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wisconsin engineer

I do not believe in a dice throwing God.

Albert Einstein

wisconsin engineer

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Dean's Page

Graduation - a new beginning

Dean

W. Robert

Marshall

This is the last issue of the *Wisconsin Engineer* for the 1974-75 academic year. This is just one of many of our College's student programs which completes another year and adds another chapter to the history of our College. It has been a chapter with good accomplishments due to the efforts of all those students who have given their time, thought, and effort to its success. A new chapter for the *Wisconsin Engineer* will begin in the fall of 1975, and additional good accomplishments are anticipated.

There will be other chapters to enter into our College records, namely the completion of undergraduate careers by several hundred engineering students who will receive their hard won and richly deserved engineering B.S. degrees in May of 1975. In contrast to the *Wisconsin Engineer*, however, most of these graduates will begin the next chapter of their careers away from the College of Engineering, at differing locations, in a diverse number of occupations, and with many new and exciting challenges.

To these students I offer my most sincere congratulations on having earned your engineering degree at one of the best Colleges of Engineering in the United States. When you embark on your engineering career, whether it be in industry, government service, private practice, or graduate study, you will discover and be proud of a very important fact — the University of Wisconsin-Madison is held in the highest esteem throughout the U.S. Also if you travel or work in other countries, you will be impressed by the fact that your university is known, admired, and emulated by the people and educational institutions in countries throughout the world. I am sure you will receive great satisfaction from such revelations and realizations. With this awareness of the high regard held for the University and the College, will come another realization, namely, a personal desire to uphold the high standards of the College and the faculty by carrying out your responsibilities and assignments with the highest sense of professional conduct and with the most diligent application of your technical skills.

It would be wise, at this time, to recognize that, as an engineer, your educational obligations will continue throughout your lifetime. Obtaining your baccalaureate degree is not the conclusion to your education — it is the beginning. Your education will continue along many paths. You will consolidate the engineering fundamentals you have been taught formally by application to real-world problems. You will learn new skills and new concepts through experience, study, and advancement to new positions. You **must** be prepared to learn the art of working effectively with other people — especially those who may not understand technology. This involves improving your communication skills, both written and spoken, and understanding the nature of other people's problems, with whom you work. Finally, you should consider seriously the importance and advantages of supporting the engineering profession through membership and participation in professional societies and through state licensure as a professional engineer.

To all of you leaving the College this spring, I offer the best of wishes and good luck in your new adventures — and may your purpose hold. WE

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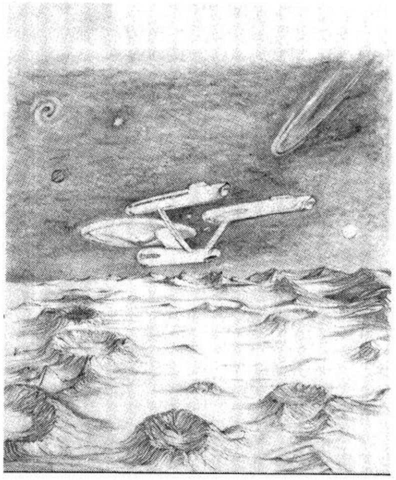
Vol. 79 No. 6

Beaming down on *Star Trek*



by
Chuck
Kuehn

When Gene Roddenberry first dreamed in the early 60's of placing a science fiction adventure thriller on television—one with real meaning and importance—he knew it would not be easy. Cynics abounded, calling his concepts 'risky', 'too different' and 'impossible to produce'.

Roddenberry persisted and in 1966, after one pilot failure, succeeded in producing a full length film which was aired by NBC. What followed was a new science fiction series called STAR TREK—a show which so captured it's audience that in 1968 when the network considered cancellation, it set off a series of marches and student protests in both Burbank and New York. Simultaneously, over 115,000 letters were received by the network from angry fans forcing an unprecedented on-the-air announcement that STAR TREK would continue.

The series, now in syndication around the country, is in the midst of a revival that is growing to such proportions that STAR TREK fans held a national convention this year. On many college campuses it is watched daily with almost a religious devotion by fans who call themselves 'Trekies'.

So what is it about STAR TREK that so magnetizes the masses? What is it that makes you fans keep coming back for more? How is it that STAR TREK succeeded when LOST IN SPACE became just that?

Three things seem to set STAR TREK apart from all other science fiction adventures produced for television: subject matter; believability, and scientific accuracy.

Instead of insulting it's audience as so many television programs do, STAR TREK prods and challenges its viewers to ponder philosophical questions about politics, economics, sex, human relations, and war, both as they relate to our present culture and as to how man's thinking may or may not change 150 or 200 years from now.

The key to STAR TREK's believability, according to Roddenberry, its creator and producer, is that it purposely avoids way out fantasy and refuses to dwell on intellectual scientific theorems and instead concentrates on problem and peril met by very human and recognizable continuing characters.

"Tales of six-headed monsters are rare among science fiction classics" says Roddenberry. "The best and most popular feature highly dramatic variations on recognizable things and themes. But even within these limits, there are myriad stories, both bizzare and shocking, plus a few monsters legitimus."

According to Roddenberry's story format, STAR TREK uses a 'similar worlds concept' in their depiction of aliens. They are presented in humanistic terms physically, adding different skin coloration, hair, noses and ears simply for dramatic effect.

Roddenberry felt that the main concentration in dealing with the concept of alien life should not be on physical differences but on the incredible differences that would probably exist in social organizations, customs, habits, religion, politics, morals, intelligence, family life, and emotions. Concentration on these topics removes the series from the realm of a mere shocker.

The creator also went to great lengths to be certain his series would maintain a high level of scientific accuracy not only in the design of the ship but in the vessel's power source and in its presentation of gadgetry and equipment.

One of the goals of STAR TREK was to break down the myth that science fiction and fantasy are the same thing. "Science fiction is based on fact or well thought out speculation." Said Roddenberry. "It is extention of current knowledge or of a theory worked out in enough detail to seem at least 'possible'. "With fantasy," he says, "you can have a guy blink and then disappear and never really explain how or why he could do that."

