Tests, demonstrations and experiments related in any way to a commercial activity or enterprise can also be infringements.

Thus, the experimental use exception is very narrow and has been confined to a use for the "sole purpose of gratifying a philosophical taste or curiosity or for mere amusement."

Federal Technology Transfer (FT^2) Program Moves Ahead - Early Snags Being Addressed

Like any major piece of legislation, the FT^2 Act passed last year (IPH 6/87) has run into early implementation snags that must be overcome. One of the first snags is the requirement for an individual federal agency to delegate authority to its labs. To date, no such delegation has taken place.

First -- what constitutes a federal lab? The entire National Institutes of Health may be considered a lab, and each of its 11 member institutes could be considered a lab, too. Furthermore, each of the institutes contain multiple labs within their infrastructure.

Secondly, who has a say-so in over-viewing the delegated authority? Service groups within a given agency all wish to have a piece of the action rather than a straight delegation of everything down to the labs. (Is this the way excessive bureaucratic red tape is procreated?) Obviously, such turf fights are slowing the process down.

A major issue is whether the FT^2 Act and the President's Executive Order cover government-owned, but contractor-operated, laboratories (GOCOs). It would appear clear that the Act and Executive Order generally cover such GOCOs and that patent ownership is to be distributed to all contractors. For some time, university contractors have been receiving the rights, but the Executive Order for the first time with the force of law extends similar rights to profit-making contractors such as Martin Marietta -- operator of the Oak Ridge National Laboratory. Lawyers of the Department of Energy are balking at this interpretation on the grounds that they are prevented by law from making such a transfer. However, the statutes they quote show a transfer to be discretionary, and, reportedly, the Office of Management and Budget is opposed to DOE's position.

Another issue is the difficult task of preparing a model cooperative research and development agreement.

Questions about the FT^2 Act also expected to arise include the inventor's rights. Under what conditions can a FedLab inventor force the Government to release the patent rights to the inventor because the Government has failed to adequately protect the invention or license others? Also, how will the government divide the royalties when a single licensed product is covered by

IPH

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NEWS BRIEF

INTELLECTUAL PROPERTY HAPPENINGS July, 1987

IPH is a monthly news brief for technology executives, inventors and software creators. News covered includes information, behind the scenes events and insights into the development of intellectual property and its protection through patents, copyrights, trade secrets, trademarks and similar rights.

Research and Development Labs New Target for Patent Infringement Suits -- Can't Rely on "Experimental Use" Exception

Corporate labs that use inventions from unexpired patents of others do so at their peril. These inventions are sometimes used to get a head start toward commercializing a product when the patent expires, so the product can be ready to go without waiting for the normal R&D and test period after expiration. Also, labs may use these inventions to garner more information about a competitor's technology so they can make leapfrog improvements.

Many thought these acts were excused by an "experimental use" exception to infringement. However, this exception is very limited. If it is coupled in any way with a commercial purpose, the exception does not apply.

Here is one example of infringement: A pharmaceutical company ordered and used a small quantity of a patented compound from a foreign source six months before the patent's expiration date, so that testing for FDA approval could begin immediately. Note: Since that case, a new law does permit -- as a very special exception from infringement liability -- uses solely for purposes of satisfying reporting requirements of federal drug laws.

Another example is the use of a patented biotech product to determine the amino acid sequence to assist in cloning a gene of the patented product. This did not fall within the narrow limitations and was therefore an infringement.

Still another infringement occurred when a developer of an automatic paper winding machine made and tested all of the various sub-assemblies and shipped them to a customer for complete assembly after the expiration of the patent. The machine was never completely assembled until after the patent expired.

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multiple patents of different inventors, especially when one patent is the basic patent and the other patents are only minor improvements? Still further, in view of the shortage of Government patent attorneys, how will increased demand for patent legal services be handled? Is the government liable for failure to protect the inventor's rights?

Continue to Patent Animals

Recent efforts by a few legislators to delay the patenting of animals have stopped. The Patent Office has no discretion in granting such patents since it has been determined that the patenting of animals is provided for by the present law. If the Patent Office is to change, the law must be changed. Hearings will be held, but the importance of inventions in this area should be understood: Patenting of animals can help the hunger situation in Africa. It can aid the shifting of U.S. farm crops from tobacco to fish. Such facts make it clear the law should not be changed. Remember that patenting of animals in no way relates to humans; emotional arguments in that direction are without foundation.

State Universities and Schools May Be Immune from Copyright and Patent Infringement

A court in California now joins with courts in Illinois, Michigan and Virginia in stating that state universities are excused from being liable for damages for copyright infringement and, by implication, patent infringement by the Doctrine of Sovereign Immunity under the Eleventh Amendment of the U.S. Constitution. The California case was a suit against the University of California, which allegedly copied copyrighted computer software. This issue will ultimately either have to be decided by the U.S. Supreme Court or by a change in the Federal statutes explicitly stating that states can be sued for copyright and patent infringement. If one or the other is not done, state schools will be free to start making their own piractical copies of video cassettes and books as well as computer programs, armed with a license to steal.

U.S. Patent Office Gives Most Comprehensive Search

It will come as a surprise to many, but the U.S. patent examiners perform a more comprehensive search than examiners in the European Patent Office or the Japanese Patent Office. In an effort to determine the similarities of the examining process with implications under both the trilateral (U.S.-Europe-Japan) and regional (U.S.-Japan-Canada-Australia) cooperative initiatives, foreign patent examiners have been searching alongside U.S. patent examiners and the U.S. Patent Office. The finding is that the U.S. search is far more comprehensive than the others. The Japanese patent examiners were reportedly astounded at the amount of prior art examined by the U.S. patent examiner in making his normal search.

It has been thought for many years that the Japanese searches and even more so the European searches were better than searches of the U.S. Patent Office. Either this was never correct or the situation has changed.

Windows May Be Transparent and Still Contain $3.2 Million Worth of Trade Secrets

Boeing sued its former supplier of cockpit windows for supplying the windows to the after market in violation of Boeing's trade secrets and in breach of their contract and breach of their confidential relationship. The vendor was found liable for all three, and Boeing was awarded $3.2 million. As an interesting side note, the breach of confidence claim was considered separate from the trade secret claim because it did not depend on whether or not trade secrets existed.

Patenting Software Is On the Rise

If the underlying concept involved in software is new and important, the best way to protect it often is by patents. The main advantage of patent protection over copyright protection is that it covers the underlying concept of the program.

At an earlier time, there were some indications that patent protection was not available for software and this misinformation is still widespread today. However, the only software that cannot be patented today is that for a mathematical algorithm. Other algorithms are patentable provided they meet the criteria normally used in determining patentability.

Examples of recently patented software inventions include: a process for a management control system, a program that checks for spelling errors, and a program that converts one language into another. Patents for software systems involving artificial intelligence and for manipulating graphic images are other examples.

An outstanding example of a lost opportunity is the case of Dan Bricklin who invented VisiCalc -- the first personal computer-based spread sheet program. A patent would have dominated such programs as Lotus 1-2-3 and the other electronic spreadsheets. As Mr. Bricklin says, "I'll go down in history as the inventor of VisiCalc. With a patent, the only difference would have been several hundred million dollars."

Major computer companies are rapidly shifting from hardware to software and services for their income. By 1992 they are expected to receive only 50% of their income from hardware. With the ever increasing importance of software, major software houses and computer companies are increasing their efforts to obtain patents on the pure software and the combination of software and hardware.

AUZVILLE JACKSON, JR.

