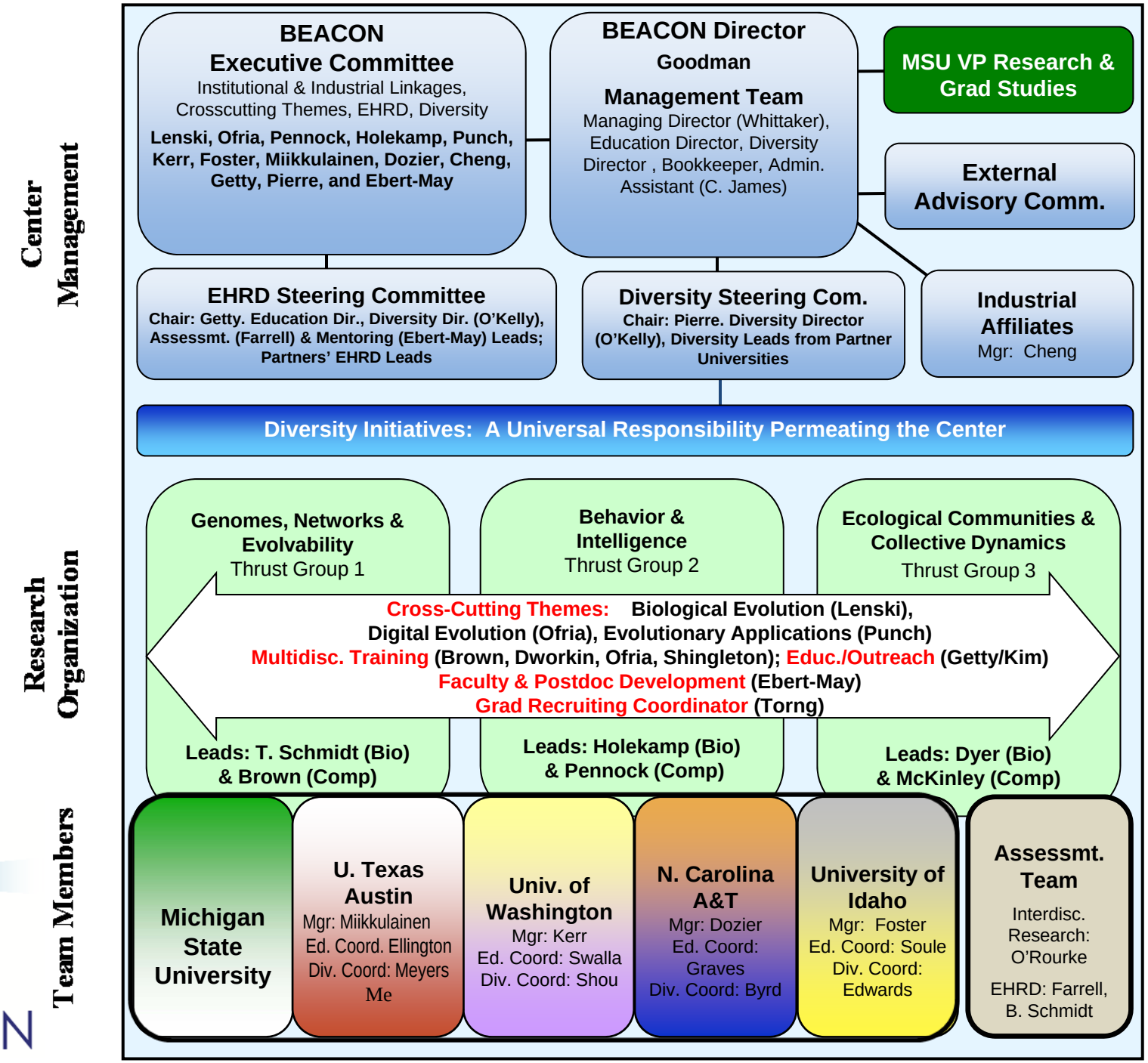
A Highly Evolved Team


Center Management
BEACON Executive Committee
Institutional & Industrial Linkages, Crosscutting Themes, EHRD, Diversity
Lenski, Ofria, Pennock, Holekamp, Punch, Kerr, Foster, Miikkulainen, Dozier, Cheng, Getty, Pierre, and Ebert-May
BEACON Director
Goodman
Management Team
Managing Director (Whittaker), Education Director, Diversity Director , Bookkeeper, Admin. Assistant (C. James)
MSU VP Research & Grad Studies
External Advisory Comm.
EHRD Steering Committee
Chair: Getty. Education Dir., Diversity Dir. (O'Kelly), Assessmt. (Farrell) & Mentoring (Ebert-May) Leads; Partners' EHRD Leads
Diversity Steering Com.
Chair: Pierre. Diversity Director (O'Kelly), Diversity Leads from Partner Universities
Industrial Affiliates
Mgr: Cheng
Diversity Initiatives: A Universal Responsibility Permeating the Center
Research Organization
Genomes, Networks & Evolvability
Thrust Group 1
Behavior & Intelligence
Thrust Group 2
Ecological Communities & Collective Dynamics
Thrust Group 3
Cross-Cutting Themes: Biological Evolution (Lenski), Digital Evolution (Ofria), Evolutionary Applications (Punch)
Multidisc. Training (Brown, Dworkin, Ofria, Shingleton); Educ./Outreach (Getty/Kim)
Faculty & Postdoc Development (Ebert-May)
Grad Recruiting Coordinator (Torng)
Leads: T. Schmidt (Bio) & Brown (Comp)
Leads: Holekamp (Bio) & Pennock (Comp)
Leads: Dyer (Bio) & McKinley (Comp)
Team Members
Michigan State University
U. Texas Austin
Mgr: Miikkulainen
Ed. Coord. Ellington
Div. Coord: Meyers
Me
Univ. of Washington
Mgr: Kerr
Ed. Coord: Swalla
Div. Coord: Shou
N. Carolina A&T
Mgr: Dozier
Ed. Coord: Graves
Div. Coord: Byrd
University of Idaho
Mgr: Foster
Ed. Coord: Soule
Div. Coord: Edwards
Assessmt. Team
Interdisc. Research: O'Rourke
EHRD: Farrell, B. Schmidt

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BEACON Status

- Beautiful new headquarters, already full of students, and remainder of management team is being assembled: 2 just hired, 2 others posted
- Abbreviated BEACON Fellowship competition resulted in 5 awards accepted (funded from MSU cost share and other non-NSF funds) (60% women).
- Abbreviated grad student recruitment process yielded new BEACON grad students, including many new minority and women students
