MAE MECHANICAL AND AEROSPACE ENGINEERING

Crowd Control: Engineering Collective Cell Behaviors

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Biological tissues can be regarded as communal, active materials whose form and function derive directly from the collective behaviors of the myriad cells that comprise them. An interdisciplinary approach—drawn from control theory, fluid mechanics, materials science, and swarm theory—has afforded us an unprecedented view of the mechanics underlying such collective systems. My work posits that understanding such collective cell behaviors should allow us to control them, just as a shepherd understands how to use sheepdogs to control a flock of sheep. This is especially exciting in the context of tissues, where new engineering rules and tools premised upon collective behaviors will help us address growing challenges in both biomechanics research and biomedical technology development.

I will present two, complimentary examples of such collective engineering—Outside-In and Inside-Out control. Outside-In control relies on external control cues to guide collective behavior, an example of which is my work to remotely herd collective cell migration using programmable, bioelectric cues and living tissues. By contrast, Inside-Out control relies on the "wolf-in-sheep's-clothing" motif, where I have created a micro-fabricated biomaterial that can trick surrounding cells into interacting with it as if it, too, were a cell. Building on these examples, I will present a vision of how understanding collective mechanics and developing collective engineering approaches will enable us to better engineer tissues and future materials.

Daniel J. Cohen is currently a Life Sciences Research Foundation Fellow in the Department of Biology at Stanford University. He holds a B.S.E. in Mechanical Engineering (Princeton, 2008), and a Ph.D. in Bioengineering (UC Berkeley / UCSF). His work includes inkjet bioprinting, highly elastic strain gauges, dinosaur biomechanics, cellular herding, and biomaterials design. The unifying theme in his research is the application of engineering approaches to controlling collective behaviors.

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