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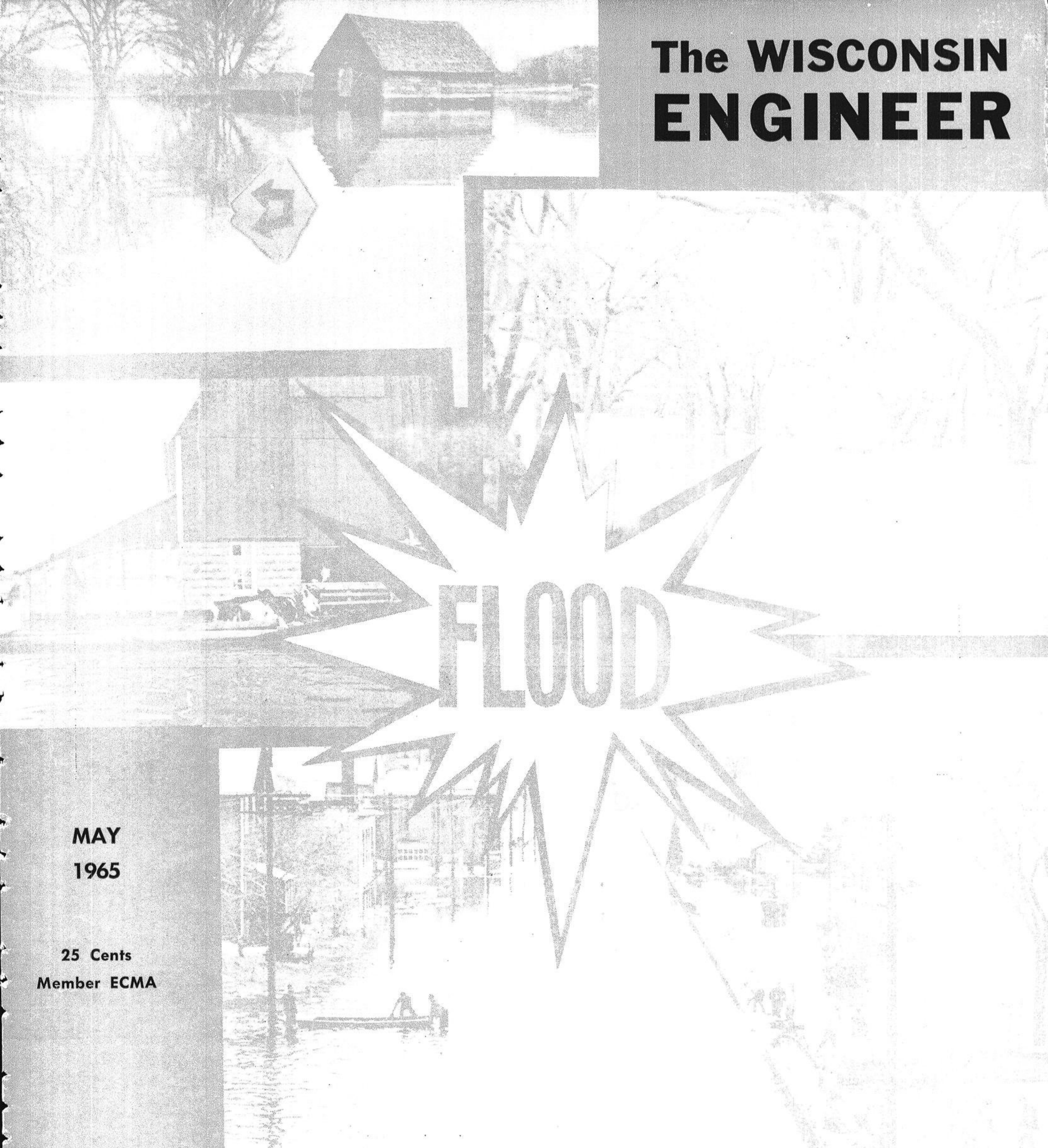
The WISCONSIN ENGINEER



MAY
1965

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Our Solution to the Flood Problems—Special Report on page 9

May In Brief

THIS MONTH . . .

May brings June, and June brings finals, graduation, jobs, summer school, and what have you. Momentarily however, May has a few good bits of reading between the covers of this magazine. Don't miss the Associate Editor's Editorial on page 7. We like to think that this is representative of most of the students here at UW. The Editor has a special report on page 9, the cover story on floods. Technically, we have an article on tapered roller bearings; on the other hand is a report on a program which some of you may be participating in. The Mental Maze is in the usual spot, complete with answers this month.

IN RETROSPECT . . .

Some twelve months ago we took the helm of this publication with mixed emotions—apprehensiveness and confidence among many others. Since then we have become a year older and much wiser, more knowledgeable in the details of producing a magazine. As we put Volume 69 to bed at last, there are numerous people deserving of an expression of our appreciation. First and foremost, to the men who gave us what we needed when we needed it—Professors G. R. Sell and H. J. Schwebke. Without their suggestions and advice our job would have been impossible.

This has not been the magazine of any one person, for there are people named Meagher, Stoelting, Fonstand, Weber, et al., who came through when needed. There have been missed deadlines, late issues, errors, insufficient photos, etc., perhaps even a few very premature gray hairs. There were times we thought that nothing else could go wrong, but something always did. In spite of the minus grade-points and headaches (aspirins are cheap), much has been gained. While experience is not tangible, it is a valuable commodity, and we hope to put it to use again next year. With a little luck, another bottle of tranquilizers, and a dash of imagination, the *Wisconsin Engineer* hopes to mature and materialize into a better magazine.

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UNION CARBIDE

LETTERS

ENGINEER:

I read your recent editorial with some interest; in attempting to understand the implication of it several thoughts crossed my mind. Here they are, just as they came to me, with no interpretation:

Almost anything can be rationalized and justified when enough imagination and distortion is used.

Newspapers may be distorting facts on King and crowd. Editor Smith knows of some such distortions, I do not.

I have heard a lecture by the author of "Black Like Me." His analysis of the Negro situation sounded just to me at the time. It may have been distorted.

Is it possible to eliminate distortions altogether? What *is* the truth?

Hitler justified Jewish atrocities, German people felt Jews were treated correctly. Hitler may have used distortions. Hitler hated meddlers.

Smith says Negroes object to "reasonable questions on voting rights. Can a man become so obsessed over reasonable questions. Does King appeal to Negroes because he dislikes reasonable questions?

Is one hundred years "overnight" to Smith? Is Smith using distortions? Does Smith understand the problem in the South from either side?

WILL MATHES
Kiel, Wisconsin

ENGINEER:

Is civil rights really within the province of engineering sophistication? Oh, it's a subject for all of us? And if the justness of constitutional law cannot be judged by the individual—if it is to be left for the group, whatever happened to the vaunted freedom of man? I've never met, but have read of men who'd rather be right than legal and if that's wrong it's their privilege to be wrong—and with our blessing!

