“The Web of Life: A New synthesis of Mind and Matter”, by Fritjof Capra, Harper Collins, Pounds 18.00 (1996).

That the story of the universe is one of unfolding complexity is almost self-evident. From the interactions of subatomic particles to the complex phenomenon of life, from the geological processes to the structure of galaxies, the canvass of nature is vast, the interconnections enormous. Yet, for centuries, we have been led to believe that the way to understand the universe is through the reductionist paradigm. That is, take a system, break it up into small, manageable parts, understand the workings of each individual entity and presto, we would have understood the whole. This approach has yielded phenomenal dividends from the time of Newton and Descartes. Indeed the whole edifice of contemporary science and technology is based on the foundations of the mechanistic , reductionist principle. Undoubtedly, the stupendous achievements of science in unraveling the mysteries of diverse entities like the atom , the DNA molecule and even the space-time continuum , are not to be underestimated.

Nevertheless, there are many systems and phenomena which have not yielded to the reductionist logic. The turbulent flow of water, the working of the human brain, the evolution of life from the primordial soup of chemicals, the unpredictability of weather are some well known examples. In these and other similar systems, the reductionist paradigm of the whole being the sum of parts has not succeeded. Indeed, the study of such systems, collectively referred to as complex systems is by far the most exciting development in science in the last few decades.

What are complex systems? Though there is no single definition or characterization of complexity, it is agreed by most researchers in the field that a defining characteristic of a complex system is that it consists of a great many independent agents interacting in myriad of ways. These agents could be molecules in the primeval soup, or neurons in the brain or even economic agents in a society. The truly amazing thing about complex systems is that though these agents are acting independently, the richness of interactions results in a spontaneous self organization of the system as a whole. Organisms, because of their adaptation to the environment, spontaneously organize themselves into an elaborate and fine tuned ecosystem. Apart from these defining characteristics, there is another special property which is seen in most systems which exhibit complex behavior. This is the property of adaptation. For instance, the human brain, an outstanding example of a complex system, obviously is an adaptive system since the connections between the neurons (synapses) are constantly being updated and reorganized to enable learning.

An important distinction needs to be made between complex systems possessing the above characteristics and systems which are complicated. The space shuttle is a complicated system but not a complex one. This is because of the inherent dynamics of these systems. In the past few years, there has been a great amount of interest in chaotic systems. These are systems in which apparently simple rules governing the behavior of the system gives rise to an amazing canvass of intricate behavior. A well known example is the formation of eddies in the flow of a water stream. Complex systems are not quite in the chaotic regime but instead hover on the edge of chaos: the delicate balance between order and chaos.

The study of complex systems, variously called complexity, nonlinear dynamics and dynamical systems theory, is increasingly playing a crucial role in our understanding of a variety of hitherto ill understood systems. The numerous applications of adaptive neural networks, algorithms for optimization problems, an understanding of certain class of chemical reactions and even the workings of the stock market are some of the areas of application of this novel approach. But by far the most important contribution of complexity has been to shed light on the enigma of biological systems. And this is what Fritjof Capra's new book is all about.

Capra is the author of the hugely successful "The Tao of Physics" and " The Turning Point". A particle physicist by training, he has over the last few years been interested in ecological debates and the Green movement. In the "Web of Life", he wants to " propose an overall synthesis that integrates the new discoveries into a single context and thus allows lay readers to understand them in a coherent way. "

It is Capra's contention that the new understanding of life is not merely a matter of details which need to be filled in the old, mechanistic canvass, but is indeed the forefront of a change of paradigms from a mechanistic to an ecological one. He is proposing a synthesis of all the current theories as an outline for a unified view of mind, matter and life.

He starts with giving a broad overview of the cultural context in which his argument his situated. One of the most important influences in his thinking has been the philosophical idea of "deep ecology", founded by the Norwegian philosopher, Arne Naess in the early seventies. Deep ecology, as the name suggests, defines itself in opposition to shallow ecology, which is anthropocentric and is mostly instrumental vis-à-vis nature. Deep ecology, on the contrary, looks at nature as a network of phenomenon which are interdependent and in which the whole natural environment is viewed as a single entity. In this sense, the worldview is ecological rather than holistic. A holistic worldview, though often used synonymously with ecological in some writings, is probably more apt in cases where the system boundaries are more or less clearly defined. An example could be a holistic understanding of an automobile would look at the whole system rather than break it up into its constituents, while an ecological understanding would necessitate an integration of the effect of automobiles on the biosphere, the sociological dimensions etc.

There is another aspect of the new "vision" which makes it novel. It places life at its center and in this implies a fundamental shift away from mechanistic metaphors. Since the time of Newton and Descartes, the dominant metaphor in science has been Cartesian in which physics stands at the heart of our understanding of nature. Capra claims that the paradigm has shifted to life sciences and it is in biology that the crux of understanding nature is to be found.

Lest one thinks that this is all philosophical verbal effusion, Capra tells us about the science of complexity and the new developments in emergent systems which allow one to understand complex systems such as the brain or the stockmarket. He has a chapter on the Models of self organization where the many systems like chemical systems in the presence of certain catalysts, neural networks, strongly interacting particles, and even the Gaia theory find a place. Unfortunately, the discussion on each one of them is to superficial to be of any use. Another chapter on the Mathematics of Complexity fares even worse. Instead of giving one some insight into the revolution brought about by the new ways of looking at complex systems, what one gets is verbiage and mathematics at the level of high school algebra. The whole realm of nonlinear systems, fractal geometry and other exciting topics is dealt with cursorily.

Most of the book is given to explaining the work of a few scientists like the Belgian chemist Ilya Prigogine, the Chilean biologist Francisco Varela and to some extent the Gaia pioneer, Lynn Margulis. While each of this work is very important, it is by no means uncontroversial. For instance, there are serious reservations among biologists about the details of Varela's autopoiesis and his recent work on the immune system. But these minor details do not bother Capra who seems to have a single minded agenda of promoting his new "vision ". Besides, apart from these few scientists, there are many more working in complex systems which have a different view point, which are not even referred to in the book. If you are attempting a grand overview of the subject, then it is only fair to lay all the positions in the field on the table and let the reader decide.

There are other major problems with the book. His predominant style of reasoning seems to be by analogy. Now analogies may be wonderful devices for pedagogy or even thinking, they are not substitutes for good, old solid argumentation. This style of his has paid him rich dividends in his earlier bestseller, " The Tao of Physics" where he seems to have seen amazing similarities between modern particle physics and Eastern mysticism A particular Zen kaon has eight syllables and there is an eight fold symmetry in certain elementary particles, ergo, the deep rooted connections between the two!!!! This kind of writing, replete with names dropping and analogies will bring you fame and fortune but will unfortunately leave the readers totally confused. (On a personal note, I once had a student come up to me and say that he wants to do a Ph.D. in "New Physics" which according to him meant exploring the eastern roots of particle physics !!) The footnotes in the book are also self referential in that they refer to each other!! This is extremely annoying and though Capra says in his preface that it is deliberate to emphasize the interconnectedness, we can do without such "complexity" in literary style.

Read the book if you want to carry out a drawing room conversation about the fascinating field. If you want to learn about the subject in any depth, I am afraid you need to find another book.