Vignettes: Artificial Life

There are . . . many ways in which to attack the problem of artificial life. The earliest, dating back at least to the Greeks, had been to copy the form of living things as perfectly as possible: *true to life*, like the waxworks at Madame Tussaud's. Later, the challenge was to make things move. The most famous example is Vaucanson's artificial duck, built towards the middle of the eighteenth century and unfortunately lost today, a marvel of mechanical ingenuity able to drink, eat, quack and splash about. . . . Two hundred years later, the interest had shifted from animation to replication. Gone was the quack of the duck; gone were the flesh and bones and all that is called, in the jargon of today's computer biology, the *wetware*. It's all reduced to coded blueprints nowadays.

—*Karl Sigmund,* in *Games of Life: Explorations in Ecology, Evolution, and Behaviour* (Oxford University Press)

The myth of artificial, man-made life is found in many cultures. In Greek mythology, Hephaestus created golden mechanical women to help him in his smithy ("There is intelligence in their hearts, and there is speech in them/and strength, and from the immortal gods they have learned how to do things," sang Homer in the *Iliad*), and built Talos, a giant warrior to protect Crete. In Jewish tradition there is the story of the Golem . . . . In China, Kung Mu of the Chou Dynasty built a robot; in Japan there is the twelfth-century tale of the wizard Mononaka, who created several automata, some of which, unbeknownst to anyone, became leading politicians.

—*Steven Lubar,* in *Infoculture: The Smithsonian Book of Information Age Inventions* (Houghton Mifflin, forthcoming)

mals, sources of funding for the development of alternatives to the use of vertebrates, high school science fairs, and the implications of animal welfare issues for the publication policies of scientific journals. Modern science is an international enterprise, and Orlans's treatment of these topics is enhanced by coverage of the legal and moral climate for animal research in Europe, Canada, and Australia.

Orlans has a point of view, and the book will no doubt draw fire from critics on both sides of the animal research controversy. By and large, she advocates compromise. Her discussion of the ethical issues raised by the experimental use of dogs and cats obtained from animal shelters is representative of her attempt at a middle ground. She reviews the history of the use of pound animals in research, describes recent legislation related to the issue, and evaluates the relative advantages and disadvantages of using these animals as subjects. She argues that dogs that were at one time family pets do, in fact, suffer more from confinement in laboratories than purpose-bred animals that have been raised in kennels from birth. On the other hand, Orlans acknowledges that pound animals are considerably less expensive to obtain and have an ethical advantage in that the vast majority of them will be euthanized anyway. She proposes a compromise that will satisfy neither animal rights activists nor their adversaries in the biomedical community. She believes that much of the suffering experienced by pound animals is a consequence of their being maintained for extended periods in laboratories and of the transportation process and advocates a policy whereby pound animals would only be used as subjects in terminal experiments of short duration undertaken within 24 hours after the animals are taken from shelters.

In the Name of Science does not gloss over the moral quagmire conveniently ignored by dogmatists on either side of the debate. Unlike Guillermo, Orlans clearly understands the relationship between animal research and biomedical progress. But, in contrast to Strand and Strand and Simon and Lutherer, she also acknowledges the ethical paradox that confronts animal researchers—we use animals because they are similar to us in behavior or physiology, but similarity in behavior and biology implies similarity of mental experience. Thus the more justified the use of a species on scientific grounds, the less justified is its use on ethical grounds.

Finally, there is some evidence to suggest that public sympathy for animal activism may be on the decline. I recently analyzed trends in media coverage of the animal rights movement by counting the number of articles on the topic that were listed in InfoTrac, a computerized periodical index, and in the *Readers' Guide to Periodical Literature*. Data from both sources indicate that the number of articles on the movement in magazines and newspapers peaked in 1990, with a substantial decline since then. There was a strong and visible anti-vivisection movement in the United States at the turn of the century. By 1920 the movement seemingly ran out of steam, not to emerge again until the mid-1970s. It is possible that public interest in animal protection, as in certain other social phenomena (drug addiction, for example) is, by nature, cyclic.

The effect that animal rights activism will ultimately have on the conduct of science remains to be seen. But, almost certainly, the long-term solution to the practical problem of facilitating biomedical progress while at the same time reducing numbers and suffering of experimental animals lies largely within the province of Donnelley's troubled middle. Thus Orlans's book will, in the long run, be considerably more important than diatribes from either extreme.

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Spy Secrets

Beyond the Wall. Memoirs of an East and West German Spy. WERNER STILLER, with Jefferson Adams (editor and translator). Brassey's (US), McLean, VA, 1992 (distributor, Macmillan, Riverside, NJ), and Maxwell Macmillan, London. xxii, 240 pp., illus. $25 or £19.95. Translated from the German edition (Mainz, 1986).