To achieve maximum accuracy, Roddenberry called on a number of specialists. Personnel from space technology labs and the Air Force Space Systems division acted as advisors. Harvey P. Lynn, a physicist at Rand Corporation acted as a script consultant for over a year and a half on his own time, simply because of his fascination in STAR TREK concepts.

The design for the space ship, the USS Enterprise, came about from researching a collection of drawings gathered from various personnel at North American, Douglas, and NASA, plus reviewing the previous research done for the Flash Gordon and Buck Rodgers series.

All apparatus, equipment and gadgetry used in the show were likewise the result of known or tested concepts of design or at least theorized models of the future.

For example, the source of power for this futuristic vessel, the Enterprise, is matter-anti-matter engines. This concept was not decided on until after the show was already on the air. As the matter was being discussed, a rather vague term, 'space warp' was used to explain the vehicle's thrust.

As Stephen Whitfield explains in *The Making of Star Trek* "Discussion with scientific consultants had alrady ruled out atomic power as inefficient and inadequate for achieving hyper-light speeds. Ion drive was ruled out for the same reason. Finally, the conclusion was reached that the only power source conceivable large enough to do the job would be energy released by the sheer annihilation of matter and anti-matter. This has already been achieved on a small scale by several research laboratories."

One of the most popular pieces of apparatus among fans is the transporter mechanism. This device will temporarily convert matter into energy, beam that energy to a predetermined point, and then reconvert the matter to its original pattern and structure. No receiver is needed. With a range of about 16,000 miles, it can transport up to six people at one time. As incredible as it seems for viewers to see people dissolve in one spot and reappear in another location, the idea of a transporter is a concept that has long been discussed by the scientific community.

Another piece of equipment used aboard the Enterprise which has definite implications for the future is found in the vessel's sick bay. Script designers, considering our present methods of taking temperatures and blood pressure as primitive, designed a machine which rests above the patient in bed. The mechanism will run a continous scan of the physiological body functions by means of sensor devices records all pertinent information on a screen monitor.

Roddenberry, surprised, explained later, "we weren't on the air long when we were contacted by no less than three separate research organizations, all of whom demanded to know how we had obtained the information on the same devices they had under development."

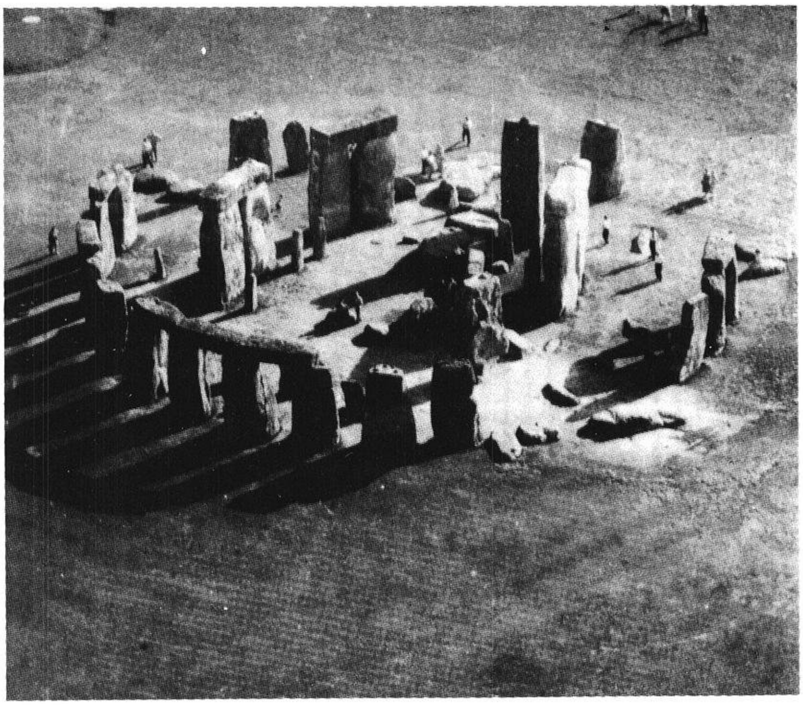
Although STAR TREK ran for only two and a half seasons on television, it appears that it was simply a drama ahead of its time. Revivals will undoubtedly occur from time to time as we approach in reality many of the concepts that the show presented only theoretically. It has already proven itself to be a piece of science fiction with real meaning and importance. In 1967, the National Air Museum a branch of the Smithsonian Institution placed the episode, 'Where No Man Has Gone Before' in its archives.

The future of space exploration by the United States will probably continue to face political battles over monetary priorities. Roddenberry hopes that among STAR TREK's achievements, it can promote the space program.

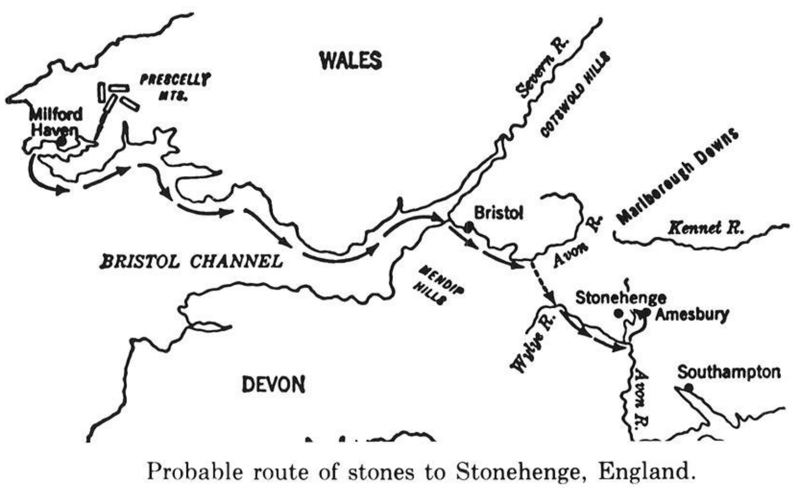
"We hope we are helping to form the concept that present space attempts are not wasted money—or that future interplanetary space travel is not just 'wild fiction'. It will be as important to mankind tomorrow as the discovery of America was in its day." WE

The Mystery of Stonehenge

by Bruce Handley



Stonehenge



Probable route of stones to Stonehenge, England.

