

say, "Yup. To you it's new. It may be new to the world. But it's still not good."

To say what is beautiful you have to take a sophisticated group of people, people who know that particular art and have seen a lot of it, and say this is good art, or this is good music, or this is a good invention. And that doesn't mean everybody can vote on it; they don't know enough. But if a group of engineers who work on new stuff look at it and say, "That's pretty nice," that's because they know. They know because they've been trained in it.

And a good creative person is well trained. So he has first of all an enormous amount of knowledge in that field. Secondly, he tries to combine ideas, because he enjoys writing music or enjoys inventing. And finally, he has the judgment to say, "This is good, I'll pursue this further."

It would be very difficult to improve on this description of how the systems model works after it is internalized. Drawing on over eighty years of varied experience, Rabinow has distilled with great insight what is involved in being a creative inventor. And as his words suggest, the same process holds for other domains, whether poetry, music, or physics.

THREE

THE CREATIVE PERSONALITY

To be creative, a person has to internalize the entire system that makes creativity possible. So what sort of person is likely to do that? This question is very difficult to answer. Creative individuals are remarkable for their ability to adapt to almost any situation and to make do with whatever is at hand to reach their goals. If nothing else, this distinguishes them from the rest of us. But there does not seem to be a particular set of traits that a person must have in order to come up with a valuable novelty. What John Reed, the CEO of Citicorp, who has thought quite a lot about such things, says about businesspeople could be applied to creative persons in other domains as well:

Well, because of my job, I tend to know the guys who run the top fifty, one hundred companies in the country, and there's quite a range. It has little to do with the industry. It's funny, there is a consistency in what people look at in businesspeople, but there's no consistency in style and approach, personality, and so forth. There is not a consistent norm with regard to anything other than business performance.

Personality type, style. There are guys who drink too much, there are guys who chase girls; there are guys who are conservative, do none of the above; there are guys who are very serious and workaholics; there are guys who—it's quite amazing, the range of styles. You're paid to run companies, they watch quite carefully as to results. But there's an amazing lack of consistency on any other dimension. How you do it seems to be a wide-open variable. There isn't a clear pattern, tremendously different personality types. And it doesn't seem to run by industry either.

The same is true for scientists: What leads to an important discovery doesn't matter as long as you play by the rules. Or for artists: You can be a happy extrovert like Raphael, or a surly introvert like Michelangelo—the only thing that matters is how good your paintings are judged to be. This is all well and true; yet at the same time it is somewhat disappointing. After all, to say that what makes a person creative is his or her creativity is a tautology. Can we do any better? We don't really have very sound evidence, let alone proof, but we can venture some rather robust and credible suggestions.

Perhaps the first trait that facilitates creativity is a *genetic predisposition* for a given domain. It makes sense that a person whose nervous system is more sensitive to color and light will have an advantage in becoming a painter, while someone born with a perfect pitch will do well in music. And being better at their respective domains, they will become more deeply interested in sounds and colors, will learn more about them, and thus are in a position to innovate in music or art with greater ease.

On the other hand, a sensory advantage is certainly not necessary. El Greco seems to have suffered from a disease of the optic nerve, and Beethoven was functionally deaf when he composed some of his greatest work. Although most great scientists seem to have been attracted to numbers and experimentation early in life, how creative they eventually became bears little relationship to how talented they were as children.

But a special sensory advantage may be responsible for developing an early *interest in the domain*, which is certainly an important ingredient of creativity. The physicist John Wheeler remembers being interested in "toy mechanisms, things that would shoot rubber bands, Tinkertoys, toy railroads, electric light bulbs, switches, buzzers." His

father, who was a librarian, used to take him to New York State University, where he left John in the library office while he lectured. John was fascinated by the typewriters and other machines, especially hand calculators: "You pushed a button down and turned a crank, and how the thing worked, that intrigued me immensely." When he was twelve, he built a primitive calculator that had gears whittled out of wood.

Without a good dose of curiosity, wonder, and interest in what things are like and in how they work, it is difficult to recognize an interesting problem. Openness to experience, a fluid attention that constantly processes events in the environment, is a great advantage for recognizing potential novelty. Every creative person is more than amply endowed with these traits. Here is how the historian Natalie Davis selects what historical projects to focus on:

Well, I just get really curious about some problem. It just hooks in very deeply. At the time I don't know why necessarily it is that I invest so much curiosity and eros into some project. At the time, it just seems terribly interesting and important for the field. I may not know what is personally invested in it, other than my curiosity and my delight.

Without such interest it is difficult to become involved in a domain deeply enough to reach its boundaries and then push them farther. True, it is possible to make one creative discovery, even a very important one, by accident and without any great interest in the topic. But contributions that require a lifetime of struggle are impossible without curiosity and love for the subject.

A person also needs *access to a domain*. This depends to a great extent on luck. Being born to an affluent family, or close to good schools, mentors, and coaches obviously is a great advantage. It does no good to be extremely intelligent and curious if I cannot learn what it takes to operate in a given symbolic system. The ownership of what sociologist Pierre Bourdieu calls "cultural capital" is a great resource. Those who have it provide their children with the advantage of an environment full of interesting books, stimulating conversation, expectations for educational advancement, role models, tutors, useful connections, and so on.