A. J. VARNER
Editor, *Coins* Magazine
Iola, Wisconsin

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VOLUME 69, NUMBER 8

MAY 1965

COVER STORY

ARTICLES

THE WISCONSIN ENGINEER

The Student Engineer's Magazine Founded in 1896

FEATURES

THIS MONTH'S COVER

Our May cover, designed by Jim Tyndall, shows the devastating power and destruction of floods. For our editor's comment, see page 9.

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Across the Editor's Desk

ON VIETNAM

There are some people on this campus who are agitating for U.S. withdrawal from Vietnam. There have been public meetings and rallies and in the last few weeks "End the War in Vietnam" buttons have appeared all over campus.

While we are all in favor of free speech and the right to assemble, we think that anyone who advocates U.S. disengagement in Vietnam is either completely naive or an ignorant fool. The naive are tolerable, but the fools are not. These people, the perennial chicken-headed in our society, would rather hide their heads in the sand than face up to the facts.

The fundamental principle that the "End the War" faction doesn't understand is that no war in the 20th century started because of a firm stand against aggression, but because of a lack of resolution at the crucial moment. Aggressive empire-builders have always been trying to conquer the world and they always have begun by nibbling like the Reds in Vietnam. Finally, they always manage to get up enough courage to take a gulp unless they're stopped. And there aren't really any moral or ethical principles involved in the dirty business of stopping a nibbler. The U.S. may be imperialistic and supporting a dictatorship in Vietnam for all we care. That is not the point. What is the point is that we are fighting in Vietnam because we have learned we have to.

That we have to fight is a simple lesson of history, not ethics. Looking back, with all the advantages of 20–20 hindsight of course, clearly demonstrates what we mean. In 1914 the assassination at Serajevo didn't start World War I—Austria-Hungary started it at Germany's urging. The Axis figured they could get away with a gulp after blackmailing the French out of a piece of the French Congo in 1911, and annexing Bosnia and Herzegovina in 1908 which violated the Berlin Treaty of 1878.

World War I resulted in the Versailles Treaty of 1919. Germany signed, and violated the Treaty from the beginning by training troops in Russia and cruising the seas in submarines "sold" to the Japanese. When Hitler's troops, armed in violation of the Versailles Treaty, invaded the Rhineland in 1936 they had orders to run if the French resisted—the French ran instead. In 1938 Chamberlain gave away Czechoslovakia on Hitler's orders, and then returned to London with his speech about ". . . never to go to war again." Churchill in *The Gathering Storm* documents the evidence that until 1937 Britain and France could have enforced the Versailles Treaty with force as they were pledged to do—but they were too chicken-headed to do it.

When Italy attacked Ethiopia in 1935 her troops sailed through Suez under the silent guns of British battleships. The famed British seapower didn't amount to a leaky canoe that day—because they didn't have the sense to use it.

Japan nibbled at China from 1931 on and in 1936 deliberately bombed and strafed the U.S. gunboat Panay in Chinese waters just to test the mettle of the U.S. We did nothing and the Japanese went on to grab most of Asia by December 7, 1941.

Between 1919 and 1939 so many end-war treaties were signed that their combined weight would have sunk a small continent. We list a few, each one broken or allowed to fizzle because the U.S., Britain, France, and Russia let them be broken in spite of provisions in some calling for armed enforcement: the Treaty of Versailles of 1919; the Five Power Naval Treaty, the Pacific Four Power Treaty, and the Nine Power Treaty Concerning China, all of 1921–22; the Treaty of Mutual Guarantee in 1925; the Pact of Paris in 1928; the Litvinov Protocol in 1929; the Stresa Revolution of 1935; the Franco-Russian Treaty of 1935; and Hitler's non-aggression treaties with nearly every country he overran. Germany, Italy, and Japan signed nearly all of these and nibbled just the same.

In 1954 another treaty was signed in Geneva concerning Vietnam. The Reds promised to stay on their own side of the fence; but they decided to nibble anyway. Faced with a nibbler again, the U.S. has kept its head out of the sand. Hopefully the lesson has been learned that there is one way to stop a treaty-signing nibbler—by force—and we are all for it. If the relatively pacific measures employed to date don't work, we suggest that more force be applied, including bombing Hanoi and strategic targets in China.

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SPECIAL REPORT

Cogitatin' on the Flood of '65

OUR cover shows some of the situations that prevailed in the Mississippi River valley a few weeks ago. As we expected, before the flood waters began subsiding, certain self-appointed champions of the citizenry were chanting for a Federal program to forever control the "Father of Rivers." We heard and read that it was the responsibility of the government to control floods and prevent recurring property damage. The famed and controversial Tennessee Valley Authority system was deemed an excellent pattern to follow.

We don't believe that a Mississippi River counterpart of the TVA (or any wholesale means of control) is the least bit realistic or practical, and this special report is published to inform the public of the reasons.

Granted, TVA has been extremely beneficial to the Tennessee Vally, as much as we personally dislike saluting a government endeavor of this nature. However, in the proposals advocating a similar system for the Upper Mississippi, several fallacies exist. Costs and benefits must be considered in a reasonable perspective—so far they haven't been.

The fact is that the primary tangible benefits derived from the TVA project have come from hydro-electric power ($150 million annually) and navigation (20 million annually). In comparison, estimated yearly savings from flood reduction total only $13 million. Now we all know that the Mississippi is presently navigable to the Twin Cities and beyond. And harnessing the river for hydroelectric uses is technically and economically unfeasible because of its level profile.

Physical characteristics must also be considered. The Tennessee River at Chattanooga drains 1/3 the area of the Mississippi at Winona, Minnesota, but the discharge at Chattanooga is normally 1-1/3 times as great, and up to twice as great at times of high stages—quite a difference in runoff indeed.

As engineers we take the position that recognizes floods as a thing of Nature, subject to recurrence at irregular intervals. We could have told you last fall that sometime within the next 100 years there would be a flood of the magnitude of the flood that occurred this year at La Crosse, Prairie du Chien, etc. We can affirm occurrence and accurately predict stage, discharge, and frequency in advance. So you ask, why not design a system of structures and channels to control these damaging waters? Naturally it can be done, but for which flood shall we design? The one that occurs once in 100 years, once in 1000 years, or how often? We could design and construct for a 100-year flood and have a 1000 year flood the next year. Wham! No more dams. Obviously there is an equilibrium point where prevention costs essentially equal the benefits received, but to us this is an inefficient compromise for rivers like the Mississippi, as ridiculous as building dams to contain a 1000 year flood. TVA officials advised a deaf Congress of this several years ago.

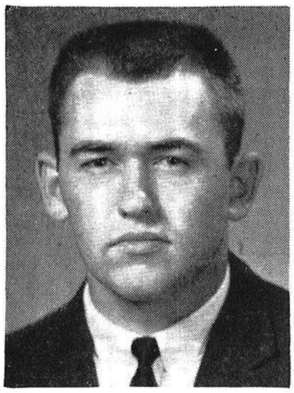
The solution is manifest. Why not stay out of the way? Over thousands of years rivers have carved valleys which contain flood plains. Occasionally the rivers have to use these overflow areas. We should respect these flood plains as property of the rivers, rather than encroaching upon them with our homes, stores, factories, and gas storage tanks. It is almost superfluous to say that man loses money when a river jumps its banks.