SCIENCE

13 MARCH 1987
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Export Controls of High-Technology Goods

The impaired ability of the United States to compete internationally and even at home in high-technology products is a matter for searching examination. Our failures come from many sources. Recently, U.S. procedures for controls of exports of high-technology goods have been added to the list of causes. The National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine have rendered a public service by sponsoring a major study that has illuminated the need for changes in our system of controls.*

Japan, France, and members of NATO have recognized that advanced technology confers military advantages over the Communist Bloc and have cooperated to limit transfer of technology there. However, the United States has imposed controls that go beyond those of its allies. In earlier times, we enjoyed a monopoly on high technology. But that status is gone. Japan and some members of the Common Market have been joined by Hong Kong, Singapore, South Korea, Taiwan, and others as exporters of microelectronics goods. Today, the United States purchases only 30 percent of the high-technology goods sold on the world market. If our manufacturers are to achieve economies of scale, they must distribute their products globally.

In spite of these developments, the United States behaves as if it still had the monopoly it enjoyed 20 years ago. We continue to assert "jurisdiction over goods and technology even outside the territorial United States when (i) the product or technology in question originated in or is to be or has been exported from the United States; (ii) the product or technology incorporates or uses products or technology of U.S. origin; (iii) the exporter is a U.S. national or is owned or controlled by U.S. interests." Thus when a U.S. subsidiary operating in West Germany wishes to export a high-technology item, permission must be sought from Washington.

The machinery for control of exports from the United States is slow and not very discriminating. The interval measured from when the application leaves the company to when the company receives an export license averages 54 days. In Japan, export licenses are processed in 2 to 3 days. Expeditious schedules prevail in other competing countries.

Delays and uncertainties handicap U.S. firms. Competitors can supply many of the high-technology items at lower prices or with better quality than can the U.S. firms and without delays. A survey conducted showed that many erstwhile customers of U.S. suppliers are turning to other sources.

An example from the report illustrates effects of U.S. export controls. In March 1983, a U.S. company sought a license to export a $450,000 nuclear magnetic resonance spectrometer to a medical research institute in Eastern Europe. The application was not approved until November 1985. Although U.S. firms pioneered the development of NMR, German and Japanese companies now hold two-thirds of the world market for such instruments. During the review period in Washington, a German competitor sold several similar NMR systems to Communist Bloc customers. The NMR instruments do not appear on the U.S. control list, but the equipment was subject to licensing because it contained 32-bit array microprocessors and 30-megabyte Winchester disk drives.

To obtain information for the report, teams were sent to Europe and Asia. They heard many comments about deleterious effects of delays of processing export licenses and were reminded of the problem of the "$2 microchip in the $20,000 machine." When the U.S. chip was used, the entire product had to receive a U.S. re-export license. They also conversed with U.S. customs officers stationed abroad. One officer complained that on instructions from Washington, he spent most of his time "chasing" personal computers.

The United States is trying to control items produced by the millions in many countries. In 1979, legislation was enacted that called for elimination of controls on items that the Soviet Union either can make for itself or freely buy from uncontrolled sources. However, the will of Congress has been thwarted. Substantial progress has not been made in eliminating outdated controls.—PHILIP H. ABELSON

Balancing the National Interest* (National Academy Press, Washington, DC, 1987). See also, C. Norman, *Science* **235, 424 (1987).

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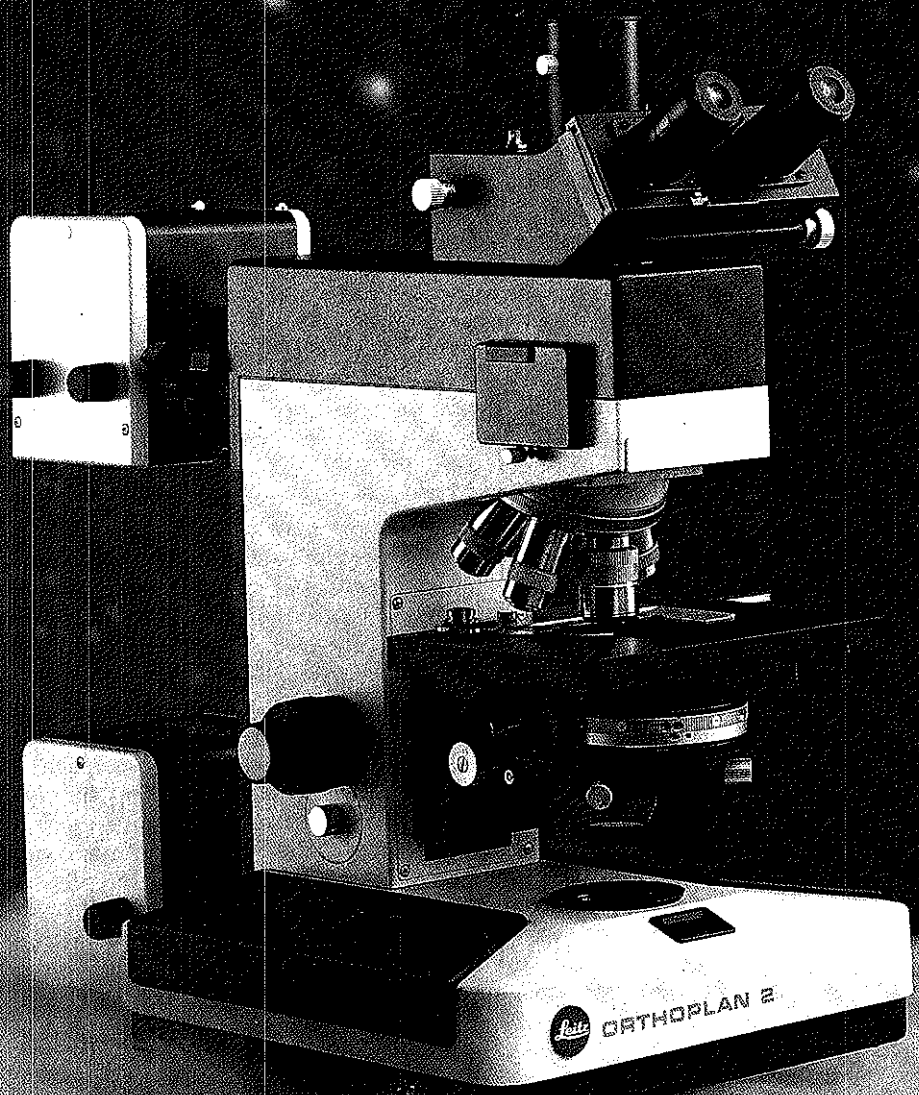