But here too, luck is not everything. Some children fight their way

to the right schools while their peers stay behind. Manfred Eigen was captured by Russian troops at age seventeen and taken to a prisoner-of-war camp at the end of World War II, because he had been drafted to serve in an antiaircraft unit two years earlier. But he was determined to get back to studying science, even though he had had to leave high school at fifteen and never finished his studies. He escaped from the POW camp, walked back across half of Europe, and made a beeline for Göttingen, for he had heard that the best faculty in physics was reassembling there after the ravages of the war. He reached the city before the university actually had a chance to open but was admitted later with the first cohort of students, even though he lacked a high school diploma. Caught up in the ascetic postwar dedication to scholarship, led by the most knowledgeable teachers, surrounded by other equally dedicated students, he made quick progress. A few years later he received his doctorate and in 1967 the Nobel Prize. It is true that in early childhood Eigen could draw on substantial cultural capital, because his family had been musical and intellectually ambitious. Nevertheless, few people tossed by fate so far outside the circle of knowledge found their way back to its center as quickly and surely as he did.

Access to a field is equally important. Some people are terribly knowledgeable but are so unable to communicate with those who matter among their peers that they are ignored or shunned in the formative years of their careers. Michelangelo was reclusive, but in his youth was able to interact with leading members of the Medici court long enough to impress them with his skill and dedication. Isaac Newton was equally solitary and cantankerous, but somehow convinced his tutor at Cambridge that he deserved a lifetime tenured fellowship at the university, and so was able to continue his work undisturbed by human contact for many years. Someone who is not known and appreciated by the relevant people has a very difficult time accomplishing something that will be seen as creative. Such a person may not have a chance to learn the latest information, may not be given the opportunity to work, and if he or she does manage to accomplish something novel, that novelty is likely to be ignored or ridiculed.

In the sciences, being at the right university—the one where the most state-of-the-art research is being done in the best equipped labs by the most visible scientists—is extremely important. George Stigler

describes this as a snowballing process, where an outstanding scientist gets funded to do exciting research, attracts other faculty, then the best students—until a critical mass is formed that has an irresistible appeal to any young person entering the field. In the arts, the attraction is more to the centers of distribution, now primarily New York City, where the major galleries and collectors are located. Just as a century ago aspiring young artists felt they had to go to Paris if they wanted to be recognized, now they feel that unless they run the gauntlet of Manhattan they don't have a chance. One can paint beautiful pictures in Alabama or North Dakota, but they are likely to be misplaced, ignored, and forgotten unless they get the stamp of approval of critics, collectors, and other gatekeepers of the field. Eva Zeisel's work received the imprimatur of the art establishment after her ceramics were shown by the Museum of Modern Art. The same is true of the other arts: Michael Snow spent ten years in New York City to catch up with the field of jazz music, and writers have to make connections with the agents and publishers there.

Access to fields is usually severely restricted. There are many gates to pass, and bottlenecks form in front of them. Writers who want to catch the attention of an editor long enough to have their work read have to compete with thousands of similarly hopeful writers who have also submitted their manuscripts. The editor typically has only a few minutes to dedicate to each writer's work, assuming he or she even glances at the submission in the first place. Getting a literary agent to sell the manuscript is no solution either, since a good agent's attention is as difficult to get as that of an editor.

Because of these bottlenecks, access to a field is often determined by chance or by irrelevant factors, such as having good connections. Students applying to good universities in some disciplines are so many and have such excellent credentials that it is difficult to rank them in any meaningful way. Yet the openings are few, so a selection must be made. Hence the joke that the admissions committee throws all the application folders down a long stairway, and the students whose files travel farthest get admitted.

THE TEN DIMENSIONS OF COMPLEXITY

Access to the domain and access to the field are all well and good, but when are we going to deal with the *real* characteristics of creative

persons? When do we get to the interesting part—the tortured souls, the impossible dreams, the agony and the ecstasy of creation? The reason I hesitate to write about the deep personality of creative individuals is that I am not sure that there is much to write about, since creativity is the property of a complex system, and none of its components alone can explain it. The personality of an individual who is to do something creative must adapt itself to the particular domain, to the conditions of a particular field, which vary at different times and from domain to domain.

Giorgio Vasari in 1550 noted with chagrin that the new generations of Italian painters and sculptors seemed to be very different from their predecessors of the early Renaissance. They tended to be savage and mad, wrote the good Vasari, whereas their elders and betters had been tame and sensible. Perhaps Vasari was reacting to the artists who had embraced the ideology of Mannerism, the style ushered in by Michelangelo near the end of his long career, which relied on interesting distortions of figures and on grand gestures. This style would have been considered ugly a hundred years earlier, and the painters who used it would have been shunned. But a few centuries later, at the height of the Romantic period, an artist who was not more than a little savage and mad would not have been taken very seriously, because these qualities were *de rigueur* for creative souls.

In the 1960s, when abstract expressionism was the reigning style, those art students who tended to be sullen, brooding, and antisocial were thought by their teachers to be very creative. They were encouraged, and they won the prizes and fellowships. Unfortunately, when these students left school and tried to establish careers in the art world, they found that being antisocial did not get them very far. To get the attention of dealers and critics they had to throw wild parties and be constantly seen and talked about. Hence a hecatomb of introverted artists ensued: Most were selected out, ending up as art teachers in the Midwest or as car salesmen in New Jersey. Then the Warhol cohort replaced the abstract expressionists, and it was young artists with cool, clever, flip personalities who projected the aura of creativity. This, too, was a transient mask. The point is that you cannot assume the mantle of creativity just by assuming a certain personality style. One can be creative by living like a monk, or by burning the candle at both ends. Michelangelo was not greatly fond of women, while Picasso couldn't get enough of them. Both changed

the domain of painting, even though their personalities had little in common.

Are there then no traits that distinguish creative people? If I had to express in one word what makes their personalities different from others, it would be *complexity*. By this I mean that they show tendencies of thought and action that in most people are segregated. They contain contradictory extremes—instead of being an “individual,” each of them is a “multitude.” Like the color white that includes all the hues in the spectrum, they tend to bring together the entire range of human possibilities within themselves.