Past floods have delineated flood plain boundaries accurately. The problems have resulted from toothless or inexistent zoning ordinances and the "It can't happen to me" attitude of many citizens. In zoning, more people should follow the fine example set by Milwaukee, where flood plains do double duty.

The Mississippi River floods of 1965 are over, the damage has been done. It is not too late however to take some intelligent definitive action. We join other engineers and land economists in proposing alternate uses for flood plain lands—ball parks, playgrounds, summer crops, camping and picnic areas, etc., none of which will be appreciably damaged by inundating flood waters. Even selected industrial uses are possible. An excellent accompaniment to renewal programs could be the relocation of homes and factories to higher ground. Since most communities grew up from river banks anyway, the buildings are generally old in these areas.

Despite the destruction, perhaps an important lesson has been learned from the recent floods. We think our proposals are only logical when you consider the premise that it is much easier to keep people out of the path of a flood than it is to keep a flood out of the path of people.

ROBERT J. SMITH
Editor-in-Chief



Gene Miller, a ME-4 from Green Bay, specialized in design in his undergrad years, which will end with graduation this June. A member of ASME, Gene hopes to be employed in the design field upon graduation.

Tapered Roller Bearings

By GENE R. MILLER

INTRODUCTION

THE reduction of friction is more important today than it has ever been, because of the vast number of mechanisms having rolling or sliding surfaces. The abundance of automobiles testifies to this.

Alleviation of friction in the past, for rolling contact surfaces, was mainly accomplished by ball bearings. The idea of putting ball bearings between the wheel and the axle was just one of many ways of solving this problem. Ball bearings can carry either thrust or radial loads, but not both. The development of the straight roller bearing cut down the size of the bearings, while maintaining load specifications, but it still carried only one load. The advent of the tapered roller bearing, which could carry both thrust and radial loads seemed to be the solution.

Engineering personnel and students in engineering design readily appreciate the capabilities of this device when the aspects of its design are grasped. The questions that ultimately come to mind are: How is the tapered roller bearing designed and manufactured? How can this type of bearing be applied to an engineering problem of friction reduction, and do a good job? These are the questions that this report is intended to answer.

BACKGROUND

The basic reason for using bearings is to reduce friction. Friction is common in all areas where contact between two surfaces exists: either one surface stationary and one surface moving, or both surfaces in motion. Friction is what makes sliding one object over another difficult, slows down motion, and causes parts to wear out. Thus it is one of man's greatest mechanical problems.

Ancient man reduced friction when he discovered the principle of rolling motion and began using round logs under platforms to roll heavy objects. Centuries later, some forgotten genius invented the wheel. This was man's greatest step in fighting friction. But he had not eliminated sliding friction between the wheel and axle.

After many years, the principle of the wheel's rolling motion brought forth a new basic idea. It was an idea so simple that today man hardly realizes how greatly this innovation affects his everyday life. The idea was to put balls or rollers between the rubbing surfaces of the wheel and axle to further reduce friction. This then was a wheel within a wheel. From this was born one of industry's great improvements, the anti-friction bearing. Crude as they were, these early bearings were the first big step toward reduction of friction.

There are four basic types of bearings in use today with combinations of them to get a desired load of force distribution in a mechanical system.

These four basic types are:

1. Cup-and-cone ball bearing. To obtain this type of bearing, the cup and and the cone of the bearing are set at an angle. This bearing will withstand occasional end thrust (axial) load, but sacrifices radial (vertical) load capacity. Since the slightest wear on the ball race destroys the curvature of the bearing and the principle of its operation, it is somewhat impractical.

2. Annular ball bearing. This type of bearing has considerably less thrust capacity than radial capacity. When this bearing becomes worn, it must be discarded. It must be larger than a roller bearing to carry the same amount of load, since roller bearings carry the loads along the full length of the rollers.

3. Ball thrust bearing. This type of bearing carries only thrust loads. Its use is supplementary: to replace annular ball bearings where thrust loads are encountered. This usually leads to a needlessly complicated as well as costly design. A bearing of this type is usually limited to low-speed use.

4. Straight roller bearings. This type of bearing uses rollers in place of the balls, and its use is primarily in radial loads. Its radial capacity is greater than a ball bearing of the same size because loads are distributed over the entire length of the rollers. However, it has no capacity for thrust loads; therefore when thrust loads are present, it must be used with special thrust bearings.

DESIGN OF THE TAPERED ROLLER BEARING

As shown in Figure 1, there are four basic parts which make up the tapered roller bearing:

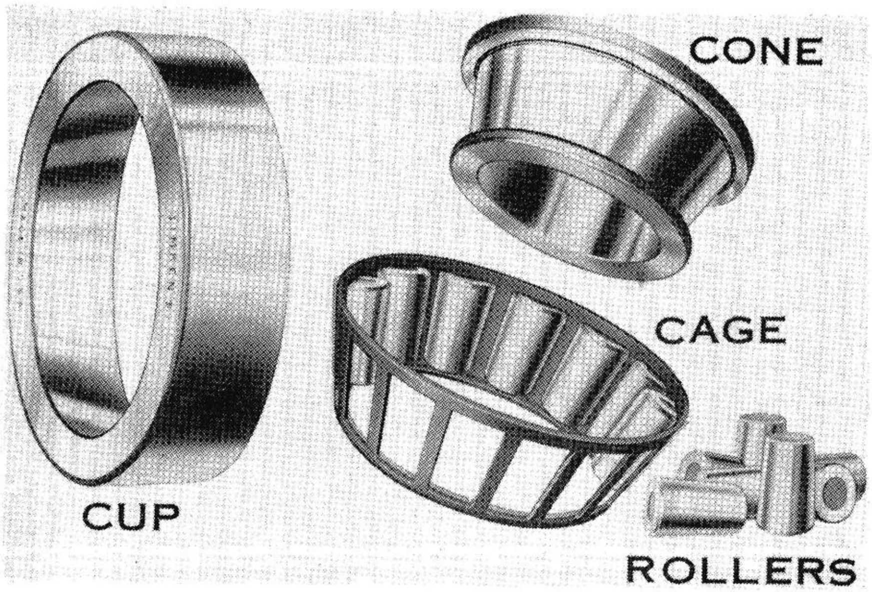
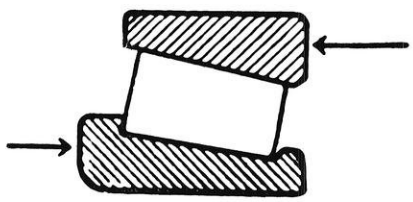


Figure 1.—Four Main Components of a Roller Bearing.

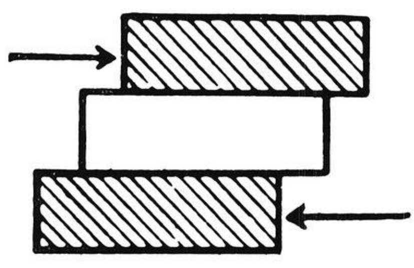
1. The cone—inner race.
2. Tapered rollers—which roll freely between the cup and cone.
3. The cage—which serves as a retainer to maintain the proper spacing between the rollers grouped around the cone.
4. The cup—outer race, which fits around the cone and roller assembly.