THE TIME: *3600 years ago; it is the morning after the longest night of winter.*
THE PLACE: *A desolate, treeless plain; grayish clouds drift slowly across the sky as the sun rises above the horizon. At the center of a huge temple an early Briton stands awestruck as the first rays of the returning sun burst through a narrow slit in two stone arches.*

Today, shattered and in ruins, Stonehenge remains an object of awe and mystery. Why and how was it built? What dark ceremonies were performed there? Recent research at Stonehenge has thrown new light on questions concerning this ancient monument which since its construction has been steeped in speculation and conjecture. The history of the search for its meaning or purpose has ranged from fable and legend to computer analysis.

The first mention of Stonehenge, though admittedly obscure, comes from the **History** of Diodorus Siculus (c.300B.C.) in which he describes a "magnificent circular temple" built by the inhabitants of Hyperborea (Britain). The first reference in English literature was written in about 1130 A.D. by Henry of Huntingdon, in his *Historia Anglorum.*

(Continued on page 10)


The Nuclear 500. Are you goo
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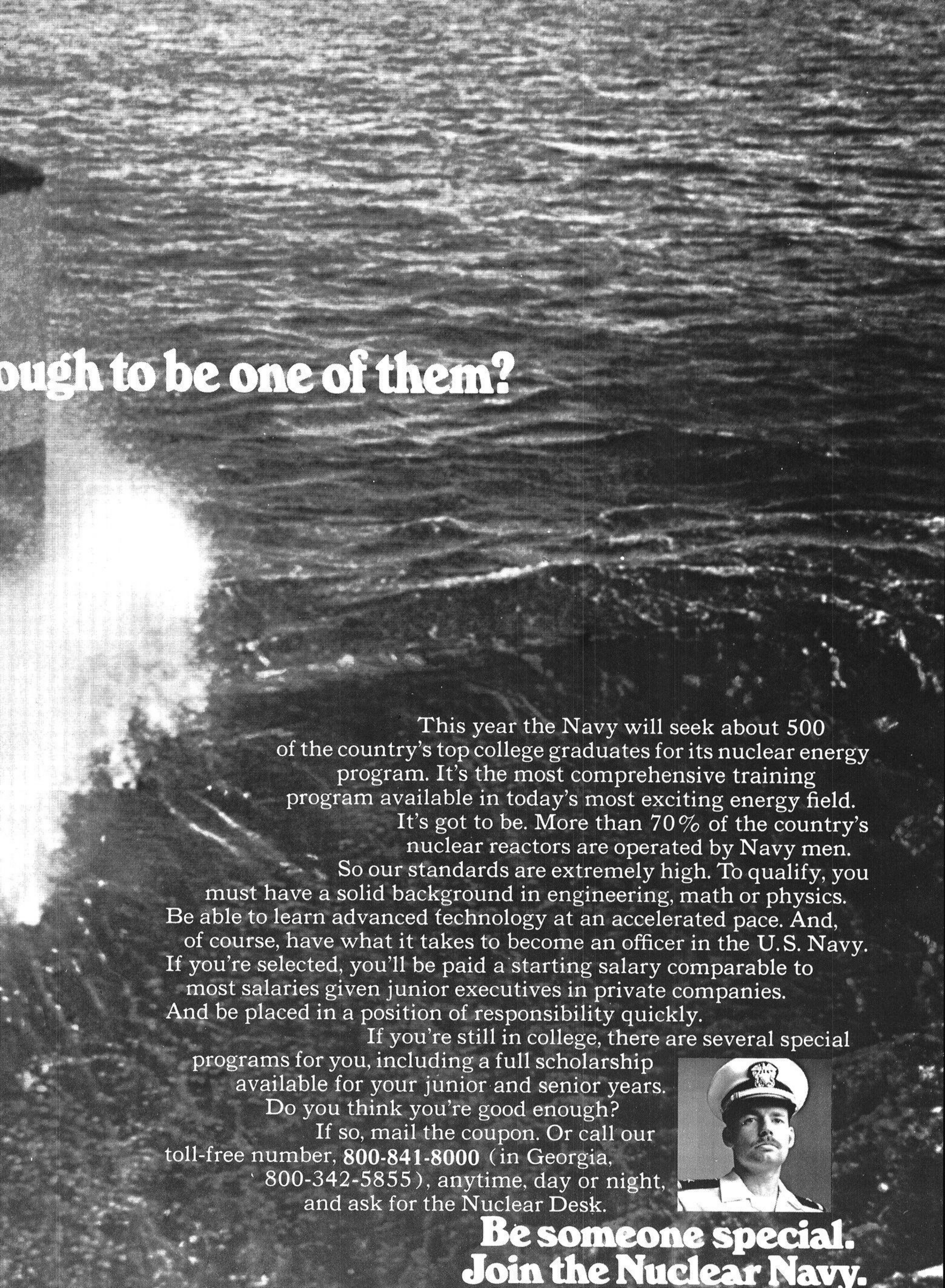
ough to be one of them?
This year the Navy will seek about 500 of the country's top college graduates for its nuclear energy program. It's the most comprehensive training program available in today's most exciting energy field.
It's got to be. More than 70% of the country's nuclear reactors are operated by Navy men.
So our standards are extremely high. To qualify, you must have a solid background in engineering, math or physics. Be able to learn advanced technology at an accelerated pace. And, of course, have what it takes to become an officer in the U.S. Navy.
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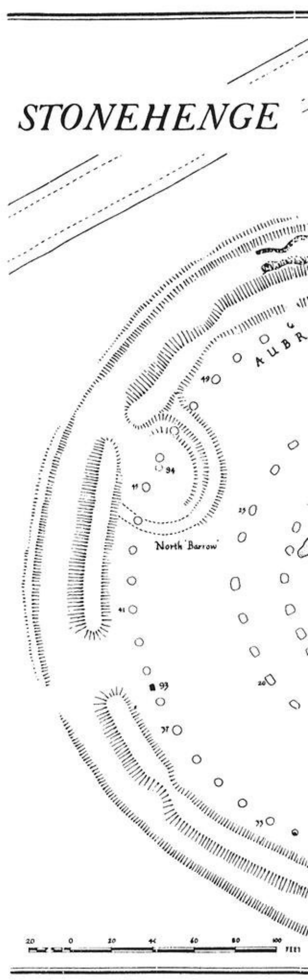
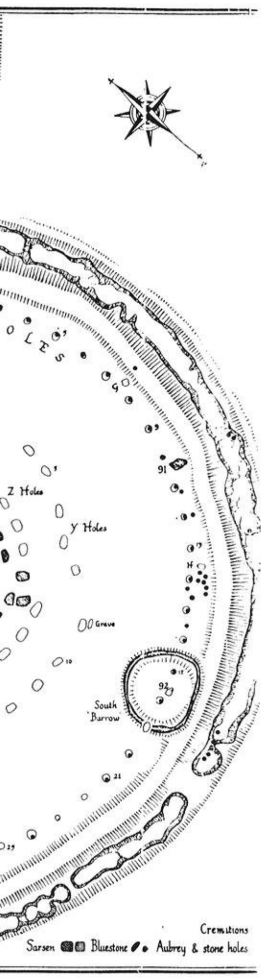
He merely mentions the monument and expresses wonder at its purpose and construction. In 1136, Geoffrey of Monmouth gave an account of its construction that was accepted for centuries. It seems that Aurelius Amborsius, king of the Britons, desired a fitting monument to commemorate the nobles treacherously murdered by Hengist the Saxon. The King consulted Merlin, a prophet and mechanical genius, and was told: "If you wish to honor the grave of these men with an everlasting monument, send for the Giant's Dance which is in Killaraus, a mountain in Ireland. For there is a stone structure, which no one today could raise without a profound knowledge of the mechanical arts. They are stones of vast size and wonderful quality, and if they can be brought here they will stand forever." Evidently the King's armed services subdued the Irish in battle but it took some of Merlin's magic to disassemble, transport, and rebuild the structure in its original form. This was a very popular explanation until the 1660's, when a number of new theories were published. In 1655, John Webb, who surveyed and studied the site, came to the conclusion that Stonehenge was erected by the Romans to the god Coelus. This dispute over the origin of Stonehenge continues on until 1740, when William Stukeley, an eminent British antiquarian, published his book *Stonehenge, A Temple Restored to the British Druids*. His assertion, that Stonehenge was built by the Druids, rapidly replaced Webb's theory in popularity. In the next 150 years, an immense quantity of literature on Stonehenge was produced. Theories on the identity of its builders ranged through the Atlanteans, Romans, Celts, and Phoenicians. This period of speculation was replaced by a period of practical research when Professor Gowland presented the results of his extensive excavations in 1901. Excavations made in the following years uncovered the so-called Aubrey Holes and the Y and Z holes which inevitably led to the formation of new and radical theories as to the purpose of Stonehenge. Also, a large part of the huge body of data being accumulated was due to the increased interest in the construction of Stonehenge. It wasn't until the 1950's, however, that any detailed research was done in relation to its construction, especially in the alignment of the stones and in their mode of transportation from the quarries. Before these topics are discussed in depth, however, a description of the site itself would be in order.