These qualities are present in all of us, but usually we are trained to develop only one pole of the dialectic. We might grow up cultivating the aggressive, competitive side of our nature, and disdain or repress the nurturant, cooperative side. A creative individual is more likely to be both aggressive and cooperative, either at the same time or at different times, depending on the situation. Having a complex personality means being able to express the full range of traits that are potentially present in the human repertoire but usually atrophy because we think that one or the other pole is “good,” whereas the other extreme is “bad.”

This kind of person has many traits in common with what the Swiss analytic psychologist Carl Jung considered a mature personality. He also thought that every one of our strong points has a repressed shadow side that most of us refuse to acknowledge. The very orderly person may long to be spontaneous, the submissive person wishes to be dominant. As long as we disown these shadows, we can never be whole or satisfied. Yet that is what we usually do, and so we keep on struggling against ourselves, trying to live up to an image that distorts our true being.

A complex personality does not imply neutrality, or the average. It is not some position at the midpoint between two poles. It does not imply, for instance, being wishy-washy, so that one is never very competitive or very cooperative. Rather it involves the ability to move from one extreme to the other as the occasion requires. Perhaps a central position, a golden mean, is the place of choice, what software writers call the default condition. But creative persons definitely know both extremes and experience both with equal intensity and without inner conflict. It might be easier to illustrate this conclusion in terms of ten pairs of apparently antithetical traits that are

often both present in such individuals and integrated with each other in a dialectical tension.

1. Creative individuals have a great deal of physical energy, but they are also often quiet and at rest. They work long hours, with great concentration, while projecting an aura of freshness and enthusiasm. This suggests a superior physical endowment, a genetic advantage. Yet it is surprising how often individuals who in their seventies and eighties exude energy and health remember a childhood plagued by illness. Heinz Maier-Leibnitz was bedridden for months in the Swiss mountains recovering from a lung ailment; György Faludy was often ill as a child, and so was the psychologist Donald Campbell. Public opinion analyst Elisabeth Noelle-Neumann was given no hope of survival by her physicians, but a homeopathic cure so improved her health that thirty years later she works harder than any four persons half her age. It seems that the energy of these people is internally generated and is due more to their focused minds than to the superiority of their genes. (Although it must be said that some respondents, such as Linus Pauling, answered "good genes," when asked to explain what accounted for their achievements.)

This does not mean that creative persons are hyperactive, always "on," constantly churning away. In fact, they often take rests and sleep a lot. The important thing is that the energy is under their own control—it is not controlled by the calendar, the clock, an external schedule. When necessary they can focus it like a laser beam; when it is not, they immediately start recharging their batteries. They consider the rhythm of activity followed by idleness or reflection very important for the success of their work. And this is not a biorhythm they inherited with their genes; it was learned by trial and error, as a strategy for achieving their goals. A humorous example is given by Robertson Davies:

Well, you know, that leads me to something which I think has been very important in my life, and it sounds foolish and rather trivial. But I've always insisted on having a nap after lunch, and I inherited this from my father. And one time I said to him, "You know, you've done awfully well in the world. You came to Canada as an immigrant boy without anything and you

have done very well. What do you attribute it to?" And he said, "Well, what drove me on to be my own boss was that the thing that I wanted most was to be able to have a nap every day after lunch." And I thought, What an extraordinary impulse to drive a man on! But it did, and he always had a twenty-minute sleep after lunch. And I'm the same. I think it is very important. If you will not permit yourself to be driven and flogged through life, you'll probably enjoy it more.

One manifestation of energy is sexuality. Creative people are paradoxical in this respect also. They seem to have quite a strong dose of eros, or generalized libidinal energy, which some express directly into sexuality. At the same time, a certain spartan celibacy is also a part of their makeup; continence tends to accompany superior achievement. Without eros, it would be difficult to take life on with vigor; without restraint, the energy could easily dissipate.

2. Creative individuals tend to be smart, yet also naive at the same time. How smart they actually are is open to question. It is probably true that what psychologists call the *g* factor—meaning a core of general intelligence—is high among people who make important creative contributions. But we should not take seriously the lists that used to be printed on the sidebars of psychology textbooks, according to which John Stuart Mills must have had an IQ of 170 and Mozart an IQ of 135. Had they been tested at the time, perhaps they would have scored high. Perhaps not. And how many children in the eighteenth century would have scored even higher but never did anything memorable?

The earliest longitudinal study of superior mental abilities, initiated at Stanford University by the psychologist Lewis Terman in 1921, shows rather conclusively that children with very high IQs do well in life, but after a certain point IQ does not seem to be correlated any longer with superior performance in real life. Later studies suggest that the cutoff point is around 120; it might be difficult to do creative work with a lower IQ, but beyond 120 an increment in IQ does not necessarily imply higher creativity.

Why a low intelligence interferes with creative accomplishment

is quite obvious. But being intellectually brilliant can also be detrimental to creativity. Some people with high IQs get complacent, and, secure in their mental superiority, they lose the curiosity essential to achieving anything new. Learning facts, playing by the existing rules of domains, may come so easily to a high-IQ person that he or she never has any incentive to question, doubt, and improve on existing knowledge. This is probably why Goethe, among others, said that naïveté is the most important attribute of genius.

Another way of expressing this dialectic is by the contrasting poles of wisdom and childishness. As Howard Gardner remarked in his study of the major creative geniuses of this century, a certain immaturity, both emotional and mental, can go hand in hand with deepest insights. Mozart comes immediately to mind.