The fall of the Berlin wall four years ago not only unleashed a chain of events leading to democratization in East Germany and unification for all but also opened a Pandora's box of troubling secrets previously locked in a heavily fortified complex of buildings in East Berlin: the Ministry for State Security, or Stasi—East Germany's secret police and intelligence agency. Since unification, every citizen has been given the right to see his or her file, and the files have also been used or misused to exonerate or condemn citizens ranging in profession from public servant to scientist. In the world of science, most of the Stasi activity that has become known consists of cases of scientists who worked as informal staff members, or informants (*inoffizielle Mitarbeiter*), for the Stasi.

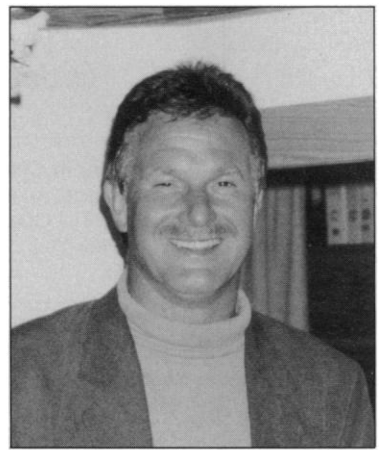
This book, first published in German in 1986 under the title *Im Zentrum der Spionage*, provides an absorbing account of the science espionage enterprise from the vantage point of a case officer in the nuclear physics department at the Stasi's Berlin headquarters.

While Werner Stiller is well known in Germany, most of the English-speaking world is unaware of the secrets he has revealed. Stiller worked for the Stasi from 1970 to 1979, starting as a part-time agent, going to the Stasi's training school, rising to first lieutenant, and becoming a double agent before he defected to the West in 1979 at the age of 31. After his defection he was sentenced to death in absentia by an East German court and lived under a new name in America and England, only stepping onto the public stage when a reporter recognized him in his new identity as a banker at the Frankfurt stock exchange in 1991. Since then he has appeared in public several times and has begun to take part in the national working through of East Germany's Stasi past. Although the book ends with Stiller's defection to the West in 1979, its availability in English in the context of the post-wall openness should allow a broader public to gain a new understanding of the Cold War years.

A Stasi officer approached Stiller about becoming an informant when he was a physics student at the University of Leipzig, a common recruiting ground for the secret service. Back then Stiller was an exemplary socialist and had all the most promising characteristics of a loyal citizen of the German Democratic Republic, being a member of the Free German Youth and of the Socialist Unity Party (SED). After some "tests" and the traditional rites of passage for a Stasi novice, and after receiving his master's degree in physics, he was assigned to the staff of East Germany's Physics Society for a year to further his intelligence training. Located in the heart of Berlin, this society was responsible for organizing scientific meetings and projects and cooperated with groups in other countries. Robert Rompe, East Germany's leading physicist and a member of the SED Central Committee, chaired the society. Its secretary was Reinhard Linke, who Stiller later found out was the Stasi man. In addition to its legitimate and important scientific function, the Physics Society became a Stasi clearinghouse for all Western physicists who visited East Germany for professional reasons. Stiller reports that every visitor had an East German colleague attached to him who was responsible for writing a report that then went to Linke, to the international relations division of the Academy of Sciences, and to the extensive Stasi file on the Physics Society. These dossiers included character profiles of political attitudes and personal weaknesses and habits along with professional and other personal information.

It was at the Physics Society that Stiller began his first double life: by day he worked at the society, and in the evening he met his case officer in the safe house for training in initiation of personal contacts, surveillance techniques, and the use of dead-letter drops. During this extensive training program Stiller learned that his specialty was going to be espionage against the West.

After a year, in August 1972, Stiller had done so well that he was promoted to the Chief Intelligence Directorate (Hauptverwaltung Aufklärung, or HVA), the Stasi's foreign intelligence branch, and received the rank of lieutenant while being assigned to the nuclear physics department. During his seven years there Stiller created a domestic network of 30 people while placing agents in the West; in fact, recruiting, training, and running agents for the collection of information were his chief activities. But, according to Stiller, during these years he became painfully disillusioned with the East German communist regime and decided to work secretly for the West German Intelligence Service (Bundesnachrichtendienst, or BND).


Werner Stiller, East Berlin, 1993. [Courtesy B. Priesemuth]

Stiller worked in division XIII of the HVA's Sector for Science and Technology, which included specializations in physics, biology, chemistry, and medicine. According to his estimate in the book, the science sector employed approximately 200 officers and 2000 agents at home and abroad (he has recently revised the latter figure to 400). There were three other divisions in the science sector—for the summary and dissemination of the information, for microelectronics and instrument construction, and for vehicle and ship construction and aviation.