Stonehenge is located on a large tract of treeless chalk downs and was obviously not intended to have a commanding view of the surrounding countryside. It consists of a large number of mounds, holes, and stones placed in concentric circles. The first structure one encounters is an irregular ditch 4½ to 7 feet deep with a flat bottom and vertical walls which has been largely filled with chalk rubble. A bank is immediately inside the ditch and is close to a true circle with a diameter of 320 feet and a width of 20 feet. Working inwards, one next encounters the Aubrey Holes, named after John Aubrey, the British antiquarian who discovered them. They are set in a circle 288 feet in diameter immediately within the bank. They are from 30 to 70 inches across and 24 to 45 inches deep. Their contents, in most cases, are the charred remains of human bones. Naturally the excavation of such remains tends to reinforce some of the grislier legends. Another feature of Stonehenge which should be noted are called the "Outlying Stones"; namely, the Heel Stone, the two "Station Stones", and the "Barrows". The Heel Stone is a single large block of sarsen stone, a type of natural sandstone, that stands in the avenue outside the entrance to the Stonehenge earthworks. This stone is the object of a popular misconception concerning Stonehenge. It does not, as most believe, mark the point of sunrise on Midsummer Day. The point of true sunrise, when the first gleam



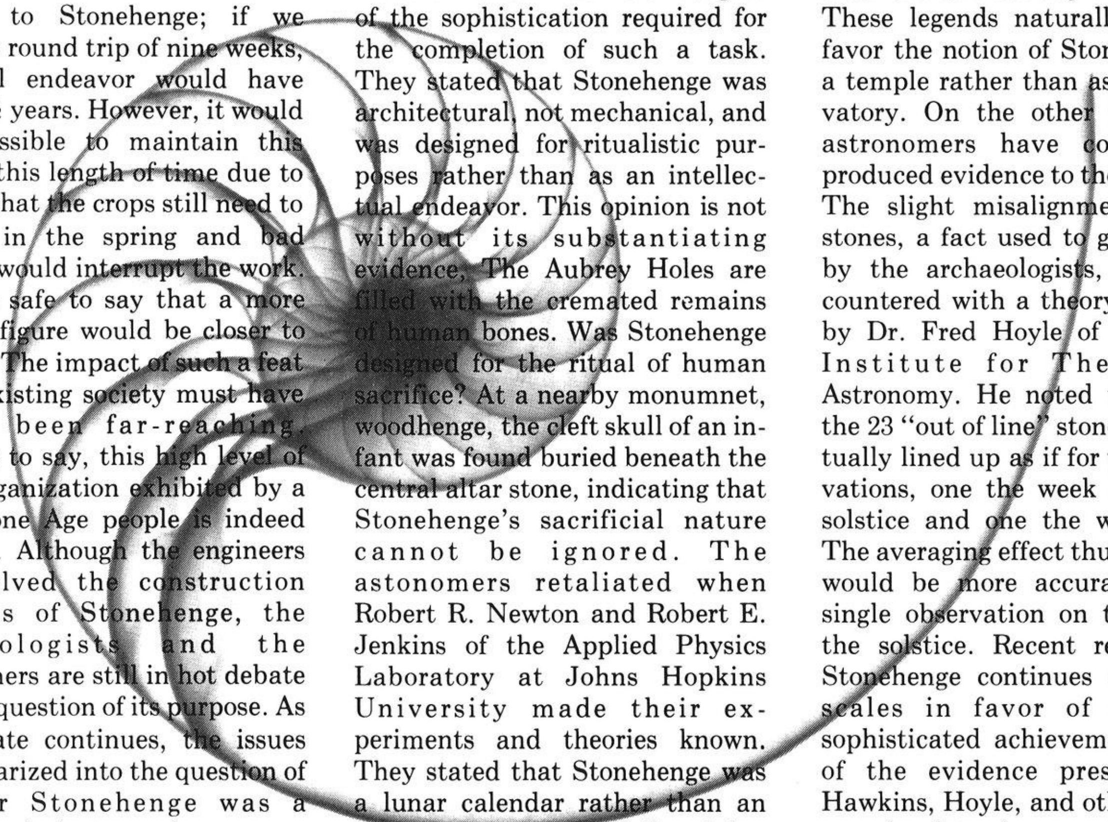
of light shines on the horizon, occurs slightly to the west of the stone.

The Station Stones stand just within the bank on the southeast and northwest. The Barrows, which are actually the stoneholes associated with two more missing station stones, lie on the north and south. If you draw lines connecting the two station stones and the two barrows they interset at an angle of 45 degrees and are symmetrical with respect to the Stonehenge axis. One must indeed suppose that the station stones and their missing companions were actually reference points for a large scale and fairly sophisticated exercise in field geometry. The next structures, well inside the ring of Aubrey holes, are the Y and Z holes. Undiscovered until 1923,



they form two irregular rings of holes which have filled with debris over the ages. The purpose of these holes is still uncertain. They seem to have been part of a plan to place a double ring of stones around the inner ring of sarsen stones but for some reason the plan was abandoned. Since the floors of these holes are flat and absent of the impressions of a large stone it is therfore certain that no stones were ever placed in the holes. Immediately inside the circle of Y and Z holes is the impressive "Sarsen Circle". The average height of these stone uprights is 13½ feet and their average weight is in the vicinity of 26 tons, the largest weighing over 50 tons. Of the original sarsen lintels (top stones) only five remain in position. Being about one fourth as large as the uprights the lintels made easy prey for medieval stonemasons. The lintels do not merely rest atop the uprights but are held in position by round pits carved into the bottoms of the lintels and these correspond to small projecting knobs on the uprights. This technique, called mortise-and-tenon, is characteristic of carpentry rather than stonework. Inside the Sarsen Circle is a group of stones called the Sarsen Trilithons; five groups of three stones, each group consisting of two uprights and a lintel. The heights of the trilithons increase toward the central one, which contains the largest worked monolith in Britain — 29 feet 8 inches in length. Contained within the horseshoe shaped arrangement of trilithons are the "bluestones". These stones also form a horseshoe and stand a few feet within the sarsen trilithons. There are also remains of a circle of bluestones between the Sarsen Circle and the horseshoe of trilithons. All the bluestones have been very carefully tooled and exhibit far better workmanship than that displayed on the sarsen stones. The term "bluestones" conceals the