THEORY

The greatest advantage of tapered roller bearings is their ability to carry both radial and thrust loads. The bearing has greater of the same size, and equal capacity to a straight roller bearing. The tapered construction gives it the caered construction gives it the capacity to carry thrust loads and all combinations of radial and thrust loads. The tapered roller bearing can take a thrust load while a straight bearing cannot. This is easily seen by referring to Figure 2, where the tapered roller bearing is compared to the straight roller bearing, both under thrust loads.



a. Tapered Roller Bearing.



b. Straight Roller Bearing.

Figure 2.—Load comparison.

The body diagram in Figure 3a shows the different forces acting on the bearing which include:

W, radial force.

T, thrust force.

P, resultant load on one roller normal to OA.

Also indicated are:

P_o, resultant load on one roller normal to OB.

P_i, resultant load on one roller normal to OC.

α, angle of contact (angle of taper).

Figure 3b shows a vector diagram of the thrust force (T) and radial force (W) vectorially added to give the load (P) on the roller bearing at the angle of taper. The angle of contact (angle of taper) is also half the pitch-cone angle and ranges between 7½° to 25°.

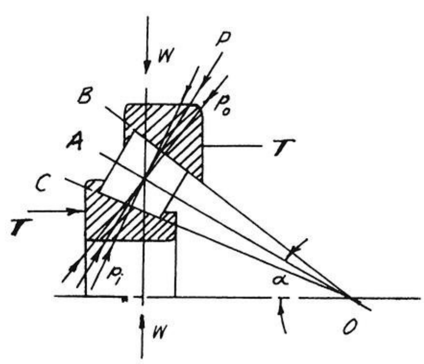
It is easily seen that the roller bearings revolve about a cone when in operation. There is contact in a wide area between the end of the roller and the rib or shoulder of the cone, and because of the wide area of contact the rollers keep themselves in perfect alignment at all times. With the roller positively aligned, full-line contact is maintained between the rollers and the cup, and the rollers and the cone. The cage merely spaces the bearings about the cone properly.

The full-line contact permits distribution of uniform pressures over the full length of each roller. Because pressures are distributed over a line of contact, the bearings have extra-load-carrying capacity, and there is minimum distortion under load. Less distortion under load permits greater precision, greater rigidity, less wear, and consequently, a longer life for both the bearing and the machine parts it supports.

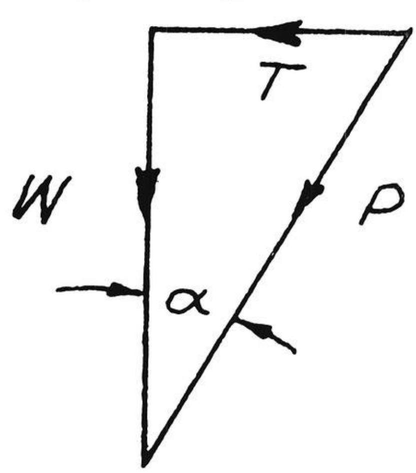
MANUFACTURE

Materials and Parts

The tapered roller bearing has to be precision manufactured to live up to its design. The four in-



(a) Loads on Rollers.



(b) Vector Diagram.

Figure 3.—Geometric Analysis.

tegral parts are made of a high grade steel including molybdenum, manganese, and a high percentage of nickel. After the right combination of these materials is reached, in either a blast furnace or an electric furnace, the furnace contents are transferred to giant ladles which can hold about 100 tons of molten white hot metal. These ladles are then emptied into ingots. Once the ingots have cooled sufficiently, the ingot mold is stripped off and the ingot is then placed in a soaking pit awaiting rolling to reduce it to the needed size. The ingots are shaped into blooms which are correspondingly rolled or cut into the desired size. The blooms are made into wire or seamless tubes from solid bars.

Rollers for the tapered roller bearings are either made from wire stock or machined. The smaller rollers are made by a cold-heading operation using the wire stock or rods up to 1¼ inch diameter. Rollers larger in diameter are usually machined by a turning operation on automatic screw machines.

Cups are also made from the same steel and in two different ways. The smaller cups, up to an outside diameter of 10 5/16 inches, are machined. The larger cups, larger than 10 5/16 inches outside diameter, are machined from forged steel rings on semi-automatic lathes. They may vary in outside diameter from less than two inches up to as wide as six feet.

Cones are made in a similar fashion to the cups. Their machining operations are somewhat different but their size distinction is in the same division. They are made either from tubings or forgings for the extra large size cone. They are usually shaped on a multi-spindle screw machine to facilitate production.

The cages represent the fourth member of the basic tapered roller bearing. The main types of cages are made by pressing strips or by turning, drilling, or other methods of forming from solid material. The pressed cages lend themselves to mass production and are of less weight than machined cages. In larger bearings, however, machined cages are preferred for reasons of manufacture and strength.

Metal Treatment

Metal treatment of rollers, cups, and cones is necessary so they are tough and resilient on the inside and also surrounded on the outside with an evenly distributed case of high-carbon steel. This steel is heat treated in a carburizing furnace for high hardness to withstand wear. Once the carburizer stage is complete, the parts are oil quenched, after which they are reheated for hardening. The last operation is tempering, which relieves stresses that may have been set up during the previous heat treatment. Tempering also increases the stability and shock resistance of the parts.

Heat treatment operations usually leave the part somewhat inaccurate dimensionally. A grinding operation is necessary to impart dimensional accuracy as well as smooth the surfaces. Even after finish grinding, cups, cones, and rollers are honed until the contacting surface variations are reduced to millionths of an inch. The honing operation is especially necessary on critical surfaces where rollers come into contact with cups and cones.

The cages are given the least amount of treatment. Once they are made, they are annealed to provide just the right properties. They are not ground to a clean glossy finish but are shot blasted to clean them and phosphated to make them rust resistant.

Assemblage

The assemblage of all four parts is the test of all the care to dimensions given of the components. Will they go into one complete unit? All the parts are inspected before the assembly step to insure the product quality and standards. The cone, cage, and rollers form an inseparable unit. Everything, including the cup, is demagnetized so the steel will not pick up floating magnetic particles. Cups and cones must have the right finish and taper concentrically. Every cone assembly is tested at high speed under high pressure with a master cup. After this inspection procedure, the unit is usually washed, dryed, and slushed in oil, leaving it ready for packing. Many of the large industrial bearings are not yet ready for shipment and may be sent through a series of phosphate baths which will prevent rust and corrosion during storage, shipment, and use.

APPLICATION

Great care must be taken in the selection of bearings for any particular application since numerous points have to be considered. Physical proportions and capacities must be seen to, the type of bearings most suitable for the load, either radial or thrust, or both, must be studied, and the size of the bearings should be such that they will be economical in service. A bearing which is oversize will waste a large portion of its usefulness, while one undersize will require premature replacement.