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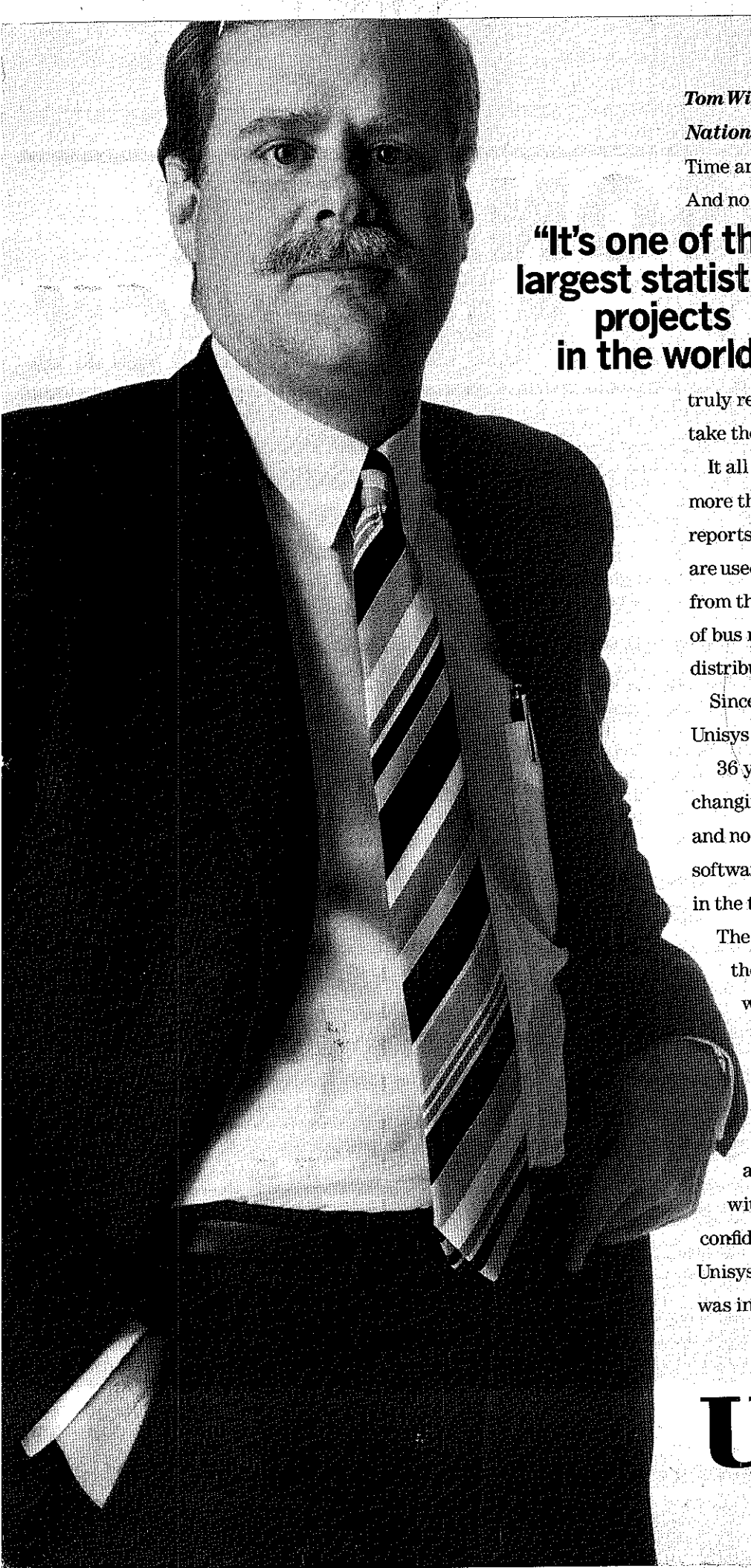

Tom Wilson,

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MANAGING

PERSONALITY TESTS ARE BACK

The latest management tool dates to Carl Jung. It slices executives into 16 categories and purports to help different types communicate. Some managers like the test so much they give it to their children. Which type are you? ■ *by Thomas Moore*

"ESFJ SPOKEN HERE," reads the sign on the accountant's desk at Compass Computer Services in Dallas. Her boss, the controller, has a card that says he speaks "ISTJ." The scrambled letters have also been spotted in Transamerica's pyramid in San Francisco, at the Naval Surface Weapons Center near Washington, and at Virginia Power Co.'s headquarters in Richmond. They turn up in church-group discussions, on license plates, even in personal ads—"ENFP female desperately seeking INTJ male."

No, the proliferation of these mysterious initials does not represent an invasion of extraterrestrials or even the rise of a new order of Masons. The four-letter combinations are the hallmarks of a theory of psychological types that is spreading rapidly out of counseling circles into corporate America. According to the tenets, people of different psychological types may have a hard time working together mostly because each has a distinctive way of perceiving the world and making decisions. Make people aware of which types they and their co-workers are, the theory goes, and *voilà*, communication improves and with it productivity. While some psychologists are not impressed, business people are lapping this stuff up.

The letter combinations stand for personality traits first posited by the Swiss psychologist Carl Jung in 1921 and further amplified after World War II by a mother-daughter team in the U.S., Katherine Briggs and Isabel Briggs Myers. Just as people are born with a predisposition to be left- or right-handed, says the so-called type theory, they are also predisposed to be either extroverted or introverted (E or I), sensing or intuitive (S or N), thinking or feeling (T or F), and perceiving or judging (P or J). Extroverts are oriented toward the outer world of people and things, introverts toward the inner world of ideas and feelings. Sensing types sniff out detail, while intuitive souls prefer to focus on the big picture. Thinkers want to decide things logically and objectively; feelers base their decisions on more subjective grounds. Perceiving types tend to be flexible and to seek more information, while the judging sort want to get things settled.

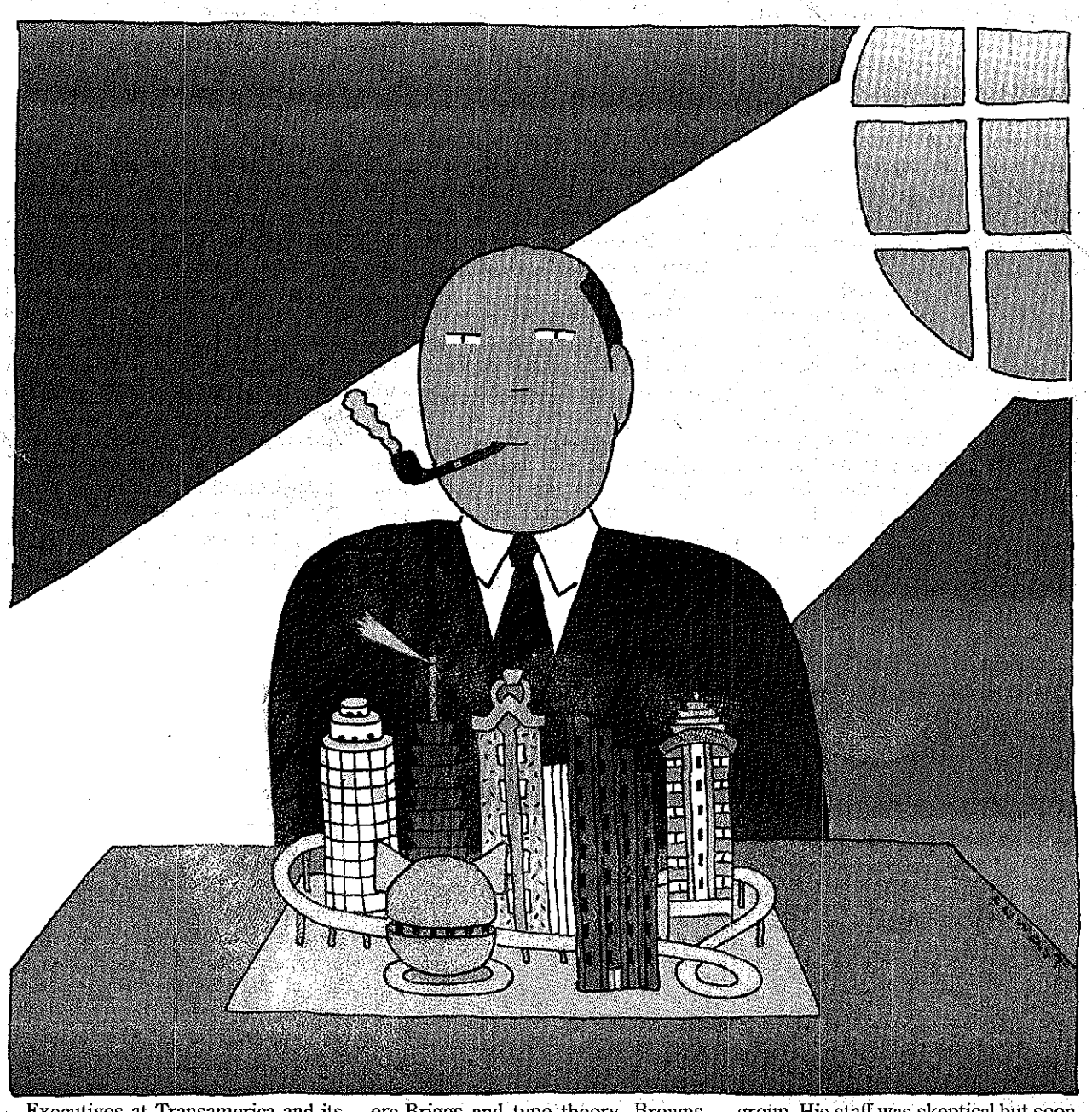
Type theorists divide people into 16 distinguishable personality types according to these four dimensions (see table). In the course of 20 years' work, Briggs and Myers developed a test—or inventory of preferences, as they called it, since there are no right or wrong answers—that indicates an individual's predispositions. It does not measure intelligence, motivation, maturity, or mental health.