The nuclear physics department attempted to gather intelligence material regarding efforts in atomic weaponry, and West Germany was its primary concern. The department's objective was to acquire any scientific or technical information that could help East Germany's shaky economy. The Soviets, whose own efforts were concentrated on the United States, received copies of everything. Stiller reports that his superiors told him that most of the information gathered by the physics department was of little use to East Germany but of great value to the KGB because the Soviet Union was involved in laser weaponry and the building of major nuclear fission reactors and nuclear power stations, whereas East Germany had only one reactor and no nuclear power plant. A recently found diary of another Stasi agent quotes Caspar Weinberger as stating that 50% of all high technology in the Soviet Union came from secret service sources.

The head of the whole division was Lieutenant-Colonel Horst Vogel, a commanding, intimidating personality. Stiller's department head, who figures prominently in the book, was Christian Streubel, a man Stiller humorously describes as reminding him of a menacing schoolteacher he had dubbed "Jailhouse Schmidt," with his vulture-like and furtive-looking face. Some of Stiller's superiors come across as dangerous and criminal. In a recent interview I conducted with Stiller in Berlin, he himself struck me as affable as well as intelligent and knowledgeable. In that interview, Stiller evaluated the influence of the division's physics personnel as "disruptive and disturbing" for East German physics. He estimated that at least a quarter of all physicists were connected to the Stasi and commented that they spent so much time analyzing the voluminous material gathered by the Stasi that "creative thinking was taken away." In the book, Stiller refers to only one case in which knowledge stolen from the West benefited East Germany greatly. This involved an electrical engineer, Gerhard Arnold (cover name "Sturm"), who was placed in Munich and secured a position at IBM. According to Stiller, Sturm's "copious and valuable information proved essential for both the army and the economy as a whole," and he can be considered one of the founders of data processing in East Germany.

During his seven years at the HVA Stiller was able to gain an increasingly detailed knowledge of its structure, its activities, and its working methods and, as he examined more and more dossiers, revelations about which physicists were willing to place themselves at the service of the Stasi. For example, Rompe's name kept recurring in the files, and it turned out that he played a critical role in the construction and cementing of the relationship between the scientific community and espionage. Rompe, who was born in St. Petersburg, had returned to Germany with his family in 1914 when he was nine. He had worked for the "friends" (the KGB) since the 1930s and became one of the science sector's most valuable agents. He placed many agents in Western colleagues' institutes with the story that they were penniless East German refugees.

In addition to its revelations about the science sector, the book has a subplot that gives it its spy-thriller character: Stiller's work as a double agent for the BND and his suspenseful escape to the West. These episodes are replete with spy paraphernalia: in-visible ink, radio transmitters, secret meetings, stashes in safe houses, dead-letter drops, and an attractive woman. Stiller reports having delivered over 20,000 pages of secret documents to the West to be analyzed. Since the wall fell, he has admitted in several public appearances that the account in the book of the way in which contact was made with the BND is not quite true; despite further questioning, Stiller remains reticent on this question and loyal to the BND. Reportedly the BND reviewed the manuscript before publication.

After his spectacular defection in 1979, about 20 East German agents were arrested in the West, including many of Stiller's own agents. For example, Stiller's first agent active in the West, Rolf Dobbertin (cover name "Sperber"), a physicist from Rostock sent to Paris in 1956 to study at the expense of the Stasi (and placed in a French science institute by Rompe), was sentenced to 12 years in prison for his espionage activities. He sat in a French jail for five years before he was released in 1991. Although Dobbertin denies spying, calling his activity "scientific developmental aid for his GDR colleagues," Stiller describes the hundreds of documents Sperber collected from his contacts with French physicists and even Americans from Princeton, Berkeley, and the Lawrence Livermore Laboratory; these documents were passed to Stiller by way of West Berlin train-station lockers. During his first five-hour meeting with Sperber in an East Berlin safe house, Sperber received 4350 marks of "operational money." In addition, after the wall fell, more East German agents were unearthed at West Germany's major Nuclear Research Center in Karlsruhe, which was one of Stiller's main objects of study.

One revelation that should play a role in the current restructuring of the German science landscape is the number of Stasi agents placed in the Central Institute of Electron Physics of the East German Academy of Sciences: the institute was, according to Stiller, "interlaced" with Stasi agents and became an outpost for the Stasi. In contradiction to this view, however, a former physicist at the institute, Hans-Jürgen Fischbeck, in an interview in a recent compilation by Guntolf Herzberg and Klaus Meier (*Karrieremuster: Wissenschaftlerporträts*, Aufbau-Taschenbuch Verlag, Berlin, 1992), minimizes the influence of the Stasi and claims that the institute was not instrumentalized by them. Stiller's assertion may at least serve to confirm what we have begun to learn: that most academic institutes, to varying degrees, were interlaced with informants.