Furthermore, people who bring about an acceptable novelty in a domain seem able to use well two opposite ways of thinking: the *convergent* and the *divergent*. Convergent thinking is measured by IQ tests, and it involves solving well-defined, rational problems that have one correct answer. Divergent thinking leads to no agreed-upon solution. It involves fluency, or the ability to generate a great quantity of ideas; flexibility, or the ability to switch from one perspective to another; and originality in picking unusual associations of ideas. These are the dimensions of thinking that most creativity tests measure and that most workshops try to enhance.

It is probably true that in a system that is conducive to creativity, a person whose thinking is fluent, flexible, and original is more likely to come up with novel ideas. Therefore, it makes sense to cultivate divergent thinking in laboratories and corporations—especially if management is able to pick out and implement the most appropriate ideas from the many that are generated. Yet there remains the nagging suspicion that at the highest levels of creative achievement the generation of novelty is not the main issue. A Galileo or a Darwin did not have that many new ideas, but the ones they fastened upon were so central that they changed the entire culture. Similarly, the individuals in our study often claimed to have had only two or three good ideas in their entire career, but each idea was so generative that it kept them busy for a lifetime of testing, filling out, elaborating, and applying.

Divergent thinking is not much use without the ability to tell a

good idea from a bad one—and this selectivity involves convergent thinking. Manfred Eigen is one of several scientists who claim that the only difference between them and their less creative colleagues is that they can tell whether a problem is soluble or not, and this saves enormous amounts of time and many false starts. George Stigler stresses the importance of fluidity, that is, divergent thinking on the one hand, and good judgment in recognizing a viable problem on the other:

I consider that I have good intuition and good judgment on what problems are worth pursuing and what lines of work are worth doing. I used to say (and I think this was bragging) that whereas most scholars have ideas which do not pan out more than, say, 4 percent of the time, mine come through maybe 80 percent of the time.

3. A third paradoxical trait refers to the related combination of playfulness and discipline, or responsibility and irresponsibility. There is no question that a playfully light attitude is typical of creative individuals. John Wheeler says that the most important thing in a young physicist is “this bounce, which I always associate with fun in science, kicking things around. It’s not quite joking, but it has some of the lightness of joking. It’s exploring ideas.” David Riesman, in describing the attitude of “detached attachment” that makes him an astute observer of the social scene, stresses the fact that he always “wanted at the same time to be irresponsible and responsible.”

But this playfulness doesn’t go very far without its antithesis, a quality of doggedness, endurance, perseverance. Much hard work is necessary to bring a novel idea to completion and to surmount the obstacles a creative person inevitably encounters. When asked what enabled him to solve the physics problems that made him famous, Hans Bethe answered with a smile: “Two things are required. One is a brain. And second is the willingness to spend long times in thinking, with a definite possibility that you come out with nothing.”

Nina Holton, whose playfully wild germs of ideas are the genesis of her sculpture, is very firm about the importance of hard work:

Tell anybody you're a sculptor and they'll say, "Oh, how exciting, how wonderful." And I tend to say, "What's so wonderful?" I mean, it's like being a mason, or being a carpenter, half the time. But they don't wish to hear that because they really only imagine the first part, the exciting part. But, as Khrushchev once said, that doesn't fry pancakes, you see. That germ of an idea does not make a sculpture which stands up. It just sits there. So the next stage, of course, is the hard work. Can you really translate it into a piece of sculpture? Or will it be a wild thing which only seemed exciting while you were sitting in the studio alone? Will it look like something? Can you actually do it physically? Can you, personally, do it physically? What do you have by way of materials? So the second part is a lot of hard work. And sculpture is that, you see. It is the combination of wonderful wild ideas and then a lot of hard work.

Jacob Rabinow uses an interesting mental technique to slow himself down when work on an invention requires more endurance than intuition:

Yeah, there's a trick I pull for this. When I have a job to do like that, where you have to do something that takes a lot of effort, slowly, I pretend I'm in jail. Don't laugh. And if I'm in jail, time is of no consequence. In other words, if it takes a week to cut this, it'll take a week. What else have I got to do? I'm going to be here for twenty years. See? This is a kind of mental trick. Because otherwise you say, "My God, it's not working," and then you make mistakes. But the other way, you say time is of absolutely no consequence. People start saying how much will it cost me in time? If I work with somebody else it's fifty bucks an hour, a hundred dollars an hour. Nonsense. You just forget everything except that it's got to be built. And I have no trouble doing this. I work fast, normally. But if something will take a day gluing and then next day I glue the other side—it'll take two days—it doesn't bother me at all.

Despite the carefree air that many creative people affect, most of them work late into the night and persist when less driven individuals would not. Vasari wrote in 1550 that when the Renaissance painter Paolo Uccello was working out the laws of visual perspec-

tive, he would walk back and forth all night, muttering to himself: "What a beautiful thing is this perspective!" while his wife kept calling him back to bed with no success. Close to five hundred years later, physicist and inventor Frank Offner describes the time he was trying to understand how the membrane of the ear works:

Ah, the answer may come to me in the middle of the night. My wife, when I was first into this membrane stuff, would kick me in the middle of the night and say, "Now get your mind off of membranes and get to sleep."

4. Creative individuals alternate between imagination and fantasy at one end, and a rooted sense of reality at the other. Both are needed to break away from the present without losing touch with the past. Albert Einstein once wrote that art and science are two of the greatest forms of escape from reality that humans have devised. In a sense he was right: Great art and great science involve a leap of imagination into a world that is different from the present. The rest of society often views these new ideas as fantasies without relevance to current reality. And they are right. But the whole point of art and science is to go beyond what we now consider real, and create a new reality. At the same time, this "escape" is not into a never-never land. What makes a novel idea creative is that once we see it, sooner or later we recognize that, strange as it is, it is true.