The Myers-Briggs Type Indicator, or MBTI as it is commonly known, poses over 100 questions about how the test taker usually feels or acts in particular situations. For instance, in a group, do you often introduce others, or wait to be introduced? (Extroverts tend to introduce, introverts to be introduced.) Do you find it harder to adapt to routine or to more-or-less constant change? (Judging types have a tougher time with change, perceiving types with routine.) Would you rather work under someone who is always kind or always fair? (Feelers go for the kind boss, thinkers prefer a fair boss.) Research suggests that about 60% of men are thinkers, about 60% of women feelers. But the majority of women executives are thinkers, as likely as their male counterparts to neglect others' feelings.

In 1986 some 1.5 million people took the MBTI, according to its publisher, Consulting Psychologists Press in Palo Alto, California. It is almost certainly the most widely used personality test in the U.S., at least among the allegedly normal population, and the test whose use is growing fastest. Average cost of the test: less than $1. The corporate world is by far the biggest user, and businesses accounted for 40% of test sales last year, double their share of three years ago. Companies that give it include Allied-Signal, Apple, AT&T, Citicorp, Exxon, GE, Honeywell, and 3M. Colleges, hospitals, churches, and the U.S. armed forces also administer the test.

MOST COMPANIES use the Myers-Briggs Type Indicator primarily in management development programs, to help executives better understand how they come across to others who may see things differently. Converts are going forth to apply type theory to chores ranging from job assignment, performance appraisal, and negotiation to strategic planning and marketing. In defending the new gospel, they stress the damage that botched communications and internecine conflicts can do.

REPORTER ASSOCIATE *Wilton Woods*



Visionary

INTJ

This type is introverted (I), intuitive (N), thinking (T), and judging (J). While INTJs make up only a small percentage of the population, a disproportionate number rise to become chief executives.

Executives at Transamerica and its subsidiaries, past and present, rank among the most fervent of the believers. In 1979 Lad Burgin, a former offensive tackle from Ohio State with an MBA and a Ph.D., created the company's management development program using ideas on motivation developed by Harvard psychologist David McClelland. Burgin concluded, however, that "an important piece of the puzzle was missing." He found it when he began working with a former history professor turned management consultant, Alan Brownsword, who had become a leading expert on Myers-Briggs and type theory. Brownsword specialized in applying the theory to team building—getting a bunch of individuals to work together effectively. Says Burgin: "We found that by joining the theories of motivation and type, we can solve a lot more problems in the business world."

One of their most successful students was David Carpenter, chief executive of Transamerica's Occidental Life Insurance Co., which generated 60% of the parent holding company's profits in 1986. After he took over in 1983, Carpenter insisted his top management team take the course as a group. His staff was skeptical but soon found type theory a big help in transforming the subsidiary from a sleepy life insurance bureaucracy to a streamlined, competitive financial services company. Carpenter says, "We've used the theory to help us change our corporate culture; it has turned out to be one of the most meaningful things we've done."

An example: Shortly after he took over, Carpenter called in two top executives to talk about how to turn the company's five-year management plan from a dull cover-your-behind forecast to a visionary, best-guess document

ILLUSTRATIONS BY SEYMOUR CHWAST

that laid out the changes they hoped to bring about. While Carpenter and Executive Vice President Simon Baitler started bouncing ideas off each other about the new "picture" they wanted to present, the other executive, a numbers man, just sat looking puzzled. "He didn't get it," Baitler says. "We're talking pictures, but he's looking for details. To him, we're not even talking the English language."

Carpenter then spelled out to the numbers guy exactly how he wanted the first three tables in the plan changed. But when the executive came back with the new plan, two of the tables were the same as before. Carpenter was furious. "The guy must think he's brighter than me," he told Baitler. In fact, the executive had concluded that he wasn't in the same league as Baitler and Carpenter; he was thinking about quitting.

Two weeks later Carpenter and his top management team took the week-long course on type theory, and as Baitler put it, "the lights went on." It turned out that the finance guy, like many number crunchers, was an ISTJ, a very different personality type from Carpenter and Baitler, who were an ENTJ and an ENTP, respectively. The financial executive was introverted, while they were extroverted—a situation that promoted constant misunderstandings. But more important, the numbers man was a sensing type, someone who thinks largely in terms of facts and detail, while the other two were intuitives, people who think in terms of context first and fill in pertinent facts later.

"After the class, we knew he didn't hear the instruction about Tables 2 and 3, much less form an overall picture of what we were talking about, because he was still focusing on the details of Table 1," explains Baitler. "It had nothing to do with motivation and intelligence." Carpenter and Baitler now often ask the finance man to summarize what was agreed upon at a meeting and then they fill in any gaps. They have also come to recognize that an ISTJ, whose type is more realistic and pragmatic than theirs, has a better grasp of the risks in any big-picture idea than they do—an invaluable asset that can save them from intuiting their way into a debacle.

In turn, the financial executive now thinks twice about how he is going to present information to the chief. At one point he had to make a report to Carpenter that combined ten pieces of bad news and one big element of good news—a positive that outweighed all the negatives. True to his orderly ISTJ type, he had planned to list each bad news item and then give Carpenter the good news. But Baitler advised: "If you present it that way, Carpenter, being an ENTJ, will judge each piece of bad news adversely. Why not give him the overall picture first—that you've got good news that outweighs some bad news—and then fill in the details?" The revised presentation worked nicely.

COMPASS COMPUTER, a computer reservations company owned jointly by Hilton Hotels and Budget Rent-a-Car—and formerly owned by Transamerica—is a virtual laboratory on the chemistry between different types. President Michael Carrico and some of his top managers went through Transamerica's course and tried to put what they learned to work. Says Carrico: "We had some morale problems. I realized I had a mixed bag of people reporting to me and that this could help us understand each other better and also understand how we make decisons."

Over 100 of 180 employees have taken Brownsword's team-building program. Executives say it helped the company adjust to a recent major upheaval after Hilton and Budget forced Compass to drop a big project and make major cutbacks. As an introvert, Carrico was inclined to withdraw and make decisions alone when under pressure. But with the training in mind, he went out of his way to get his management group's advice on where to cut back. One piece of advice he accepted was to continue the team-building program, which had cost the company $400,000 over two years. Says Linda Edwards, the company's human resources vice president: "We wouldn't have made it through without type training."

Other outfits experimenting with type theory tell similar stories. Apple Computer uses it to help different teams work on task force projects together. West Jersey Health Systems,

Organizer

ESTJ

He or she is extroverted (E), sensing (S), thinking (T), and judging (J). It is one of the most common types in the general population as well as among managers.