Because the HVA files were systematically (and legally) destroyed after the wall fell, Stiller's book will continue to be a major source on the HVA and its Sector for Science and Technology. It shows that, contrary to popular wisdom and the view reflected by the current de-Stasification of East German academics and scientists, the Stasi's grip embraced the scientific community perhaps more firmly and in a more far-reaching way than it did the humanities and social sciences. Whatever purposes the book may have initially served as a political instrument for the BND, it is of value for enlightening the reader about the realities of scientific espionage. The secrets Stiller reveals about the extent, scope, and inner workings of the Stasi's activities uncover a whole new world behind the crumbling and drab East German facade most Westerners encountered on crossing the wall.

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Order in Disorder

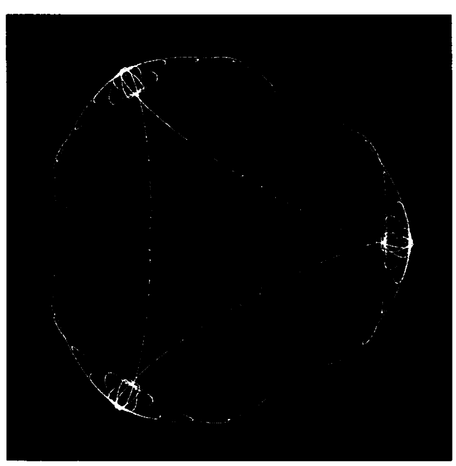
Symmetry in Chaos. A Search for Pattern in Mathematics, Art and Nature. MICHAEL FIELD and MARTIN GOLUBITSKY. Oxford University Press, New York, 1992. xii, 218 pp., illus. $35 or £19.95.

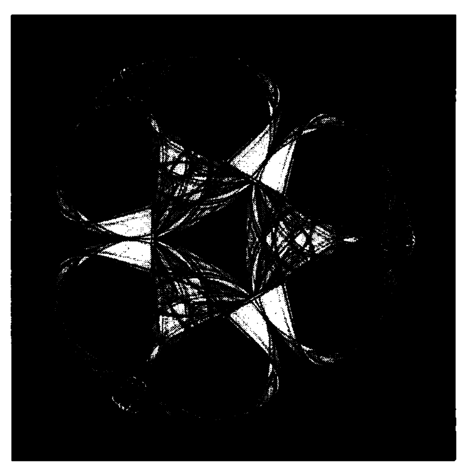
In nonequilibrium systems the transition to states of lower spatial symmetry, often with more complicated dynamics, is a commonly observed behavior. Characteristically such transitions occur as one increases the applied stresses forcing the system out of equilibrium. In mathematical models, these transitions are described as symmetry-breaking bifurcations; the progression from symmetric states with simple dynamics to asymmetric states with complex dynamics is captured by a sequence of progressively less symmetric attractors in the space of states of the system (the phase space). In the best-understood examples, the emergence of complex dynamics corresponds to the appearance of a chaotic attractor in phase space.

Less widely recognized is the possibility of an inverse phenomenon if the applied stresses are increased further after an asymmetric chaotic state has been reached. Known as symmetry-increasing bifurcations, these latter transitions have been studied recently in mathematical models ranging from the cubic logistic map in one dimension to reaction-diffusion equations and the complex Ginzburg-Landau equation, both infinite-dimensional dynamical systems. Some evidence for such bifurcations in real systems has been noted in experiments on fluids, specifically in the flow between concentric rotating cylinders.

In a symmetric system, the attractor corresponding to an asymmetric chaotic state is a set in phase space whose elements correspond to the instantaneous physical states that lack (or "break") the symmetry of the system. The dynamics on the attractor takes the system along a chaotic trajectory from one asymmetric instantaneous state to another. Despite the lack of symmetry in the individual states, the attractor may nevertheless be invariant under the full symmetry of the system, or it may have only partial symmetry. The symmetry characteristics of the attractor cannot be detected by examining the instantaneous states; rather, they are revealed by computing time-averaged states over intervals long enough for the trajectory to effectively cover the attractor. Thus the symmetry of an attractor is observable only in the statistical features of the chaotic state that Field and Golubitsky dub "symmetric chaos." Chaotic states that have the full symmetry of the system only on average have recently been reported in experiments on chaotic surface waves in square geometry and in chaotic fluid convection in circular and hexagonal containers.

If the chaotic attractor does not have





Left: "Three conjugate attractors of a triangularly symmetric mapping." *Right:* "Attractor with full triangular symmetry." [From *Symmetry in Chaos*]