This dialectic is reflected by the way that, many years ago, the artists we studied responded to so-called projective tests, like the Rorschach or the Thematic Apperception Test. These require you to make up a story about some ambiguous stimuli, such as inkblots or drawings, that could represent almost anything. The more creative artists gave responses that were definitely more original, with unusual, colorful, detailed elements. But they never gave "bizarre" responses, which normal people occasionally do. A bizarre response is one that, with all the goodwill in the world, one could not see in the stimulus. For instance if an inkblot looks vaguely like a butterfly, and you say that it looks like a submarine without being able to give a sensible clue as to what in the inkblot made you say so, the response would be scored as bizarre. Normal people are rarely original, but they are sometimes bizarre. Creative people, it seems, are original without being bizarre. The novelty they see is rooted in reality.

Most of us assume that artists—musicians, writers, poets, painters—are strong on the fantasy side, whereas scientists, politicians, and businesspeople are realists. This may be true in terms of day-to-day routine activities. But when a person begins to work creatively, all bets are off—the artist may be as much a realist as the physicist, and the physicist as imaginative as the artist.

We certainly think of bankers, for example, as having a rather pedestrian, commonsense view of what is real and what is not. Yet a financial leader such as John Reed has much to say that dispels that notion. In his interview, he returns again and again to the theme that reality is relative and constantly changing, a perspective that he thinks is essential to confronting the future creatively:

I don't think there is such a thing as reality. There are widely varying descriptions of reality, and you've got to be alert to when they change and what's really going on. No one is going to truly grasp it, but you have to stay truly active on that end. That implies you have to have a multifaceted perspective.

There is a set of realities that exist at any moment in time. I always have some kind of a model in my mind as to what I think is going on in the world. I'm always tuning that [model] and trying to get different insights as I look at things, and I try to relate it back to what it means to our business, to how one behaves, if you will.

I don't mean to say there isn't anything in the center. I just think we can look at it [reality] in so many different ways. Right now, in my business, banks are deemed to be successful based on capital ratios. Ten years ago there was no concept of the "capital ratio." I failed totally to understand the impact of the savings and loan crisis on Congress, the regulators, and the industry. The world I'm living in today bears little resemblance to the world I lived in ten years ago, with regard to what was thought to be important. So we have defined a reality, which as I say is not empty, but it's close to being empty.

Like anybody else, I was slow to recognize the new reality. Knowing these kinds of things turns out to be awfully relevant, because your degrees of freedom get taken away if you're off base. I went through a massive adjustment to play a game that

was different from the one you saw before. But it's a changing reality. I know goddamn well that these capital ratios are not sufficiently robust to be long-term, decent leading indicators of things, and five years from now the people who worry about how to price bank stocks are not going to be focusing on those. I describe success as *evolutionary* success.

What Einstein implied about art and science reappears in this account of banking: It is an *evolutionary* process, where current reality becomes rapidly obsolete, and one must be on the alert for the shape of things to come. At the same time, the emerging reality is not a fanciful conceit but something inherent in the here and now. It would be easy to dismiss Reed's visionary view as the romancing of a businessman who has had one too many encounters with reality. But apparently his unorthodox approach works: A recent issue of *Newsweek* announced: "John Reed might be excused a little gloating. . . . Since his darkest days three years ago he's quietly produced a stunning 425 percent return for investors who bought Citicorp shares." And one commentator adds that the overseas investments Reed made were considered junk five years ago, whereas now they are seen as a hot stock. "Nothing's changed but the perception," the financial expert says, echoing Reed's take on the reality of the market.

5. Creative people seem to harbor opposite tendencies on the continuum between extroversion and introversion. Usually each of us tends to be one or the other, either preferring to be in the thick of crowds or sitting on the sidelines and observing the passing show. In fact, in current psychological research, extroversion and introversion are considered the most stable personality traits that differentiate people from each other and that can be reliably measured. Creative individuals, on the other hand, seem to express both traits at the same time.

The stereotype of the "solitary genius" is strong and gets ample support also from our interviews. After all, one must generally be alone in order to write, paint, or do experiments in a laboratory. As we know from studies of young talented people, teenagers who cannot stand being alone tend not to develop their skills because practicing music or studying math requires a solitude they dread.

Only those teens who can tolerate being alone are able to master the symbolic content of a domain.

Yet over and over again, the importance of seeing people, hearing people, exchanging ideas, and getting to know another person's work and mind are stressed by creative individuals. The physicist John Wheeler expresses this point with his usual directness: "If you don't kick things around with people, you are out of it. Nobody, I always say, can be anybody without somebody being around."

Physicist Freeman Dyson expresses with a fine nuance the opposite phases of this dichotomy in his work. He points to the door of his office and says:

Science is a very gregarious business. It is essentially the difference between having this door open and having it shut. When I am doing science I have the door open. I mean, that is kind of symbolic, but it is true. You want to be, all the time, talking with people. Up to a point you welcome being interrupted because it is only by interacting with other people that you get anything interesting done. It is essentially a communal enterprise. There are new things happening all the time, and you should keep abreast and keep yourself aware of what is going on. You must be constantly talking. But, of course, writing is different. When I am writing I have the door shut, and even then too much sound comes through, so very often when I am writing I go and hide in the library. It is a solitary game. So, I suppose that is the main difference. But then, afterward, of course the feedback is very strong, and you get a tremendous enrichment of contacts as a result. Lots and lots of people write me letters simply because I have written books which address a general public, so I get into touch with a much wider circle of friends. It's broadened my horizons very much. But that is only after the writing is finished and not while it is going on.