Other things to be taken into consideration are the type and purpose of the machine for which the bearings are required, its power input, speed in rpm, the loads and their direction, and uniformity of the loads. The drive mechanism (spur, bevel, helical or worm gearing, ropes or belts), the diameter of the shafts at bearing points, and the type of service the machine is to give (continuous or intermittent) must be dealt with. It is impossible, with so many points to be reviewed, for even a highly skilled and experienced engineer to say what types of bearings are required for a particular application without studying the details of a job.

An American phrase, "engineered into the job," succinctly expresses what is required of a bearing when fitted for service, if its performance is to be all that could be desired. Therefore, the knowledge of bearing and machinery characteristics in all relevant detail is necessary before service application. Haphazard bearing selection can only lead to uneconomical design and possibly expensive and fatal accidents. The largest manufacturers of bearings usually maintain a large technical staff of experienced engineers solely for dealing with problems of their customers, and the advice given by them is of great practical value. Machine designers are wise to make the most of that technical assistance in the early stages of design, for if the technical prob-

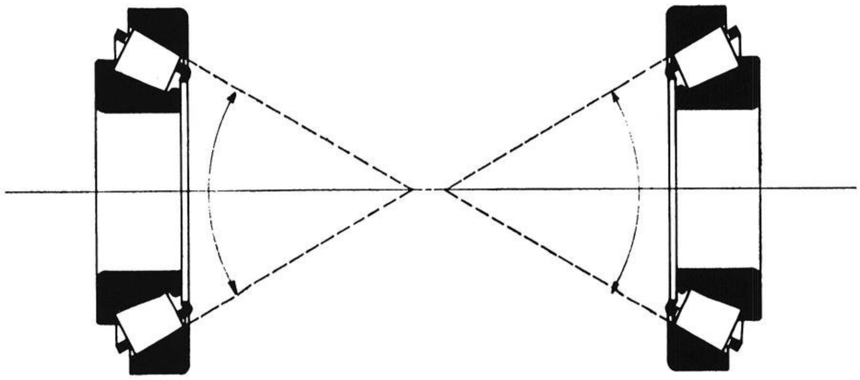


Figure 4a.—Indirect Mounting.

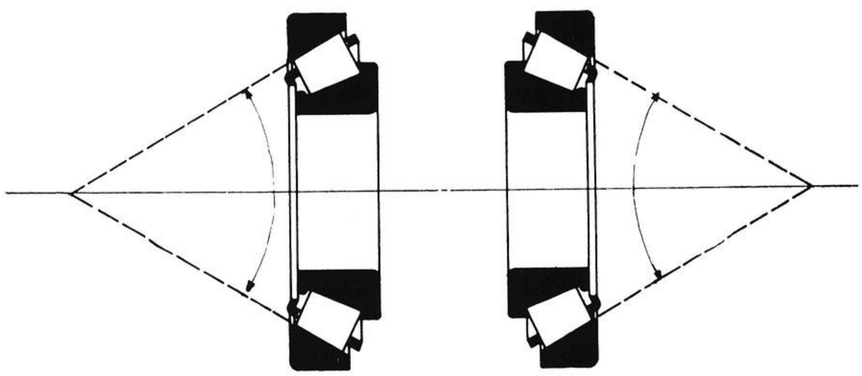


Figure 4b.—Direct Mounting.

lems are left until an advanced stage, when changes may be necessary, they may be very difficult or impossible to make.

Principle considerations which may be submitted with a sketch or drawing together with data are:

a. Dimensional restrictions.
b. Functioning of the machine.
c. General operating conditions (clean, dirty, dry or wet).
d. Calculated loads or data, enabling them to be estimated.
e. Safety factors used in the load calculations.
f. Character of the loading (steady, fluctuating, or shock).
g. Speeds.
h. Temperatures.
i. Any preferences.

Mounting

The final consideration in the application of tapered roller bearings is their mounting. Single row tapered bearings, when applied to a mechanism, are mounted in one of two distinctive designs which are known as "Indirect" and "Direct" mountings. Each of these designs provide certain desirable characteristics depending upon the type of unit in which they are used. Although economy in manufacture of the machine part is an important item in selecting the mounting to be used, the importance of rigidity provided by the arrangement is in many cases a greater determining factor. The design required to obtain a rigidity can best be illustrated by considering these two mounting arrangements. Figure 4 shows both mountings.

Figure 4a shows the "Indirect" mounting where the bearings are applied with the included angle of the conical members of the bearing turned away from each other. In this case the large diameter ends of the rollers of the bearings point out or away from each other.

Figure 4b shows the "Direct" mounting where the bearings are applied with the included angle of the conical members of the bearings turned toward each other. In this case the large diameter ends of the rollers of the bearings point toward each other.

CONCLUSION

Problems arise with tapered bearings, as they do in other friction-reduction devices. The bearing has its own characteristics. Shaft deflection upsets the geometry basis. The bearing is effective in a temperature limiting range as are the dimensions. The machines into which bearings are mounted usually have their own characteristics, menacing the bearing choice and application. Bearings have to be securely and conveniently mounted on shafts and housings. Bearing protection is necessary for bearing life. Lubricants are necessary also for longevity as well as an aid to friction reduction. Limits and fits are determined also by application of the bearing.

Is it possible to satisfactorily and thoroughly solve all the problems of bearings? The answer is, no! A complete and thorough bearing is hard if not impossible to find. How would it be done? The first attack of the problem is mathematics. Basic calculations of loads on body diagrams of shaft mountings help determine the required bearing loads. With this information, a rough estimation of the desired bearing can be established by using a manufacturer's catalog. Size requirements will help reduce the selection of possible bearings. Applications of the bearings in a housing will show if the design requirements and specifications have been met. Experience in application of hearings is a great help, and determines, to a great extent, the performance different bearings have to offer and their consistency over the years. All these, even when used to their fullest, can only attempt to solve the problems. Some problem solutions may have to be sacrificed, but so doing a more desired feature or important problem may be more completely answered. Obviously there is no single answer.

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END

William Spychalla is a civil engineering senior from Antigo, Wisconsin. His first-hand report is based on participation in the program during the 1963–64 school year. Bill is a member of Tau Beta Pi and Chi Epsilon honorary fraternities.

The Wisconsin-Monterrey Exchange Program

By WILLIAM SPYCHALLA

INTRODUCTION

THE Wisconsin–Monterrey Program is designed for undergraduate engineering student exchange. It provides U.S. engineering students with the opportunity to spend their junior year at El Instituto Tecnologico y de Estudios Superiores de Monterrey, Monterrey, N.L., Mexico, and Monterrey students to spend their junior year at the University of Wisconsin, Madison, Wisconsin. Although the Wisconsin–Monterrey Program is concerned mainly with the undergraduate exchange, it also deals with graduate and faculty exchange; this article will only cover the undergraduate phase of the Program for U.S. engineering students.

The Program was initiated in December of 1960; the first group of undergraduates spent the school year of 1961–1962 at Monterrey. Since that time a new group has participated each year, giving, in the four-year period, a total of forty-two U.S. engineering students and four Monterrey Tec students that have participated.