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Morgan Guaranty

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Morgan Guaranty

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Morgan Guaranty

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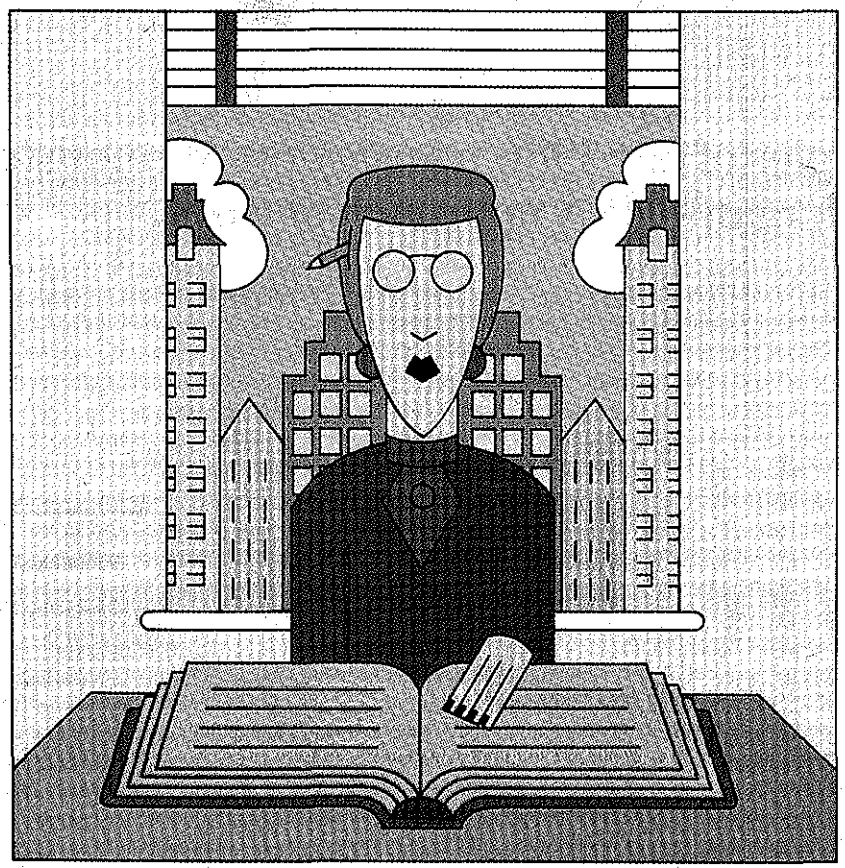
Morgan Guaranty

Traditionalist

ISTJ

These introverted (I), sensing (S), thinking (T), and judging (J) souls may be sticklers for detail and rules. ISTJs often become accountants and financial executives.



a small nonprofit hospital group, is using a type program to help its nurses, doctors, and managers come up with ways to make patient services friendlier. Virginia Power uses type theory in strategic planning workshops to jar managers into thinking more competitively. The utility industry may be deregulated down the road, and the company wants to explore new ventures—a discipline many of its executives have never undertaken. "Everybody knows we're in a new ball game, yet they keep doing what they've always done," says Wylie WanVeer, senior training specialist. "We've got a lot of sensors who worry about the next five quarters, but we need intuitive thinking that focuses on the next five years."

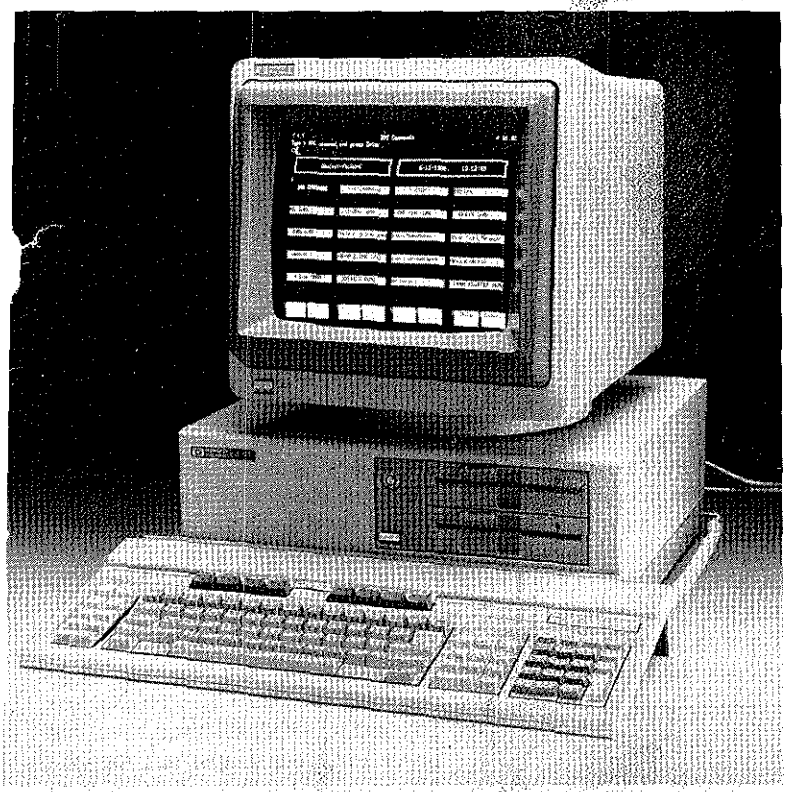
Knight-Ridder's *Charlotte Observer* used type theory as a basis for team building in a fractious newsroom that had been jolted by a series of management changes. The outcome was so successful, says publisher Rolfe Neill, that he and his executive team took the same course and then turned loose the trainer, Dolly