fact that there are actually three completely different types of stone included under the name: dolerite (a coarse-grained rock of a greenish-blue color), rhyolite (a form of blue-gray volcanic lava), and volcanic ash (a softer stone with an olive-green color). The complex composition of the dolerite enabled archaeologists to positively identify its source. In 1923, Dr. H.H. Thomas discovered their area of origin to be the Prescelly Mountains of north Pembrokeshire. In an area only about a mile square all three types of stone were identified. The fact that this site is 135 miles in a straight line from Stonehenge leads one to speculate on how the mammoth stones were transported such a distance.

From an engineering standpoint, the transportation of the stones is probably the most interesting aspect of the construction of Stonehenge. The sarsen stones were hauled from a quarry 20 miles distant and the bluestones followed a circuitous route 235 miles long. An idea of the complexity of this task can be appreciated if we recreate the problems encountered by Stonehenge's early builders. The largest of the foreign stones is the Altar Stone, which weights 6¼ tons. Before tooling, the stone probably weighed about 7 tons. Assume that a raft was used to transport the stones over the sea portion of their route; a crew of a dozen men averaging 130 pounds each would call for a raft with a total supportive capacity of 15,500 pounds. Given the supportive ability of dry pine (28 pounds per cubic foot) the raft would have to contain about 550 cubic feet; a raft of this capacity would be about 17 feet square with a draft of 2 feet. Rafts of this size would be incapable of navigating the inland waterways so therefore another conveyance must have been used. In 1954, an experiment was carried out on British television with three canoes built of elm boarding. The canoes were each 12' x 2' 3" x 1' 6" and were fixed together with four large beams. A replica of a bluestone and a crew of four schoolboys provided a total load of 3600 pounds. The praticality of this type of transportation was indicated when it was found that the craft could be manuevered easily. The overland sections of the route were probably accomplished with sledges drawn by men. In the same B.B.C. telecast 32 students from a local school hauled the 3100 pound bluestone replica up a four per cent grade. Using rollers instead of a sledge the number of haulers could be reduced to 24. The same number of experienced men could probably move the stone several miles a day. The total number of men required to move the Altar Stone, figuring 16 men per ton of weight, would therefore be about 110. Even this figure is dwarfed when you realize that the sarsen stones, which were hauled overland almost exactly the same distance as the bluestones, weigh about 7 times as much. The increased weight of the sarsens would demand more rollers and therefore a larger party engaged in shifting them. Estimating about 32 men per ton of weight the total labor force required to haul the fifty ton stones would be 1100 men. A sharp escarpment at Redhorn Hill would call for at least an additional 400 men, bring the total to 1500. There were 81 sarsens brought to Stonehenge; if we assume a round trip of nine weeks, the total endeavor would have taken 5½ years. However, it would be impossible to maintain this pace for this length of time due to the fact that the crops still need to planted in the spring and bad weather would interrupt the work. It seems safe to say that a more realistic figure would be closer to 10 years. The impact of such a feat on the existing society must have indeed been far-reaching. Needless to say, this high level of social organization exhibited by a Late Stone Age people is indeed amazing. Although the engineers have solved the construction problems of Stonehenge, the archaeologists and the astronomers are still in hot debate over the question of its purpose. As the debate continues, the issues have polarized into the question of whether Stonehenge was a ceremonial temple or an astronomical instrument.