Unlike other undergraduate foreign exchange programs, which deal mainly with humanities students who are sent to the recognized European universities, the Wisconsin–Monterrey Program deals with engineering students In doing so, however, the program has a problem; the engineering profession in the U.S. demands, for best results, that one obtain his formal undergraduate engineering education in the U.S., where a student is taught the methods and the knowledge that are needed for work in the U.S. Thus, engineering studies in a foreign country are of questionable value. The Wisconsin–Monterrey Program exists to show the actual value of such a program and its effect on the U.S. engineer.

BASIC AIMS OF THE PROGRAM

Technical Aims

To have a successful engineering exchange program, a foreign school must exist which has a good level of technical training so that American undergraduate engineering students have some basic incentive for studying in a foreign country. Since foreign language study is not stressed in U.S. engineering schools, the students usually have little interest in foreign countries. The U.S. schools are geared more toward the single goal of technology and more technology. This is due to the demand from U.S. industry that the engineer have a good, solid background in the methods and knowledge necessary to work in the U.S. as an engineer. Engineering may justly be called a narrow field, with generally narrowly educated people in the profession. This, unfortunately, is not a virtue in this ever-shrinking world, where international relations play a very important role. Engineering students must realize this, and not place so much importance on the purely technical training that they receive, but rather place it on the overall effect of their formal education and what they have learned about the world in which they are going to live and work.

Economic–Political Aims

One effective way of acquainting students with the world they live in is to send them to another country to see how 'foreigners' live, think, and act. They can then notice the differences in environment and start realizing how the actions of one country, especially the U.S., affects the life of people in other countries. The foreign-exchange engineer will also realize the importance of engineering in determining the future of a country. A country that can boast of its engineering feats has influence over countries of lesser development and can cause a shift in world politics and economics. Confronted with the interdependence of a country's prestige and importance, and with its technical development, an engineering student will become truly aware of the importance of engineering as a profession. He will then either become more intrigued and interested in his engineering studies or will realize that he is not truly in the area to which he is best suited.

By being outside of the U.S. and looking back at it through the viewpoint of a foreigner, one may change greatly his feelings toward his own country. He will realize the mistakes that his government makes and has made, but he will also begin to appreciate many of the privileges that he so often took for granted.

Only by confronting a distinctly different standard of living, will one realize the problems of the foreign world: the problems that are rarely encountered in the U.S.; the problems which must be taken into account when dealing with other countries.

Social Aims

Living in a foreign country and studying with fellow students who speak a different language than your own is a very broadening experience. You will find out that your language is not the language of the world and that if you wish to converse and exchange ideas, you must adapt to the environment at hand. In speaking this new language, one will learn to think through what he says and will make his words count so that he will not be misunderstood.

By participating in a student-exchange program, one will be with people his own age and of the same interests. He will get to know the 'foreigners' (in this case, Mexicans) as they actually are. He will learn how they act, react, and think. He will become acquainted with their social behavior and note the difference in their moral code.

He will, through all of his new contacts, and experiences, become more aware of and will come to see the world in a new light; a light which is composed of many components, each exhibiting its own distinct characteristics, and each being necessary to make the whole. Speaking a new language, he will gain the respect of many people who before only saw Americans as the tourists who only spoke English and expected everyone else to be able to do the same.

The student will gain self-respect and self-confidence which will be helpful to him in his professional duties. He will also be more apt to look at any situation from more than one viewpoint after having been introduced to the extreme points of view concerning situations of international importance where his viewpoint will not be accepted and he will have to acknowledge the others' views.

PROVISIONS OF THE PROGRAM

Preparation

To gain the full benefit of this program, specific goals and a means of obtaining these goals must be incorporated in the program. Most American undergraduate students are not aware of the full value of such a program and do not know what must be accentuated to gain its full value. For this reason, the Wisconsin–Monterrey Program has a complete preparation program for its participants.

There are two semesters of oral Spanish instruction given to each participant in his sophomore year at the University of Wisconsin. This course is the regular University course with the oral phase of the language being greatly emphasized. In addition to the language instruction, the participants also attend conferences which are designed to introduce them to the history, economic conditions, political system, and social behavior of the Mexican people. Through these conferences the participant gets an idea of what Mexico is really like. He will begin to understand that after the initial romance of a new environment has worn off, he will be subjected to the routine life which will be harder to adjust to because of being in a foreign country where everything is different.

Receiving this insight to the Program is perhaps most important, as it gives the participant a background to his new environment and also points out the not-so-obvious benefits to be obtained from the Program.

After the initial preparation, the participants attend a six-week summer session in Mexico at Monterrey Tec in an intensive Spanish instruction program. Once arriving in Mexico, where English is not generally spoken, the student finds himself with an immediate need to communicate with others. This need is satisfied in the Spanish classes, where everything that the student has learned about Spanish is reviewed and applied to the everyday life, so that his adaptation to the society will be quick and he will feel at ease with the new language. This period of adjustment is essential before the regular technical training starts so that nothing is lost due to language difficulties.

Technical Studies

Monterrey Tec offers a large and varied curriculum in all phases of engineering, so that every U.S. student will receive the technical training that he and his special advisor feel essential. The student will also have a Mexican advisor who will look over the student's many needs and wants and see that the student is progressing satisfactorily.

Although the laboratory facilities may not be comparable to the large, extensive laboratories of the U.S. schools, Monterrey Tec does have all the essentials of laboratory instruction and is constantly improving its facilities. Some examples include a very good Fluid Mechanics laboratory of Iowa State, a leader in the field, and a closed circuit television station designed to give instruction via television. These and many other features make it the top technical school in Latin–America.

There are no American faculty members residing in Monterrey during the year. The Mexican professors, while not giving any special considerations to the American students, make sure that the students are not missing out on anything that could be to their advantage. The professors are also available to give assistance to students who are having difficulties in the course. Since most of the texts are in English, the student's only language problem will be in the explanation of the material in the text.

Social Experiences

Besides the technical aspect of the Program, there is the social experience offered in the Program.

All of the participants have Mexican roommates. The participant learns first-hand how a Mexican student differs from an American student. The participant is able to discuss various topics with his new friends that point out their attitudes towards Americans, school, and other things which may affect the participant's stay in Mexico.

Through his roommate and other friends, the participant has

(Continued on page 18)

Exchange Program

(Continued from page 15)

the chance to visit the Mexican home and observe how Mexican family life differs from American family life. He also has the chance to date Mexican girls and from them learn about the differences in social customs and how the moral code differs from that of the U.S.

Last but not least, the student becomes familiar with the typical U.S. tourist and sees the impression that a tourist gives of American life.

Cultural Experiences

Along with the other experiences, the student also becomes acquainted with the culture of Mexico. Through the Program the visits to the industries of Monterrey—the industrial center of Mexico and visits with prominent men in industry as well as in the community are arranged. The student can also attend the concerts and other cultural events that are given those of Mexican origin and those from countries that have had an influence on Mexico. Sports, such as the bullfights, soccer games, and cockfights, which depict the Mexican outlook on entertainment are attended by the student for both pleasure and observation of the Mexicans.