John Reed builds the alternation between inner-directed reflection and intense social interaction into his daily routine:

I'm an early morning guy. I get up at five always, get out of the shower about 5:30, and I typically try to work either at

home or at the office, and that's when I do a good bit of my thinking and priority setting. I'm a great lister. I have twenty lists of things to do all the time. If I ever have five free minutes I sit and make lists of things that I should be worrying about or doing. Typically I get to the office about 6:30. I try to keep a reasonably quiet time until 9:30 or 10:00. Then you get involved in lots of transactions. If you are chairman of the company it's like being a tribal chieftain. People come into your office and talk to you.

Even in the very private realm of the arts the ability to interact is essential. Nina Holton describes well the role of sociability in art:

You really can't work entirely alone in your place. You want to have a fellow artist come and talk things over with you—"How does that strike you?" You have to have some sort of feedback. You can't be sitting there entirely by yourself and never show it. And then eventually, you know, when you begin to show, you have to have a whole network. You have to get to know gallery people, you have to get to know people who work in your field who are involved. And you may want to find out whether you wish to be part of it or not be part of it, but you cannot help being part of a fellowship, you know?

Jacob Rabinow again puts into clear words the dilemma that many creative individuals face:

I remember once we had a big party and Gladys [his wife] said that I sometimes walk to a different drummer. In other words, I'm so involved in an idea I'm working on, I get so carried away, that I'm all by myself. I'm not listening to what anybody says. This sometimes happens. That you've got a new idea and you feel that it's very good and you're so involved that you're not paying attention to anybody. And you tend to drift away from people. It's very hard for me to be objective. I don't know. I'm social, I like people, I like to tell jokes, I like to go to the theater. But it's probably true that there are times when Gladys would have liked me to pay more attention to her and to the family. I love my children, they love me, and we have a

wonderful relationship. But it could be that if I were not an inventor but had a routine job, I'd spend more time at home and I'd pay more attention to them, and the job would be something that I wouldn't like to do. So maybe people who don't like their jobs love their home more. It's quite possible.

6. Creative individuals are also remarkably humble and proud at the same time. It is remarkable to meet a famous person whom you expect to be arrogant or supercilious, only to encounter self-deprecation and shyness instead. Yet there are good reasons why this should be so. In the first place, these individuals are well aware that they stand, in Newton's words, "on the shoulders of giants." Their respect for the domain in which they work makes them aware of the long line of previous contributions to it, which puts their own into perspective. Second, they also are aware of the role that luck played in their own achievements. And third, they are usually so focused on future projects and current challenges that their past accomplishments, no matter how outstanding, are no longer very interesting to them. Elisabeth Noelle-Neumann's answer to the question "Looking back on all your accomplishments, which one would you say you are most proud of?" is typical:

I never think of what I am proud about. I never look back, except to find out about mistakes. Because mistakes are hard to remember and to draw conclusions from. But I only see danger in thinking back about things you are proud of. When people ask me if I am proud of something, I just shrug and hope to get away as soon as possible. I should explain that my way is always to look ahead, all my pleasant thoughts are about the future. It has been this way since I was twenty years old. I start every day fresh. The most important thing for me is to keep up the research institute, to keep up empirical research.

Despite her great accomplishments and reputation in the field, neuropsychologist Brenda Milner tells of being very self-critical and of having enormous self-doubts about being creative. The Canadian artist Michael Snow attributes the restless experimentation that led him to so many successes to a sense of confusion and insecurity he has been trying to dispell.

Another indication of modesty is how often this question was answered in terms of the family rather than the accomplishments that made a person famous. For instance, Freeman Dyson's answer was: "I suppose it is just to have raised six kids, and brought them up, as far as one can see, all to be interesting people. I think that's what I am most proud of, really." And John Reed's: "Oh, God. That's real . . . I suppose being a parent. I have four kids. If you had to say what has both surprised and given you a lot of pleasure, I'd say that I'm close to my kids and I enjoy them, and I never would have guessed that that would be as much fun as it's turned out to be."

At the same time, of course, no matter how modest these individuals are, they know that in comparison with others they have accomplished a great deal. And this knowledge provides a sense of security, even pride. This is often expressed as a sense of self-assurance. For instance, medical physicist Rosalyn Yalow mentioned repeatedly that all through her life she never had any doubts about succeeding in what she started out to do. Jacob Rabinow concurs: "There's one other thing that you do when you invent. And that is what I call the Existence Proof. This means that you have to assume that it can be done. If you don't assume that, you won't even try. And I always assume that not only it can be done, but I can do it." Some individuals stress humility, others self-assurance, but in actuality all of the people we interviewed seemed to have a good dose of both.

Another way of expressing this duality is to see it as a contrast between *ambition* and *selflessness*, or competition and cooperation. It is often necessary for creative individuals to be ambitious and aggressive. Yet at the same time, they are often willing to subordinate their own personal comfort and advancement to the success of whatever project they are working on. Aggressiveness is required especially in fields where competition is acute, or in domains where it is difficult to introduce novelty. In George Stigler's words:

Every scholar, I think, is aggressive in some sense. He has to be aggressive if he wants to change his discipline. Now, if you get a Keynes or a Friedman, they are also aggressive in that they want to change the world, and so they become splendid public figures as well. But that's a very hard game to play.

Brenda Milner claims that she has always been very aggressive verbally. John Gardner, statesman and founder of several national grassroots political organizations, describes well both the peaceful and aggressive instincts that coexist within the same person:

I was the president of the Carnegie Corporation. I had a very interesting life, but not a lot of new challenges, not a tumultuous life. I was well protected. When I went to Washington I discovered a lot of things about myself that I didn't know. I discovered that I liked politicians. I got along well with them. I enjoyed dealing with the press, as much as anyone can enjoy dealing with the press. And then I discovered that I enjoyed a political fight, which was about as far away from my self-image as you can get. I'm a very peaceful person. But these things come out. Life pulls them out of you, and as I say, I'm a slow learner, but in my midfifties I learned some interesting things.