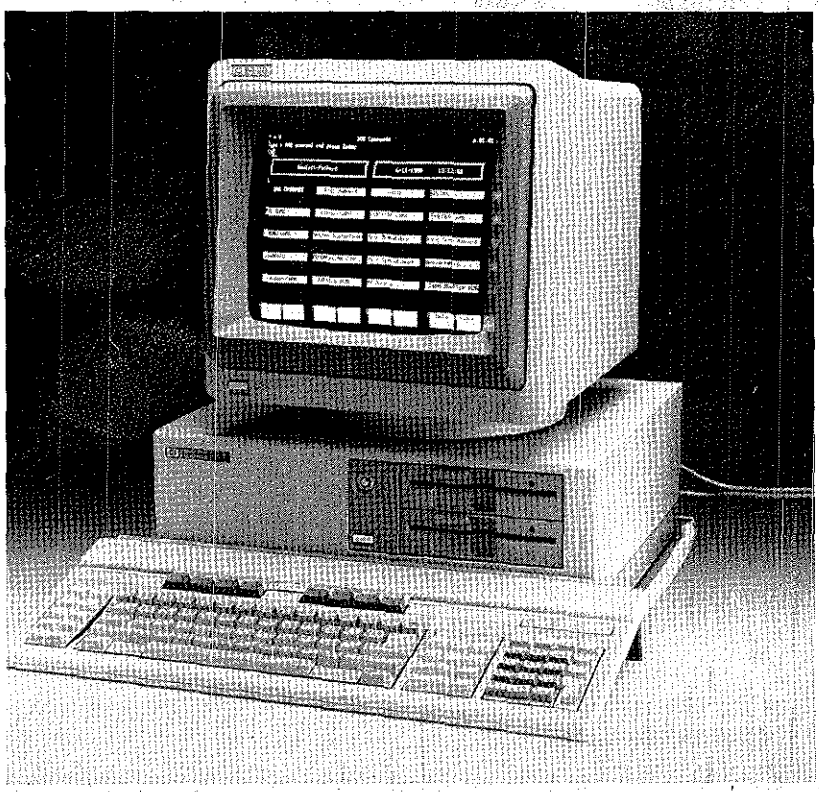
THE 16 DIFFERENT PERSONALITY TYPES

		SENSING TYPES S		INTUITIVE TYPES N	
		THINKING T	FEELING F	FEELING F	THINKING T
INTROVERTED I	JUDGING J	**ISTJ** Serious, quiet, earn success by concentration and thoroughness. Practical, orderly, matter-of-fact, logical, realistic, and dependable. Take responsibility.	**ISFJ** Quiet, friendly, responsible, and conscientious. Work devotedly to meet their obligations. Thorough, painstaking, accurate. Loyal, considerate.	**INFJ** Succeed by perseverance, originality, and desire to do whatever is needed or wanted. Quietly forceful, conscientious, concerned for others. Respected for their firm principles.	**INTJ** Usually have original minds and great drive for their own ideas and purposes. Skeptical, critical, independent, determined, often stubborn.
INTROVERTED I	PERCEIVING P	**ISTP** Cool onlookers—quiet, reserved, and analytical. Usually interested in impersonal principles, how and why mechanical things work. Flashes of original humor.	**ISFP** Retiring, quietly friendly, sensitive, kind, modest about their abilities. Shun disagreements. Loyal followers. Often relaxed about getting things done.	**INFP** Care about learning, ideas, language, and independent projects of their own. Tend to undertake too much, then somehow get it done. Friendly, but often too absorbed.	**INTP** Quiet, reserved, impersonal. Enjoy theoretical or scientific subjects. Usually interested mainly in ideas, little liking for parties or small talk. Sharply defined interests.
EXTROVERTED E	PERCEIVING P	**ESTP** Matter-of-fact, do not worry or hurry, enjoy whatever comes along. May be a bit blunt or insensitive. Best with real things that can be taken apart or put together.	**ESFP** Outgoing, easygoing, accepting, friendly, make things more fun for others by their enjoyment. Like sports and making things. Find remembering facts easier than mastering theories.	**ENFP** Warmly enthusiastic, high-spirited, ingenious, imaginative. Able to do almost anything that interests them. Quick with a solution and to help with a problem.	**ENTP** Quick, ingenious, good at many things. May argue either side of a question for fun. Resourceful in solving challenging problems, but may neglect routine assignments.
EXTROVERTED E	JUDGING J	**ESTJ** Practical, realistic, matter-of-fact, with a natural head for business or mechanics. Not interested in subjects they see no use for. Like to organize and run activities.	**ESFJ** Warm-hearted, talkative, popular, conscientious, born cooperators. Need harmony. Work best with encouragement. Little interest in abstract thinking or technical subjects.	**ENFJ** Responsive and responsible. Generally feel real concern for what others think or want. Sociable, popular. Sensitive to praise and criticism.	**ENTJ** Hearty, frank, decisive, leaders. Usually good in anything that requires reasoning and intelligent talk. May sometimes be more positive than their experience in an area warrants.

SOURCE: INTRODUCTION TO TYPE BY ISABEL BRIGGS MYERS.

WHAT MAKES ONE MORE COMPATIBLE THAN THE OTHER?





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Government has become interested too. It should come as no surprise to learn that city managers in trendy San Francisco are taking type training. But the General Accounting Office? The federal agency uses type theory to help improve the effectiveness of its teams of analysts. The Foreign Service Institute applies the theory to teaching languages. Otto Kroeger, a Myers-Briggs consultant, has taught over 4,500 officers at military colleges, including top brass at the National Defense University. Some graduates now call him in to help them with their managerial headaches.

A military chaplain had him come to West Germany a couple of years ago to analyze certain troublesome incidents at isolated defense posts. The symptoms included drug abuse, vandalism, shootings, bar fights, and suicide. Says Kroeger: "What you had was a bunch of SPs [sensing-perceptives], action-oriented kids who dropped out of high school, loved Army training, and then were shipped off to some little outpost where they were told to be constantly on alert. They sat there waiting for something to happen, but nothing ever did. So they ended up dropping a wrench somewhere to stir up a little excitement."

To make things worse, many outpost commanders were SJs (sensing-judging types) and thus sticklers for daily reports and routine procedures —the bane of SPs. Kroeger negotiated a truce between types rather than ranks. The officers relaxed some rules and cut back on paperwork, and in return the soldiers made sure they got their job done. Accidents and hooliganism declined, says Kroeger.

Despite the growing popularity of type theory, many psychologists and managers remain skeptical. An operations chief from 3M stared hard at the grid of 16 types and asked, "Why does the word *Communism* pop into my mind?" The charges that Myers-Briggs stereotypes people, that it is a static, undynamic theory that traffics in labels much like astrology, have dogged the theory for years.

Doubts linger even in some centers of faith. Transamerica Corp.'s chief executive, James Harvey, who never took the course, has decentralized t parent company's sponsorship. No each division or subsidiary chooses whether to pursue the training. Says Reed Gregg, head of Transamerica's audit department and a champion of the theory: "The top management group wanted to see something tangible, but how do you measure a change in attitude?"

SOME SKEPTICAL managers wonder whether type theory may turn out to be just another management fad. David Fry, a British-born vice president of systems development at Compass Computer and one of the few disbelievers on the staff, jokingly compares its spread through the company to a religious revival. He rejects the theory on purely scientific grounds. "You can't measure the results, and the consequences are not predictable," he says. "It does seem to make people feel better. But when the preacher leaves, I think the Christians will become heathens again."

For their part, many Myers-Briggs proponents say the test should be used only as an instrument to improve the test taker's self-awareness, and never to screen employees for jobs. They argue that type skills could be used to help, say, an introverted salesperson learn to develop the necessary extroverted behavior for the job. Other psychologists defend the MBTI as one of a battery of tests and techniques that can be used together in making evaluations. "It is a tried and true instrument," says Richard Diedrich, a clinical psychologist with Rohrer Hibler & Replogle, a consulting firm that advises corporations on matters psychological.

On balance, the theory may well be less significant than the communications it seems to foster. Talking about what type you are and what type I am and the differences between the two often proves to be an unthreatening way for people to raise and resolve problems. Indeed, many executives who have been exposed to Myers-Briggs urge their spouses and children to take the test. Some report that the results help explain behavior that has puzzled them for years. F

Conceptualizer

ENTP

This type is extroverted (E), intuitive (N), thinking (T), and perceiving (P). ENTPs love new possibilities and hate routine. They're more often entrepreneurs than corporate executives.

Patents Resulting from NSF's Engineering Program*

Robert S. Cutler, National Science Foundation, Washington, DC 20550, U.S.A.

Summary

This report presents the results of a study of engineering research project grants funded by the National Science Foundation (NSF) between 1968 and 1977. The purpose was to determine the extent to which the grants led to patented technology and to estimate the economic value of those patents.

From the names of the principal investigators supported by NSF Engineering grants, who are also named as inventors on engineering patents registered with the U.S. Patent and Trademark Office, an examination was made by technology experts from SRI International, Inc. to determine the relevance of each grant to its associated patent. An independent assessment was also made to evaluate the commercial potential of each patent and to estimate its economic value.

The study found that from some 4077 NSF Engineering project grants awarded between 1968 and 1977, about 2.6 grantees in 100 produced patents linked to his or her grant. Some 248 patents were examined in this study. Although few patents produced any economic value, seven of these patents were licensed, with royalties ranging from $10 000 to $250 000 annually.

The total long-term royalties expected from the linked patents investigated is estimated as high as $52.5 million. The aggregate value to the U.S. economy from the sales of products derived from those patents could range between ten and twenty times that amount, depending upon the industry.

One observation from the study is that a strong patent licensing program is becoming valuable to universities, not just for producing royalty income, but for the additional sponsored research funds it attracts from industrial firms.

*This paper was presented at the Eleventh Annual Meeting and International Symposium, Technology Transfer Society, Indianapolis, IN, 24 June 1986.