The Program also provides three formally organized trips—between the summer and fall sessions, at Christmas time, and at Easter or spring recess. These trips acquaint the student with the different geographical parts of the country and the differences in climate. Each trip covers a different area of Mexico and exposes the participant to the different cultural backgrounds of that section. Visits are made to the ruins of ancient civilizations and the effects of these old civilizations can be noticed in the people of that region. These observations are pointed out by professors who are experts in archaelogy, history, and Mexican lore and who accompany the students on each of the trips. The trips not only give the students a firsthand knowledge of Mexico, but also offer the opportunity of broadening themselves in things unrelated to the formal education of a technical school.

Accreditation

All courses taken at Monterrey Tec are fully accredited at the University of Wisconsin. All technical subjects are taken en lieu of their equivalents at the U.W., and all non technical subjects such as Spanish and economic problems of Mexico are taken as elective credits. In no case has a participant ever found himself on the short end of a credit transfer, since the advisors at the U.W. are well acquainted with the course content at Monterrey Tec.

Program Costs

Student Costs. The participant is expected to pay approximately the same amount as he would if he were studying at Wisconsin. He is expected to provide his own spending money, arrange for his immigration requirements, and obtain clearance from his draft board. The student must clear his financial situation with the Director of Loans and Scholarships at the University of Wisconsin before he receives his immigration papers and is approved for enrollment at Monterrey Tec.

A student who has a scholarship will have it continued while he is at Monterrey, as the Program is based on the idea that Monterrey Tec is an extension branch of the University of Wisconsin and having all the benefits available that U.W. students normally receive Students lacking funds may apply for loans or other such assistance as is available through the University.

Each student and his parents must sign an agreement stating responsibility for the student's actions and conduct while in Mexico. The rules of conduct of Monterrey Tec apply to all students and failure to comply is grounds for corrective action.

Additional Costs. Beside what the student pays, there are other costs incurred by the Program. These costs must come from the University of Wisconsin or from supporting organizations. These costs include the summer session, planned trips, calendar year insurance, and transportation. Below is a summary of the estimated cost of participating in the program.

COST OF PARTICIPATION IN THE WISCONSIN–MONTERREY PROGRAM

Student Pays

Winter tuition	$ 672
Room-board (except vacations); medical, personal laundry (except dry cleaning)	872
Books	100
Dry cleaning	20
Total essential costs paid by student	$1664
Cash deposit to cover personal expenses for the year	300
Total	$1964

Program Pays

Transportation (round trip)	$ 200
Summer tuition, board and activities	360
Calendar year insurance (approx.)	100
Orientation program at Institute	200
Vacation trips and food costs during vacations	450
Administration and overhead	540
Total	$1850

SELECTION AND ELIGIBILITY OF PARTICIPANTS

Eligibility

The Program is open to U.W. engineering students whose academic standings place them in the upper 15% of their freshman class and who by the beginning of the sophomore year have indicated interest in the Program by:

1) having made arrangements with the special program advisors who are familiar with the courses at Monterrey Tec to plan their course of study.

2) having included four credits of oral Spanish on their study lists.

3) filing approved programs for the remainder of their undergraduate study at the University of Wisconsin at the Dean's Office.

The applicants must be unmarried American citizens.

There are exceptions to the upper 15% regulation, which depend mostly on the reasons of the applicant for wanting to participate, his character, his emotional stability and other factors which are not dependent on gradepoint alone.

Selection

The students that are finally selected must:

1) Sucessfully complete two semesters of oral Spanish and dem-

onstrate the ability to understand and speak the language.

2) Maintain their high scholastic standing throughout their sophomore year.

3) Show good evidence of their;

- a) Interest in learning about another country, its culture, politics, religion, etc.
- b) Desire to meet the people of another country.
- c) Adaptability to a foreign environment.
- d) Desire to present the image of the typical U.S. student to Latin-Americans.
- e) Desire to be good-will ambassadors of the U.S. and not do anything to jeopardize any good relations.

4) Be of good health and emotional stability.

5) Be financially solvent before leaving for Mexico.

6) Be cleared of draft obligations and have proper immigration papers and registration.

7) Be endorsed by the U.W. College of Engineering.

BENEFITS OF THE PROGRAM

Value to the Participant

Faculty Viewpoint. The faculty involved have been impressed by the Program and its ideals and have watched the Program through its high points and low points. In evaluation of the Program, the faculty viewpoint can be summarized as follows:

1) All the participants sucessfully completed their courses and received full credit for them at the U.W. Their academic achievement both at Monterrey Tec and on return to the U.W. is regarded as completely satisfactory.

2) Not one student returned to the U.S. because of problems with the language. The students all acquired a sufficient knowledge of Spanish to carry themselves through the majority of situations without difficulty while in a Spanish-speaking environment.

3) It was the policy of Monterrey Tec not to give special considerations to the American students. They were expected to follow the rules as all other students; They were treated like their classmates by the instructors.

4) The participants were well-liked and not singled out as foreigners. They received invitations to homes of roommates and other classmates and participated in the extracurricular activities.

But regardless of changes in the student's interests, the first-hand knowledge of a foreign way of life opens the possibility of foreign work and travel as the representative of an American business firm. And in the last analysis, the creation of as many interesting career options as possible is the purpose of a university education.

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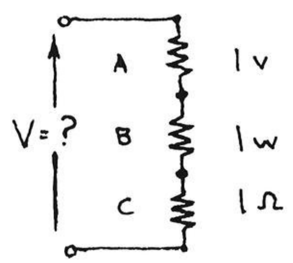
THE MENTAL MAZE

By Clifton Fonstad, Jr. ee4

MAY'S Mental Maze marks the last Maze of this school year and the last Maze from my pen, too. 1964–65 has seen eight new Maze Masters chosen and has been a good year for the Mental Maze. With your support, 1965–66 will be another successful year. There is no prize connected with this month's Maze—the answers are given at the end of the puzzles—but you should still be able to have fun working your way through the Maze.

So let's get started on the first puzzle—the first turn in this month's Mental Maze.

1. This problem is a gift for the electronics bugs, but you all should be able to get it. Suppose that you have three resistors, A, B, and C, connected in series. Resistor A has one VOLT across it, resistor B has



one WATT being dissipated in it, and resistor C is one OHM. What is the minimum voltage that could exist across the resistors to cause this situation?

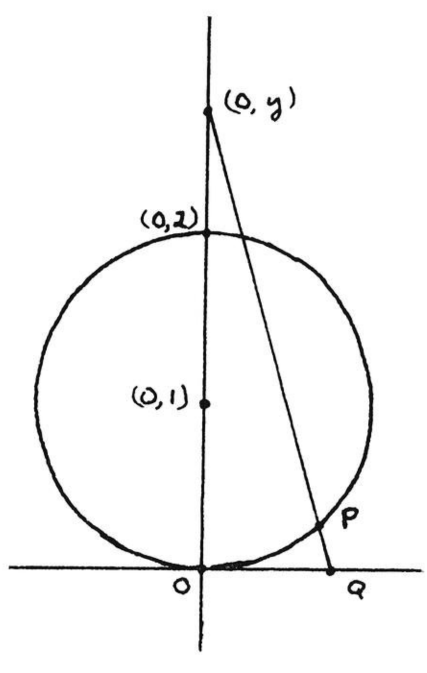
2. At Tioga Tech, commencement is held earlier than it is at the U. In fact, it was held last week-end. At the ceremony, as is the Tioga Tech tradition, the seniors formed a line two abreast (it was 100 yards long) and marched the half mile from the library to the stadium. Just as the line started to march the Tioga Tech dean started at the end of the line to walk toward the front. When he reached the front he turned and started to walk back toward the rear. He walked at a steady rate and reached the rear just as the whole line had moved 100 yards forward from its original position. How far did the dean walk on his inspection tour?

