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SFI @ 25: Very Few Cells Remain Unchanged

By David C. Krakauer, Professor and Chair of
the Faculty

In the infancy of societies, the chiefs of state shape their institutions; later the institutions shape the chiefs of state.

—Charles de Secondat, Baron de Montesquieu,
The Spirit of the Laws, 1748

SFI has now reached its 25th year. The Institute was imagined and realized by a visionary group convinced of the merits of pursuing general principles rooted in diverse, empirical phenomena. These principles would account for regularities in the complexities of adaptive systems spanning the broadest range of material characters. Through a succession of projects and personnel, SFI has grown to the stature of an internationally respected institute, with an influence significantly greater than its size might suggest, and a reputation reaching far beyond academia into business, government, and policy making.

The Institute has succeeded by pursuing theory in areas where quantitative data is abundant, where new concepts are recognized as being needed, where new computational tools might be exploited, and, equally crucial, areas that the majority of universities and institutes have ignored for falling too far from familiar disciplinary concerns. The strength of SFI has been its continued evolution, combined with a willingness to take risks and suffer the consequences, while striving to move beyond the particular concerns of its genesis. SFI is like a developing body, which remains identifiable through time but in which very few cells remain unchanged.

It is said that imitation is the sincerest form of flattery, and now that SFI's once risky research investments have yielded abundant returns, the concept of SFI is being emulated and recreated in a variety of forms elsewhere. With the shock waves from the breakdown of financial markets penetrating all spheres of society, there is some sense that the vision of SFI is more important than merely new academic or business models, and that it points towards a new framework for risk-prone collaborative research in universities and elsewhere. And at just such a time, SFI itself is reconfiguring.

This year SFI, in common with many other organizations, has been forced to eliminate positions and reduce budgets. In addition, our President, Geoffrey West, is stepping down to assume a faculty position at SFI. Our Vice President for Development, Shannon Larsen, is shifting over to the Business Network, and our Chair of the Board of Trustees, Bill Miller, is stepping down from the chair to re-join the Board. The opportunities these changes offer are great, and the science being generated is more exciting and relevant to our contemporary concerns than it has ever been.

So what is the character of complexity science at SFI? Wary of definitions, let me provide an example from one of my own research interests: the analysis of genomes. Traditionally, genetics was grounded in biochemistry, with a “disciplinary” approach of sequencing DNA and measuring gene activity. As the data increased, researchers catalogued the networks of interactions among molecules, and the genome became represented as a matrix of connections—some activating, others inhibiting. At this point, questions of the stability and complexity of these networks became major concerns, forging a link with ecology, where researchers seek to understand the emergent properties of networks of interacting species. As the functional implications of these “ecological” patterns of activity started to surface, we began to see how the matrix of interactions could give rise to coherent patterns of activity resulting from regular inputs to the system. Thus, the genome became a computational system, and questions of memory storage and information processing now dominate research.

A single mechanistic complex—the genome—thus penetrates at least three frameworks, all of which continue to contribute valuable insights into the way the genome functions, and most important, establish new connections and descriptions that serve as the raw material for subsequent forms of integrated analysis and inquiry. The same type of embedded cross-disciplinarity applies equally well to work on social systems, microbial dynamics, food webs, metabolic networks, and urban systems. This process of scientific construction, building hierarchies of nested representations, is greatly facilitated at SFI by encouraging discussion among diverse groups of scientists expert in



wide ranges of subjects. These groups are both interdisciplinary and oriented towards the search for powerful new principles and techniques.

Speaking of the emergence of the great geography and cultures of Mesopotamia, Francis Sales Betten wrote: “This Oasis is the work of the Tigris and Euphrates.” There have always been two currents organizing the Santa Fe Institute. One is inter- or trans-disciplinary, searching for solutions to the wealth of problems that lie on the membranes defining the interface of fields. The other is a search for general principles of complex, adaptive systems.

Interdisciplinary observations provide the comparative database upon which to build new synthetic theories. I increasingly see the strength of SFI as an institutional device designed for aggregating people, models, and theories around observations of interest, and when possible, seeking to unify these ideas under a general framework we label, for practicality, complexity theory. At present, complexity theory represents a significant body of ideas and methods of great value for understanding adaptive and historical phenomena from a large variety of domains.

This edition of the Bulletin provides representative insights into the current range of interests at SFI and the manner in which projects are initiated and pursued. The contributions further illustrate the importance of both exceptional individuals and the unique mechanisms for promoting collective and collaborative activity. There is little doubt in my mind that SFI remains the most systematically inclusive and diverse theoretical research environment in the global, academic community in the early 21st century. ◀