The author is a Senior Staff Associate on the Program Evaluation Staff of the National Science Foundation, Washington, DC 20550. The views expressed here are those of the author and do not necessarily reflect those of the National Science Foundation.

†For example, The Patent and Trademark Act of 1980 (P.L. 96-517) gives general authorization to universities and colleges to promote inventions resulting from government funded research.

Introduction

Whether valuable patented inventions have resulted from academic research supported by National Science Foundation (NSF) grants has been debated among members of the National Science Board and by committees of Congress for some time. The recent agenda of the House Science and Technology Committee's Task Force on Science Policy included a review of government research support and patent policy as one of the issues to be studied.[1]

An academic scientist typically is interested in teaching, doing research, and in disseminating new scientific knowledge through publication and related activities. The discovery of commercial applications for an idea or invention has been of secondary importance. However, recent changes in U.S. patent policy have awakened interest among academic institutions to transfer their research results to the marketplace.

Although the Federal agencies have routinely recorded their contractor and grantee invention disclosures since the 1960s, few systematic studies have been undertaken to assess the significance of such patent activity or its value to the national economy. Moreover recent legislative developments† have focused attention on the need to identify and evaluate patented inventions as discrete and measurable outputs of Federally-supported research.

This paper summarizes a study of NSF Engineering patents performed during 1984 by SRI International, Inc., Menlo Park, CA, under NSF Contract EVL-83 19583. The work builds upon an earlier patent study of the NSF Chemistry Program performed by Research Corporation, New York, in 1982.[2] Both studies attempt to establish reliable baseline data for making future comparisons of university patent activity resulting from NSF grant support. The procedures used can be applied, with comparable effort, to evaluating patents associated with similar research grant programs elsewhere.

Purposes and Objectives

The purposes of this study are to determine the extent to which NSF Engineering Program grants produced

In view of the contents described it is clear that the aim of the video is to be an introduction to the expanding use of computers in the daily work at the EPO. The target audience is in the first place new staff at the EPO as part of their introductory training. In the meantime, however, the video has proved to be a success when shown to visitors. The simple but accurate explanation of the mutual relations between the different databases was the feature most appreciated.

On the other hand, it is obvious that it was a low budget production, with no budget at all for special effects. But the camera, the recorder, the player (both U-matic), two monitors, a small mixing table and a lot of black coffee were excellent.

Only one concession was made. It proved to be difficult to take pictures directly from a terminal screen, especially when parts of that screen were to be enlarged for higher readability. Therefore print-outs were made from each screen output and then videoed.

Finally, the credits. The 15 minute video was made on U-matic cassette for the PAL system by two senior examiners, Mr. G. Mees and the author of this article.

patented technology and to estimate the economic value of those patents. In addition, the study develops a systematic method for evaluating patents associated with university research grants and provides some quantitative statements useful for describing the university technology transfer process.

The objectives were to:

(1) Determine whether links exist between certain U.S. patents and NSF engineering grants.
(2) Determine whether the patents identified were ever licensed or judged commercializable.
(3) Estimate the aggregate economic value of those patented inventions found to have resulted from NSF Engineering Program support.
(4) Establish a reasonable basis for evaluating patents resulting from Federally-supported university research.

The approach taken was to examine a 10-year set of 4077 NSF engineering research grants in order to determine the extent to which those grants led to patented technology and to commercial use.

Scope of Study

The study involved some 722 patents issued between 1975 and 1982 to the 4077 principal investigators supported by NSF Engineering Program grants between 1968 and 1977. Because of grant document retrieval problems, which proved to be random,* only 149 grants associated with 248 patents were actually examined. This sample is considered to be representative of the total set of 4077 grantees.

Procedure

The first part of the study sought to determine the number of research grants supported by NSF's Engineering Program which also produced U.S. patents. The second part, performed by members of the Patent Review Board of SRI International (SRI), estimated the commercial potential and economic value of the patents found. They followed the patent evaluation process typically used in industry, which is summarized below. The results of an earlier patent study of NSF chemistry grantees[3] was used to provide a basis for comparison.

*Although attempts were made to retrieve these retired grant documents from the U.S. Archives, many of the original grant folders were not found due to misplaced, lost, or destroyed records. A statistical test (chi-square, equality of proportions along five attributes) confirmed that the missing data was random: thus the available sample of 149 is considered representative of the original population of 4077 grantees.

Caveat on Baseline Estimates

This study attempts to plough new ground in an uncertain and difficult area: the relationship between university research, patented inventions, and economic impact. The database used was constructed from the best information available at NSF and U.S. Patent and Trademark Office computerized files, which may have been incomplete. The results were derived from very conservative estimates, because of the nature of the PI/Inventor name-matching process used and the restricted availability of the licensing data. The time periods selected for analysis were chosen to best approximate the mainstream of grant-patent activity within the constraints of the data. Nevertheless, the evaluation method used is straightforward and provide a reasonable basis for arriving at the results found.

Sources of Data: Patents Related to NSF Engineering Grantees

The primary data sources used were the 'NSF Engineering Program History Tape', an unduplicated alphabetical listing of some 4077 principal investigators (PIs) supported by NSF's Engineering and applied research divisions between 1968 and 1977, and the U.S. Patent and Trademark Office's (PTO) computerized list of patents issued between 1975 and 1982. (Only U.S. patents issued after 1 January 1974 were accessable by computer from the PTO files.)

Typically it takes about 2 years after a grant is awarded to do the research, from 2 to 4 years to prepare and file a patent application based on that research, and an additional 2–7 years for prosecution in the PTO before a patent is issued. Based on these time requirements, it was assumed that grants awarded between 1968 and 1977 most likely supported the research which 7 to 10 years later produced patents issued between 1975 and 1982. This constituted the search grid for the study.

Using the names of the 4077 NSF Engineering Program grantees between 1968 and 1977, we made computerized matches were made with the names of inventors listed in the PTO's database files of engineering patents (mechanical, electrical, chemical, and structural) issued during the period January 1975 to December 1982. Similar name-matches had previously been made for the list of 3766 NSF Chemistry Program PIs receiving grants for basic chemistry research between the years 1964 and 1974.

The use of comparative data from the earlier NSF chemistry patent study was considered useful since both sets of grantees are based primarily on their scientific merits. The applied nature of engineering research, however, may have included the additional criterion of practical utility, which was expected to account for significant differences in the results.

Selection Criteria

The first step in carrying out this study was to determine the extent to which the research supported by NSF's Engineering Program between 1968 and 1977 produced United States patents. The names of the PIs were matched by computer against the names of inventors listed on all patents issued by the PTO. For each match, a grantee institution was determined by reference to the inventor's name, address, and assignment of the patent. This information was later used to verify the name-identity of particular PIs and inventors.

To organize the substantive examination of the study, the full text of each patent identified was obtained from the PTO search and assigned to one of three categories using the selection criteria given in Table 1.

Table 1. Relevance of patents to grants

Category	Assignment criteria
Directly related	PI and patent inventor names are identical; NSF support acknowledged in patent.
Probably related	PI and patent inventor names are identical; Titles and/or subject matter of both grants and patents are related; Patent application date is concurrent with or follows grant award date.
Possibly related	PI and patent inventor names are identical; Titles and/or subject matter of both grants and patents are similar; Patent application date follows grant proposal date; University and geographic proximity.

Procedure for Determining Linkage of Patents to Grants

Each of the selected patents in which a named inventor and PI are identical was examined by a subject expert for possible 'relevance' of the subject matter of the patent to the research performed under the grant. About one in five of the patents (29 out of 149) contained acknowledgements to specific NSF grant support; for these no further examination for 'linkage' was considered necessary.