The first punch to be thrown in the archaeology-astronomy match was delivered by Dr. Gerald S. Hawkins of Harvard College Observatory in 1963. On an IBM 7090 Dr. Hawkins superimposed some of the 27,060 possible alignments made by pairing 165 positions of the stones, holes, and mounds upon calculations of astronomical events adjusted for the year 1500 B.C. The results produced 32 alignments of Stonehenge objects toward significant positions of the sun and moon results which apparently are not due to chance. Hawkins' resultant theory concerned the 56 Aubrey Holes; with a system of stones to be shifted from one hole to another every year, the builders of Stonehenge could calculate and predict lunar eclipses occurring 350 years in the future. These eclipses average out at intervals of 19, 19, and 18 years — a 56 year cycle. The archaeologists accepted the sunrise-moonrise alignments at Stonehenge but balked at a lunar eclipses predictor. They maintained that the builders of Stonehenge were howling barbarians with an insufficient degree of the sophistication required for the completion of such a task. They stated that Stonehenge was architectural, not mechanical, and was designed for ritualistic purposes rather than as an intellectual endeavor. This opinion is not without its substantiating evidence. The Aubrey Holes are filled with the cremated remains of human bones. Was Stonehenge designed for the ritual of human sacrifice? At a nearby monumnet, woodhenge, the cleft skull of an infant was found buried beneath the central altar stone, indicating that Stonehenge's sacrificial nature cannot be ignored. The astonomers retaliated when Robert R. Newton and Robert E. Jenkins of the Applied Physics Laboratory at Johns Hopkins University made their experiments and theories known. They stated that Stonehenge was a lunar calendar rather than an elipse predictor. While doing related research in another field the physicists found a 111 or 112 month cycle coinciding with the setting of the summer new moon. They suggest that the 56 Aubrey Holes were counted around twice in order to predict its arrival. The archaeologists countered by bringing to the astronomers attention their inability to fix precisely the location of Stonehenge's main axis, from which all calculations must necessarily be made. They added that the shape of Stonehenge was merely symbolic, the way that the shape of modern churches is symbolic.

And so the debate continues — the evidence piling up on both sides. The archaeologists have the myths and legends of many cultures to reinforce their assertions. In the days of the early Britons, there was a fear of the summer solstice; the sun might keep on receding over the horizon, never to return. The Norse sun god, Balder, slain by mistletoe revived upon the third day to spread his light over the earth. The Persian sun god, Mithras, who was born on December 25th, emerged from a rock three days after the darkest day of the year. These legends naturally tend to favor the notion of Stonehenge as a temple rather than as an observatory. On the other hand, the astronomers have consistently produced evidence to the contrary. The slight misalignment of the stones, a fact used to great effect by the archaeologists, has been countered with a theory proposed by Dr. Fred Hoyle of England's Institute for Theoretical Astronomy. He noted that 19 of the 23 "out of line" stones were actually lined up as if for **two** observations, one the week before the solstice and one the week after. The averaging effect thus achieved would be more accurate that a single observation on the day of the solstice. Recent research at Stonehenge continues to tip the scales in favor of a highly sophisticated achievement. Some of the evidence presented by Hawkins, Hoyle, and others seems very hard to deny; perhaps they would envision a . . .

TIME: *3600 years ago, the evening of the 18 year eclipse of the moon.*

PLACE: *a crude hut in a village near Stonehenge. A young Briton smears a blue pigment on his face as he readies himself for the night's festivities. A joyous celebration will be held tonight if the moon conquers the shadow that threatens to engulf it. The old priest told him months ago that the moon and its dark foe would battle again tonight. The boy did not know how the old man knew this but when the other villagers left for the temple, the boy joined them to watch the spectacle that they had all so anxiously awaited.*

WE

What's in a Name?

Some of you may be in the job market soon and with so many job titles around it's hard to keep up with which ones mean what when trying to describe "type of work desired". The following is a short job title dictionary which may help to clear up the confusion as well as define the types of jobs available. Originally printed in the January 1971 WISCONSIN ENGINEER, this dictionary has been checked by Prof. Marks of the placement office and is still up to date and accurate.

Design Engineering
The engineer in design prepares plans and specifications for new products or redesigns existing products to make improvements. He selects materials and components and may recommend manufacturing processes. Design may also include the fabrication and testing of design concepts and models. Specifications, product cost and engineering objectives must always be kept in mind.

Development
Development engineers are responsible for developing new products and finding new uses for established products to meet the needs of industry or of the individual consumer. They concentrate on problems such as planning, designing, and testing products to match performance requirements. They also seek to effect product improvement for increased performance efficiency, higher quality, and lower manufacturing costs.

Research
Obtain new scientific knowledge of physical and human phenomena. Applied research would be doing much the same thing in areas impinging upon technologies of interest to the company. Other aspects of research might include:
(a) Investigate new fields and discover new products
(b) Provide new uses for products
(c) Improve existing products and processes

Sales Engineering
The sales engineer acts as a liaison between sales and engineering and is responsible for customer contact and technical specification analysis. This includes preparing quotations and initiating and recommending engineering design changes. He may also advise on application problems, handle correspondence on product quality, toxicity, and visit customers with salesmen on serious problems, and prepare evaluation reports on experimental products with key accounts.