Several persons mention that in the course of their careers motivation has shifted from self-centered goals to more altruistic interests. For instance, Sarah LeVine, who started out as an anthropologist and then became a fiction writer, has this to say:

Up until quite recently, I used to think of production only for the greater glory of myself, really. I don't see it that way at all anymore. I mean, it's nice if one gets recognition for what one does, but much more important is to leave something that other people can learn about, and I suppose that comes with middle age.

7. In all cultures, men are brought up to be "masculine" and to disregard and repress those aspects of their temperament that the culture regards as "feminine," whereas women are expected to do the opposite. Creative individuals to a certain extent escape this rigid gender role stereotyping. When tests of masculinity/femininity are given to young people, over and over one finds that creative and talented girls are more dominant and tough than other girls, and creative boys are more sensitive and less aggressive than their male peers.

This tendency toward androgyny is sometimes understood in

purely sexual terms, and therefore it gets confused with homosexuality. But psychological androgyny is a much wider concept, referring to a person's ability to be at the same time aggressive and nurturant, sensitive and rigid, dominant and submissive, regardless of gender. A psychologically androgynous person in effect doubles his or her repertoire of responses and can interact with the world in terms of a much richer and varied spectrum of opportunities. It is not surprising that creative individuals are more likely to have not only the strengths of their own gender but those of the other one, too.

Among the people we interviewed, this form of androgyny was difficult to detect—no doubt in part because we did not use any standard test to measure its presence. Nevertheless, it was obvious that the women artists and scientists tended to be much more assertive, self-confident, and openly aggressive than women are generally brought up to be in our society. Perhaps the most noticeable evidence for the "femininity" of the men in the sample was their great preoccupation with their family and their sensitivity to subtle aspects of the environment that other men are inclined to dismiss as unimportant. But despite having these traits that are not usual to their gender, they retained the usual gender-specific traits as well. In general, the women were perfectly "feminine" and the men thoroughly "masculine," in addition to having cross-gender traits.

8. Generally, creative people are thought to be rebellious and independent. Yet it is impossible to be creative without having first internalized a domain of culture. And a person must believe in the importance of such a domain in order to learn its rules; hence, he or she must be to a certain extent a traditionalist. So it is difficult to see how a person can be creative without being both *traditional and conservative* and at the same time *rebellious and iconoclastic*. Being only traditional leaves the domain unchanged; constantly taking chances without regard to what has been valued in the past rarely leads to novelty that is accepted as an improvement. The artist Eva Zeisel, who says that the folk tradition in which she works is "her home," nevertheless produces ceramics that were recognized by the Museum of Modern Art as masterpieces of contemporary design. This is what she says about innovation for its own sake:

This idea to create something different is not my aim, and shouldn't be anybody's aim. Because, first of all, if you are a designer or a playful person in any of these crafts, you have to be able to function a long life, and you can't always try to be different. I mean different from different from different. Secondly, wanting to be different can't be the motive of your work. Besides—if I talk too much let me know—to be different is a negative motive, and no creative thought or created thing grows out of a negative impulse. A negative impulse is always frustrating. And to be different means not like this and not like that. And the "not like"—that's why postmodernism, with the prefix of "post" couldn't work. No negative impulse can work, can produce any happy creation. Only a positive one.

But the willingness to take risks, to break with the safety of tradition, is also necessary. The economist George Stigler is very emphatic in this regard:

I'd say one of the most common failures of able people is a lack of nerve. They'll play safe games. They'll take whatever the literature's doing and add a little bit to it. In our field, for example, we study duopoly, which is a situation in which there are two sellers. Then why not try three and see what that does. So there's a safe game to play. In innovation, you have to play a less safe game, if it's going to be interesting. It's not predictable that it'll go well.

9. Most creative persons are very *passionate* about their work, yet they can be extremely *objective* about it as well. The energy generated by this conflict between attachment and detachment has been mentioned by many as being an important part of their work. Why this is the case is relatively clear. Without the passion, we soon lose interest in a difficult task. Yet without being objective about it, our work is not very good and lacks credibility. So the creative process tends to be what some respondents called a yin-yang alternation between these two extremes. Here is how the historian Natalie Davis puts it:

I am sometimes like a mother trying to bring the past to life again. I love what I am doing and I love to write. I just have a

great deal of affect invested in bringing these people to life again, in some way. It doesn't mean that I love my characters, necessarily, these people from the past. But I love to find out about them and re-create them or their situation. I think it is very important to find a way to be detached from what you write, so that you can't be so identified with your work that you can't accept criticism and response, and that is the danger of having as much affect as I do. But I am aware of that and of when I think it is particularly important to detach oneself from the work, and that is something where age really does help.

10. Finally, the openness and sensitivity of creative individuals often exposes them to *suffering and pain yet also a great deal of enjoyment*. The suffering is easy to understand. The greater sensitivity can cause slights and anxieties that are not usually felt by the rest of us. Most would agree with Rabinow's words: "Inventors have a low threshold of pain. Things bother them." A badly designed machine causes pain to an inventive engineer, just as the creative writer is hurt when reading bad prose. Being alone at the forefront of a discipline also makes you exposed and vulnerable. Eminence invites criticism and often vicious attacks. When an artist has invested years in making a sculpture, or a scientist in developing a theory, it is devastating if nobody cares.