For the remaining grantees, the examination comprised a review of the original grant proposal, each interim and final technical report, and any publications resulting from the research. The technical details in these documents were compared with the specifications and claims in the associated patent. Finally, a 'patent relevance' judgment was arrived at by the subject expert and recorded on a special worksheet.

Findings:

The results of this part of the study are:

- 395 of 4077 (9.7%) NSF Engineering Program PIs were named as inventors on U.S. patents between 1975 and 1982.
- 722 patents were issued to the 395 NSF grantees; 248 of these 722 patents were issued to 149 PIs involving technology associated with the research supported by NSF.
- 51 (21%) of the 248 patents examined were found to be linked to NSF sponsored research.
- 40 of the 149 Engineering PIs had patents linked to their NSF grant. 17 patents issued to the remaining 109 grantees, which included funding acknowledgements to other NSF programs, were judged as not related to the research supported by the NSF Engineering Program.
- Median time from grant award to patent filing date was 3.8 years.

Economic Value of Patents

An economic assessment of each 'linked' patent was developed from information requested from the inventor, from the university patent administrator, or from patent owners to whom assignment of the patent had been made. A questionnaire was used to obtain information on whether the patent had been licensed, date of first sale if marketed, and estimates of total volume of business over the life of the patented products or processes. Although it is too early for full commercialization of patents covering research conducted in the 1968–1977 time period, the information on the early use of the patent itself provides a basis for estimating its potential value.

A majority of the patents examined were not licensed. For each "linked" patent, the technology covered, type of claims, and problems visualized in licensing the claims were analyzed. Most of the patents found were considered of doubtful licensability, i.e., they have limited commercial application, present insurmountable difficulties to protect against infringement, or have no apparent economic advantage over existing processes.

The actual economic value, to date (sales of patented products or processes) of these NSF Engineering patents is relatively small. This is because the full economic potential can take from 15 to 25 years longer to be realized. Also, the selection method used in this study rejected seventeen patents which were invented

by NSF grantees, who were not strictly Engineering program PIs during that time period.

A conservative estimate of the economic value of those patents resulting from NSF Engineering program support is on the order of $52 million. This estimate was based on SRI's experience in evaluating patents and in licensing high-technology inventions, including many which have resulted from basic university research.

The results of this analysis are:

- Seven of the 51 patents resulting from NSF-supported engineering research have been licensed or assigned to an industrial company and have contributed directly to industrial technology; eleven of the remainder are considered potentially licensable.

- The aggregate economic value of the eighteen NSF engineering patents found licensed or licensable is estimated at between ten and twenty times royalty income over the life of the patented product or process. (The total sales to date of the licensed patents cannot be determined with accuracy since adequate proprietary information was not available).

Analysis of Findings

The reasons for differences between the grant-patent data for the NSF Engineering Program and Chemistry Program are complex. A number of probable factors are suggested from related observations.

A comparison is shown (Table 2) between the Engineering and Chemistry program outputs. Basic research is more likely to result in dead ends or non-patentable results than is applied research or engineering.

The research proposals submitted to the NSF Engineering Program are inherently more applied in nature than those sent to the Chemistry Program. The review process employed by the two NSF programs differed; Chemistry evaluated their proposals by mail, whereas Engineering divisions used both external mail reviewers and *ad hoc* panels of experts who met to rate project proposals. While reviewers were instructed to rate proposals for 'scientific merit', there are indications in their written comments that engineering reviewers also gave weight to the practical utility of the anticipated research results.

For those 18 patents found to have commercial value, all were linked to PIs who admitted having been

Table 2. Comparison of results

	NSF Engineering Program	NSF Chemistry Program	Research Corporation chemistry grantees
Period covered	1968–77 (10 years)	1964–77 (14 years)	1964–74 (11 years)
Number of principal investigators (PIs)	4077	3766	915
Number of PIs named as inventors on any patent	395 (149)	73	57
Number of patents issued to these PIs	722 (248)	195	32
Number of patents linked to NSF sponsored research	148* (51)	95	16
Number of PI/Inventors whose NSF grants linked to patents	106† (40)	39	9
Patent ratio: (PI/I per 1000 grantees)	25.9 per 1000	10.4 per 1000	9.8 per 1000
Median time from grant award to filing patent application	3.8 years	5.2 years	6.4 years

*Factor of 0.205 used to project data ($51/248 \times 722 = 148$ patents).
†Factor of 0.268 used to project data ($40/149 \times 395 = 106$ PI/I)

consultants to industry or had prior industrial experience.

Why the Engineering Program patents were commercialized in less time than the other two groups is unclear. The data suggests that PIs who had prior industrial experience were better able to effect the commercial success of their patents.

Estimated Economic Value

As described earlier, the analysis of linked patents was limited by two conditions: (1) the difference between the period in which the grants were awarded (1968–1977) and the period in which the patents were issued (1975–1982), and (2) the lack of information about 474 patents known to be issued but for which grant information was not recovered. To reach quantitative conclusions about all linked patents issued to the grantees of interest, two statistical adjustments were made.

These two adjustments were made on the aggregate statistics of the patents examined. Considering the uncertainties of the evaluation process, this approach made it unnecessary as well as impractical to estimate the probability distribution of royalty income for each patent. Therefore, the midpoint of the range of potential royalties for each patent was used.

The sample of 248 patents showed that 92.7% of them had no commercial value. The midpoint value of the estimated royalties for the remainder was found to be approximately lognormally distributed.

A Monte Carlo simulation yielded a best estimate of the potential royalties of the 474 patents of $23.0 million. Combining this figure with the midpoint of the estimated royalties of the 248 patents examined gives an estimated total of $31.5 million in royalties for all patents known to have been issued.

To adjust for the difference between the grant award and patent issue periods, the distribution of the time lag between grant award and patent issue was determined. From this distribution, it was estimated that 60% of the patents that have been issued to the grantees were issued in the period 1975–1982. Therefore, the total royalties for all patents issued or to be issued to the group of PIs studied was estimated to be $52.5 million.

Additional Observations

One observation from this study is that a strong patent licensing program is becoming valuable to universities, not just for producing royalty income which typically is small, but for the additional sponsored research funds it attracts from industrial firms, both in the U.S. and from abroad.

Although there is insufficient evidence, to date, to know whether the recent (since 1980) shift in Federal and university patent policies toward commercializing university research results has affected U.S. competitiveness in high-technology markets, this study suggests a method for identifying and assessing the extent of university patent output attributable to Federal research grant programs.

Conclusions

Based upon the analysis of findings, the following conclusions are reached:

- Few commercialized patents resulted from NSF grants for engineering research or from the PIs who conducted the research. However, the findings for both the Engineering (3.6%) and Chemistry (1.04%) grantees studied are comparable suggesting that this is due more to the nature or direction of the research than to poor performance by the investigators.
- The PI/Inventor ratio of 26.8 per 1000 grantees, for the NSF Engineering Program, appears significantly higher than the comparable ratios (10.4 per 1000 and 9.8 per 1000, respectively) for the two more basic Chemistry research grant programs.
- The patents examined, which are linked to NSF Engineering research grants, had only a slight impact on technology to date, and can be expected to have a modest economic value in the long run.
- The PI's recognition and awareness of patents is greater today than it was 10–15 years ago.
- The median time (3.8 years) between grant award date and patent filing date is appreciably less than that found for the more basic chemistry grants.
- A strong university patent licensing program is becoming more valuable, not only for producing royalty income, but for the additional sponsored research funds it attracts from industrial firms.

Acknowledgement — The author acknowledges the contributions of Thomas P. Sheahen and Robert L. Stern of SRI International for performing the examination and evaluation of grant and patent documents for this study, and to Harry J. Piccariello and William D. Commins for their helpful comments.

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