3. It's about time for a quicky so here is one you won't have to write anything down for to solve. You are given nine small cubes that look identical but one of them weighs more than the others (whose weights are identical). Using just an equal arm balance, what is the smallest number of weighings you will have to make to be certain which cube is the heavy one?

4. Although few non-mathematical puzzles find their way into the Mental Maze, there are many kinds of puzzles that don't deal with numbers. For instance, try to work this word puzzler.

Figure out what the following sentence says and how it should be punctuated:

"That that is is that that is not is not is not that it it is."



If you are a regular Mental Maze reader you have had plenty of practice reading this type of gibberish, and you should have no trouble.

5. Doodle puzzles are non-mathematical, too. Try this one.

Can you transform the word "hole" into a building using only two straight lines?

h o l e

6. The last two puzzles were non-mathematical; this puzzle is at the other extreme. Look at the diagram below. The arc PO is the same length as the line OQ and both are t units long. The circle has radius of one and is centered at (0, 1). And, finally, the line through the points P and Q intersects the y-axis at (o, y). t goes to zero.

Answers

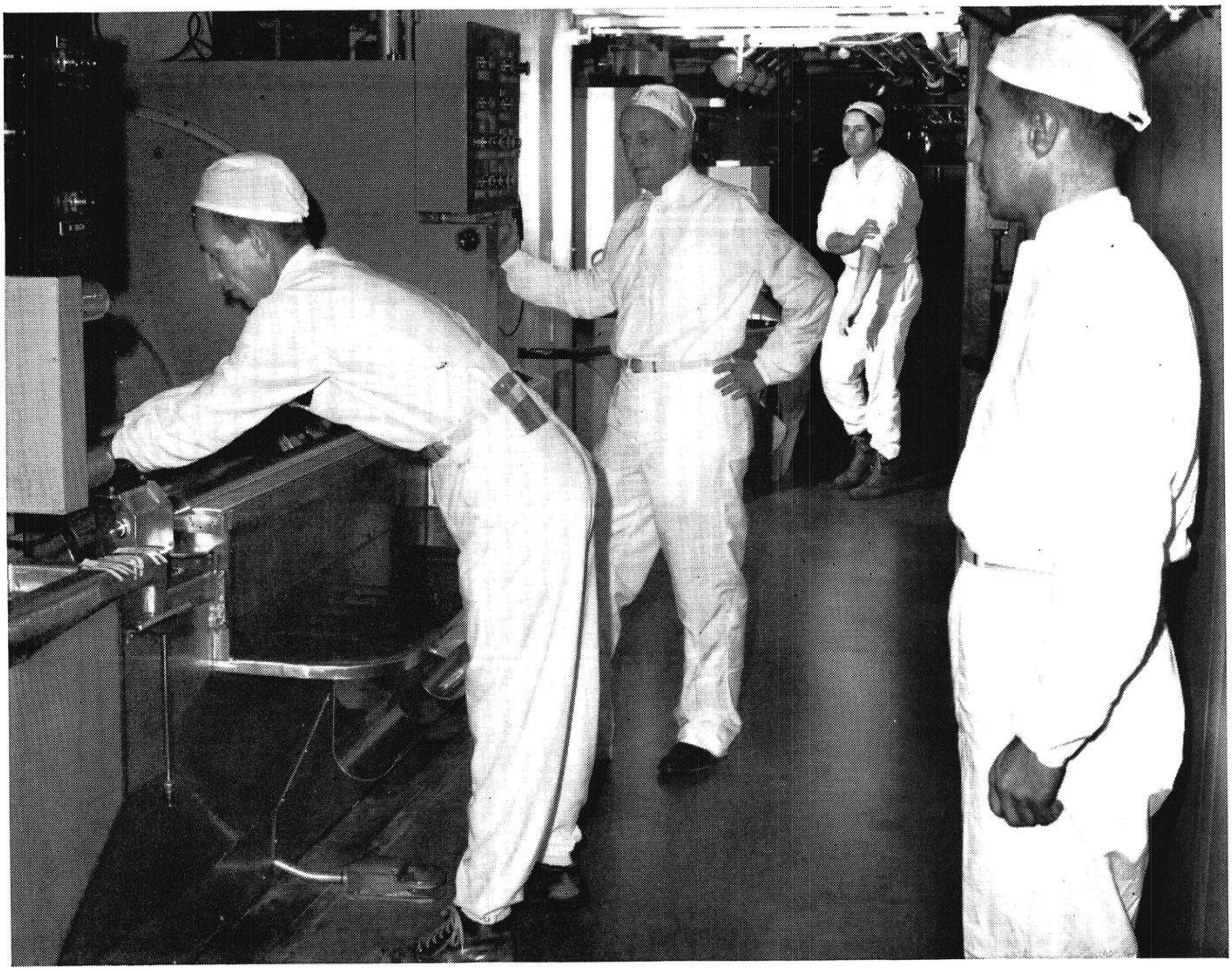
The answers for this month's Mental Maze will be found inverted below. April's answers are:

1. Tinker—3 days.
   Helper—6 days.
   Apprentice—forever.
2. 13 1/5 sec.
   12 4/7 sec.
3. 198 matches.
4. 91 zones.
6. 8, 5, and 3 years.

We've got a Maze Master to announce this month, too. March's Maze Master was Roy Noffke of Madison.

And now, for this month's answers, put the magazine down on the table, walk around to the other side, and read:

1. 3 volts.
2. 241 yards.
3. 2.
5. Cross the "L" to make a "T", add an "L" to the end—Hotel.
6. 1.



Art of creating photo-film manufacturing machines taught here

That's sure no professional ad model posing up in the foreground of the picture but a real pro of an engineer looking over his handiwork some six years after drawing the assignment.

The first three years he spent picking the best location for the thing with regard to capital cost, operating cost, and operating convenience. This means he actually put it together in a scant three years, which isn't bad, considering that it amounts to a huge integration of mechanical engineering, electrical engineering, chemical engineering, hydraulic engineering, instrumentation engineering, structural engineering, industrial engineering, and just about every other category of engineering in the catalog of a big college.

Of course, no college teaches men how to design and assemble a complex like that. You learn by doing. Not at every large company can you learn. Come to think of it, *is* there any other company whose production is of a nature and volume that demands such neat and thoroughgoing co-ordination of engineering disciplines?

We happen currently to be seeking not only engineers to create the components and subsystems but those willing to learn how to fit all the pieces together.

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