Center for Cellular Construction – Year 3 Executive Summary

Center vision

To develop an engineering discipline that will allow to design and build cells and tissue with specific three-dimensional structures. These structures will serve as living factories and building blocks for developing better and sustainable products, materials, and devices to benefit humankind.

Center structure

The Center for Cellular Construction (CCC) is **an NSF Science and Technology Center (STC)**

25 research and education faculty members from six Institutions (UCSF 11 faculty, SFSU 8 faculty, IBM 1 faculty, Stanford 2 faculty, UC Berkeley 2 faculty, Exploratorium 1 faculty) .

Timeline and renewal

The CCC was funded in October 2016 with funding for 5 years. We are currently in the middle of year 3, almost exactly halfway through our planned lifetime. We will submit a renewal application in **December 2019** to extend the Center for another five years.

Year 3 Highlights

- 41 active collaborations among center groups
- John Dueber (UCB) has joined the CCC to explore engineering the peroxisome
- Robert McGinn (Stanford U) has joined the CCC to develop the CCC Ethics program

- Research Highlights
  - Implemented Machine learning in to all projects
  - Programmable tissue self-assembly via origami and synthetic signaling
  - Developed a data-driven approach to CellCAD using vector space formalism
  - Conducted first experiments testing biochemical output versus organelle size
  - Designed deployable microscopes to infer cell state and environmental pollutants
  - Center-wide research output to date (October 2016 – present):
    - 61 publications published or submitted.
    - Collaborative publications increased from 4% pre-center to 30% in 2019.
    - 121 talks and 128 posters.

- Education Highlights
  - Launching the Cellular Engineering Summer School July 2019
    - Undergraduate and graduate students
    - Two week immersive project-based learning
    - Patterned on Woods Hole style summer courses
    - Faculty from UCSF, SFSU, UC Berkeley, Stanford, IBM
    - Held at the SFSU campus, long-term plan to be self-sustaining course
  - Two new undergraduate courses at SFSU launched by CCC faculty
    - Introduction to Cellular Engineering (offered in Spring 2019)
    - Introduction to Optical Engineering for the Biological Sciences
    - Developed and taught by CCC faculty
  - High School student-teacher workshop becoming self-sustaining
    - 2 week workshop using Mindstorms robots to model cell biology
    - Two sessions ready to start summer 2019

        - 10 teachers, 14 students per session
        - Session I: Students and teachers are paid a stipend to take part
        - Session II: Students and teachers pay to participate
        - Starting in year 4 the program will become self-sustaining
    - 46 undergraduate students involved in center lab research
        - 3 undergraduates authors on center publications
        - 22 undergraduate posters at national meetings
    - 5 CCC undergraduates and 7 CCC masters students enter Ph.D. programs
    - IBM Internship program launched with 4 center students
        - 3 month paid internships at IBM Almaden Research Center
        - 2 Ph.D. students from UCSF, 2 Masters students from SFSU
    - Exploratorium Internship program launched (3 center students, 3 months)

- Knowledge Transfer highlights
    - First round of internal knowledge transfer seed funding awarded
    - CCC prompted the UCSF Catalyst program to add an engineering-oriented "bio-tools" track for early-stage seed funding of commercializable ideas
    - 9 Invention Disclosures written, 4 patent searches underway, one being filed
    - 10 active industrial collaborations

Changes in response to October 2018 site visit:

- Add formal Program Management expertise
    - Dr. Kristin Dolan (Program Management Consultant)
    - Dr. Tom Daniel (UW, former NSF Center Director) joins EAC
- Changes in leadership team
    - Wendell Lim stepped down as co-director to focus on founding a new institute
    - William Chadwick was hired for web development and meeting organization
    - Jennifer Thompson was hired to support center administration
    - Internal Advisory Committee handles routine planning and decision-making
- Shift focus of education program to "higher" education
    - High school program transitioning to self-sustaining status
    - Outreach activities are now organized by The Exploratorium
    - Developed Summer School and two undergraduate courses on cellular engineering
- Created a strategic reserve fund to allow budget flexibility
- Held a mid-point Strategic Planning Meeting February 2019
    - Update goals and milestones to reflect evolution of center ideas
    - Focus on synergy between projects
- Ethics training takes concrete form
    - Dr. Robert McGinn (emeritus Stanford U.) was hired as adjunct Professor, UCSF, to spearhead ethics education and discussion within the CCC
    - Survey on ethics attitudes developed for CCC members, currently awaiting IRB approval
- Established a strategic reserve fund of $300,000 for last two years
- CCC Visibility
    - CCC logo T-shirts, signs, magnets, and coffee mugs distributed to all members
    - @C3STC twitter feed 50% tweets liked or retweeted by @NSF_BIOLOGY
    - CCC hosting qBio 2019 summer meeting (200 attendees, 45 speakers)

Diagram of active research collaborations in Year 3
(black) research collaborations. (red) education collaborations