Field Service Engineering
The field service engineer usually is in close contact with the customer. His duties often include supervising installation and instructing customer personnel in the operation and maintenance of the product.

Technical Services
Providing maintenance and repair of consumer, commercial and industrial products and systems at service centers and at customer sites.

Facilities Control Engineering
The Facilities Control Engineer has primary responsibility for the planning and incorporation of new equipment and facilities, the replacement of worn or obsolete facilities, and the maintenance of equipment. He prepares cost reduction and quality improvement studies. He also performs economic analysis studies—comparing models of equipment or alternate methods of operation. A Facilities Control Engineer is typically required to plan new equipment or facilities to increase existing production or to produce a new product.

Test Process Engineering
The Test Process Engineer is responsible for providing the test equipment and test procedures that will assure meeting production and manufacturing schedules. He determines the most efficient and economical methods of performing calibrations and test operations for sub-assemblies and/or completed equipment, plans and writes test specifications and processes, and determines test equipment required.

JOB TITLE DICTIONARY

Controls Engineering

The Control Engineer, usually an electrical engineer, designs and develops systems which control a large variety of machines, processing lines and material handling operations. Working with relays, transistors, silicon controlled rectifiers and accessory items; implemented by a knowledge of machine characteristics, digital logic, systems analysis and manufacturing techniques, the engineer solves the many, varied control problems encountered in industry.

Plant Engineering

Planning, developing, installing, and maintaining the plant facilities and services required by the company are the responsibilities of the Plant Engineer. Duties could be layout of machines and equipment, layout of new or existing plants, provide heavier electrical systems, expand or remodel production lines, increase compressed air services, provide air conditioning and humidity control, install larger boilers and all of the other engineered services required in a modern industrial plant.

Quality Control Engineering

The Quality Control Engineer is responsible for the quality and reliability of the product. He controls and evaluates all manufacturing materials and operations which affect product quality and reliability. His specific duties:

(a) Develop and perform incoming, in-process, and final inspection procedures.
(b) Provide facilities for calibrating instruments, equipment, and tooling.
(c) Develop quality assurance procedures that ensure that maintenance of reliability is inherent in the design.
(d) Develop methods of measurement and sampling size from which to provide design engineering with statistical guidance.
(e) Perform quality acceptance evaluations.
(f) Evaluate module and component reliability needs and status.

Process Engineering

Responsible for designing new plants, making changes in existing plants, and engineering new processes. Maybe trouble shooting an existing process and locating its bottlenecks, in order to increase production capacity, to improve product quality, and to lower operating costs. Or, you may be assigned to develop a new process, adapting it to industrial equipment in a pilot plant.

Development Engineering

A development engineer initiates design changes in existing products; modifies existing products; prepares engineering specifications to keep production within cost limits.

It is the function of the production engineer to create maximum value from given inputs. His assignments include increasing production capacity, debottlenecking, and improving overall efficiency. He is invloved in reworking existing units or designing new units to produce a new product, installing and starting up new equipment, and making improvements in procedures of materials handling and quality control.

Product Engineering

Product Engineering designs for production and solves problems of manufacturing operations, engineering changes, costs, and servicing. Responsibility continues throughout the manufacturing of a product and includes the handling of engineering changes.

Product Test Engineering

Product Test Engineering initiates the analysis of new product capabilities. Engineers in this area follow a product from early design concepts through the first manufactured units, devising test procedures in advance, and originating methods that will predict product capabilities accurately.

Materials Engineering

Advise design and development engineers on the availability of materials. Evaluate materials and process developments for product line and design groups.

Prepare specifications on non-standard equipment, initiating the purchase of components and the development of special devices to meet customer requirements. Assist and advise design engineers in the development of equipment. Direct technicians and drafting personnel in the development of customized instrumentation and control systems. Coordinate all phases of an assigned project with the customer and with the project team.

Systems Engineer (Data Processing)

Functions: Analyze the requirements of science, industry and the government in all areas of data processing, including communications, information storage and retrieval, random access, command and control, process control and real-time systems. Evaluate alternative systems to meet these requirements in both hardware and software. Design tests and diagnostic procedures to verify performance of prototype equipment according to specifications.

Reliability Engineering
Conduct component and system reliability studies in order to determine product effectiveness. Analyze test results and make recommendations for changes to insure compliance with customer specifications.

Systems Engineering
Position: Systems engineer will be trained to interpret, evaluate, and comply with customer specifications. The coordinates efforts of the various engineering disciplines (electrical, mechanical, maintainability, reliability); also procurement, production, and manufacturing engineering efforts. Customer and sub-contractor engineering liaison is also his responsibility. He schedules engineering manpower and end item design and testing to assure that the product is properly designed, tested and delivered to the customer on time. Specifications for sub-contract items are generated by the systems engineer, and he furnishes other engineering data to procurement to aid in the purchase of these items. In summary, the systems engineer obtains, analyzes and evaluates technical data to fulfill requirements of both the customer and his company's own engineering and production facilities.

Production Control Engineering
The Production Control Engineer is responsible for designing new control systems, the installation of these systems, and the improvement of scheduling systems which coordinate production efforts.

Project Engineering
The Project Engineer designs equipment, supervises its installation and handles initial operation. Development of new processes and equipment to reduce cost and improve quality, equipment and methods to promote use and sale and to provide technical assistance to plants and customers as requested.

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JOB TITLE DICTIONARY

Manufacturing Engineering

Manufacturing engineers develop new standards, study manufacturing processes for methods of improvement, prepare cost estimates for new product proposals and develop new concepts for automating machinery and equipment. Closely related to Production Engineering.

Production Supervision

The production supervisor is responsible for producing a product in desired quantity and quality and for the safe performance of the men and equipment in the operating unit assigned to him. Responsible for:

(1) Instructing others in proper operating procedures, then following up to assure compliance.
(2) Planning production and maintenance schedules.
(3) Assisting in resolving labor problems.
(4) Initiating process-improvement programs to reduce costs.