Ever since the Romantic movement gained ascendance a few centuries ago, artists have been expected to suffer in order to demonstrate the sensitivity of their souls. In fact, research shows that artists and writers do have unusually high rates of psychopathology and addictions. But what is the cause, what is the effect? The poet Mark Strand comments:

There have been a lot of unfortunate cases of writers, painters, who have been melancholic, depressed, taken their own lives. I don't think it goes with the territory. I think those people would have been depressed, or alcoholic, suicidal, whatever, even if they weren't writing. I just think it's their characterological makeup. Whether that characterological makeup drove them to write or to paint, as well as to alcohol or to suicide, I don't know. I know there are an awful lot of healthy

writers and painters who have no thoughts of suicide. I think it's a myth, by and large. It creates a special aura, a frailty, around the artist to say that he lives so close to the edge. He's so responsive to the world around him, so sensitive, so driven to respond to it, it's almost unbearable. That he must escape either through drugs or alcohol, finally suicide, the burden of consciousness is so great. But the burden of consciousness is great for people who don't—you know—want to kill themselves.

It is also true that deep interest and involvement in obscure subjects often goes unrewarded, or even brings on ridicule. Divergent thinking is often perceived as deviant by the majority, and so the creative person may feel isolated and misunderstood. These occupational hazards do come with the territory, so to speak, and it is difficult to see how a person could be creative and at the same time insensitive to them.

Perhaps the most difficult thing for a creative individual to bear is the sense of loss and emptiness experienced when, for some reason or another, he or she cannot work. This is especially painful when a person feels one's creativity drying out; then the whole self-concept is jeopardized, as Mark Strand suggests:

Yeah, there's a momentary serenity, a sense of satisfaction, when you come up with an idea that you think is worth pursuing. Another form of that is when you have completed, where you've done as much as you can with an idea that you thought was worth working on. Then you sort of bask in the glow of completion for a day, maybe. You know, have a glass or two more of wine at night because you don't feel you have to go upstairs and look at anything again.

And then you're beginning again. You hope. Sometimes the hiatus will last not overnight but for weeks, months, and years. And the longer the hiatus is between books that you're committed to finishing, the more painful and frustrating life becomes. When I say "painful," that's probably too grandiose a term for the petty frustration one feels. But if it goes on, and on, and you develop what people call a writer's block, it's painful, because your identity's at stake. If you're not writing, and you're a writer and known as a writer, what are you?

Yet when the person is working in the area of his or her expertise, worries and cares fall away, replaced by a sense of bliss. Perhaps the most important quality, the one that is most consistently present in all creative individuals, is the ability to enjoy the process of creation for its own sake. Without this trait poets would give up striving for perfection and would write commercial jingles, economists would work for banks where they would earn at least twice as much as they do at the university, physicists would stop doing basic research and join industrial laboratories where the conditions are better and the expectations more predictable. In fact, enjoyment is such an important part of creativity that we devote chapter 5 to the connection. Here I report a single illustration, just as a place marker, to make sure that we don't lose sight of this essential component:

Margaret Butler is a computer scientist and mathematician, the first woman elected a fellow of the American Nuclear Society. In describing her work, like most of our respondents, she keeps stressing this element of fun, of enjoyment. In answer to the question "Of your accomplishments at work, what are you most proud of?" she answers:

Well, in my work I think that the most interesting and exciting things that I have done were in the early days at Argonne when we were building computers. We worked on a team to design one of the first computers. We developed image analysis software with the people in the biology division for scanning chromosomes and trying to do automatic karyotyping, and I think that was the most fun that I had in all of my forty-plus years at the lab.

It is interesting that this response, stressing fun and excitement, came in answer to a question about what she is most proud of in her work. Later on, she says:

I worked and worked. You work hard. You try to do your best. When we were working on the chromosome project, Jim [her husband] and I spent sometimes the whole night over there working. We would come out in the morning and the sun would be coming up. Science is very much fun. And I think women should have the opportunity to have fun.

I may work as hard as Butler did out of ambition or a desire to make money. But unless I also enjoy the task, my mind is not fully concentrated. My attention keeps shifting to the clock, to daydreams of better things to do, to resenting the job and wishing it was over. This kind of split attention, of halfhearted involvement, is incompatible with creativity. And creative people usually enjoy not only their work but also the many other activities in their lives. Margaret Butler, in describing what she does after her formal retirement, uses the word *enjoy* in reference to everything she does: helping her husband to continue his mathematical research, writing a careers-for-women guide for the American Nuclear Society, working with teachers to get women students interested in science, organizing support groups for women scientists, reading, and being involved in local politics.

These ten pairs of contrasting personality traits might be the most telling characteristic of creative people. Of course, this list is to a certain extent arbitrary. It could be argued that many other important traits have been left out. But what is important to keep in mind is that these conflicting traits—or any conflicting traits—are usually difficult to find in the same person. Yet without the second pole, new ideas will not be recognized. And without the first, they will not be developed to the point of acceptance. Therefore, the novelty that survives to change a domain is usually the work of someone who can operate at both ends of these polarities—and that is the kind of person we call “creative.”

FOUR

THE WORK OF CREATIVITY

Is there a single series of mental steps that leads to novelties that result in changing a domain? Or, to put it differently, is every creative product the result of a single “creative process”? Many individuals and business training programs claim that they know what “creative thinking” consists of and that they can teach it. Creative individuals usually have their own theories—often quite different from one another. Robert Galvin says that creativity consists of anticipation and commitment. Anticipation involves having a vision of something that will become important in the future before anybody else has it; commitment is the belief that keeps one working to realize the vision despite doubt and discouragement.

On the other hand, in his letter of refusal, the management guru Peter Drucker lists four reasons that account for his accomplishments (in addition to the fifth, never participate in studies such as this):

- (a) I have been able to produce because I have always been a loner and have not had to spend time on keeping subordinates, assistants, secretaries, and other time-wasters; because (b) I never set foot in my university office—I do my teaching; and if students