- Three courses for new BEACON grad students are being offered this year, sharing among partners
- Year 1 projects (research, education, outreach) selected and initiated, so hiring of grad assistants and postdocs has been done at MSU, partners
- First BEACON Congress was held Aug. 11-13, bringing together 150 BEACON participants (from all 5 universities) to generate new ideas for multidisciplinary/multi-institutional projects for 2010-11

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Good News—An Endowed Chair

- With the award of BEACON, the sponsor of the Koenig Endowed Chair, in the College of Engineering, has agreed to target it to BEACON's evolutionary applications theme
- An international search for applicants is already underway, with interviews to be held in the fall
- Discussions for a complementary chair in the biological sciences are underway

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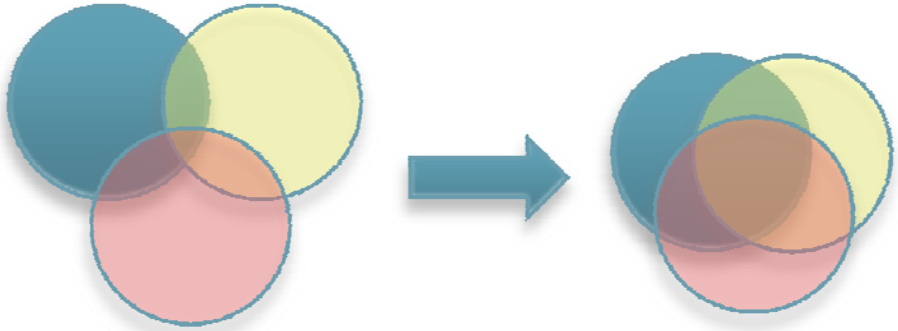
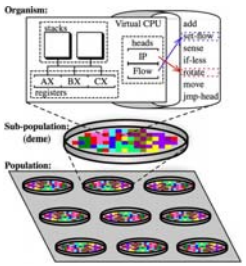
How Does BEACON Advance Science and Technology?

- "Nothing in biology makes sense except in the light of evolution." – Dobzhansky
- Evolutionary dynamics are tough to see in lab and field—and slow…
- BEACON's work in its three cross-cutting themes lets us study these dynamics more effectively
- A new generation of researchers will "grow up" with concepts and tools from all three themes *unified* in their approach to studying evolution, amplifying their scientific power



How Does BEACON Benefit Society?



- Improved understanding of evolution in action yields gains in environmental sustainability, computer security, engineering design methodology, biological mechanisms, health, and other areas
- More fundamentally: Society misunderstands science
  - Much of this misunderstanding stems from misunderstanding of evolution
  - BEACON can help to put “Evolution in Action” before the eyes of students of all ages, diverse groups
  - That can potentially change students’ ideas about evolution, at least as it goes on in the world today
  - That may help change people’s perceptions toward science in general, including global climate change and other issues critical to society

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