Programmer

Functions: Develop and maintain advanced programming systems which enhance and extend the usefulness of computer systems. Analyze software and evaluate customer's programming requirements. Provide liaison between marketing and engineering teams.

Value Engineering

Position: Value engineering has staff responsibility for reinforcing operating divisions, with the objective of improving product quality while reducing cost. The engineer's duties will involve planning, execution and evaluation of cost improvement projects covering all phases from product inception through design, development, testing, equipment design, tooling, and production.

Manufacturing Methods Engineering

The Manufacturing Methods Engineer determines the necessary equipment, tools and instructions for production of an equipment in accordance with drawings and specifications from Design Engineering. His responsibility extends:
(a) from the time a product has been designed and released for production
(b) through the design, set-up, and initial operation of the production line
(c) until the units are complete and ready for testing, and
(d) the operating production line is turned over to Line Supervision.

General duties: Prepares plans for the application of automated data processing equipment to the solution of company data recording, reporting and operational and administrative problems, and follows development of the plans to satisfactory application.

Systems Design and Development Engineering

Systems Design and Development helps to create new computer systems, with development engineering, product engineering, and programming teams working together to plan and develop an entire system, construct a working model, test it and help put it into production.

Circuit Design (Data Processing)

Functions: Design high-speed linear and switching circuits for use in central processor and input-output equipment. Develop advanced memory techniques including thin films, large-scale partial switching, linear-select core memories and coincident-current core memories. Develop microminiaturization techniques. Develop power systems for power supply design, cable design, start-up switches and interlocks.

Electro-Mechanical Engineer (Data Processing)

Functions: Design mechanical components for input-output equipment, including high-speed mechanisms operating in milliseconds, repeatable in microseconds and with operating life in the hundreds of millions of cycles. This equipment performs the functions of printing, feeding, indexing, selecting, sensing and punching. Analyze performance and reliability requirements while stressing simplicity, serviceability and cost. Develop techniques and equipment to test and evaluate prototype models. Evaluate developments in metallurgy, kinematics, fluid dynamics, physics, magnetics and optics affecting the state-of-the-art of electronic data processing mechanical components. Determine the optimum method for packaging circuitry by evaluating materials, component cooling, and vibration and structural considerations.

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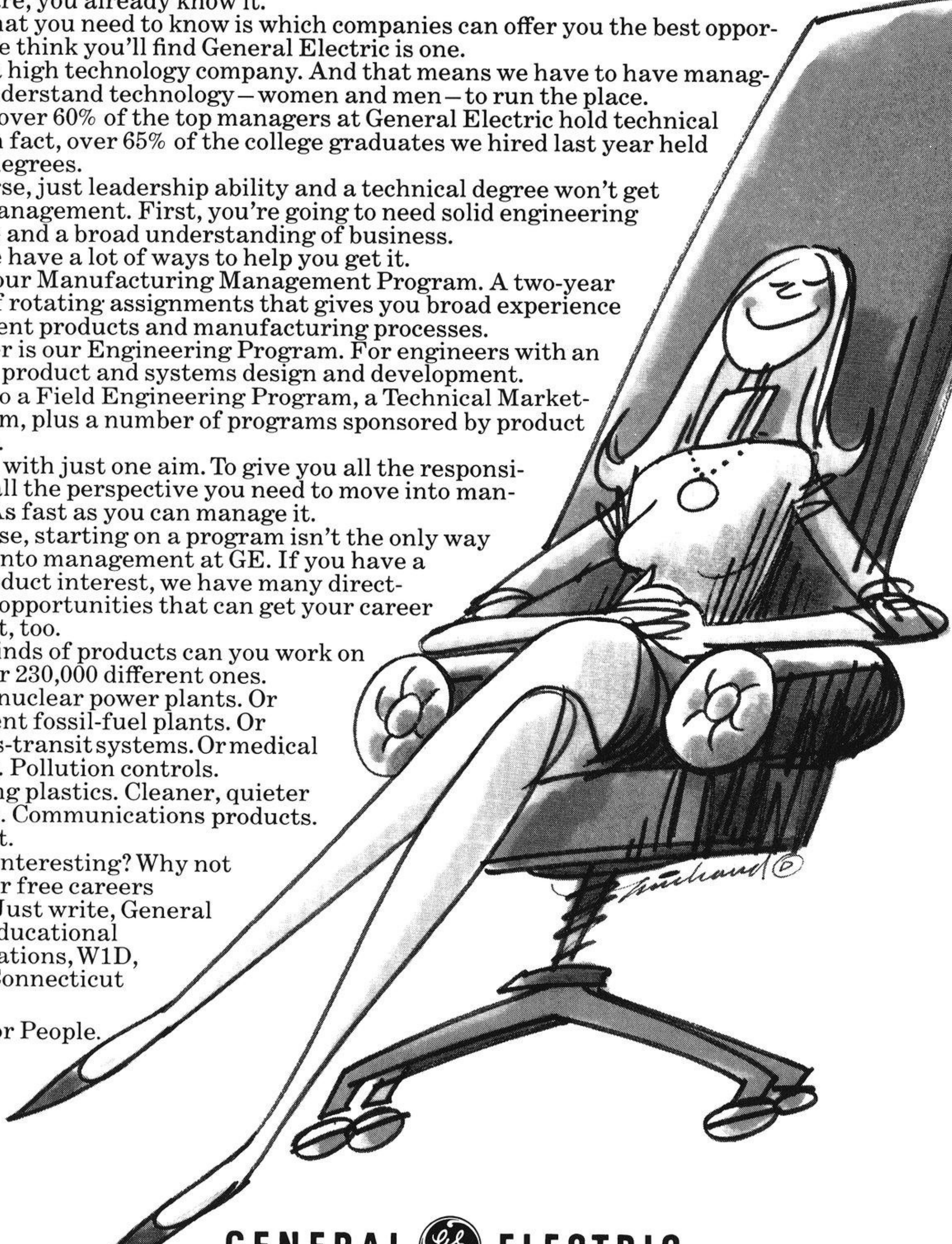

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