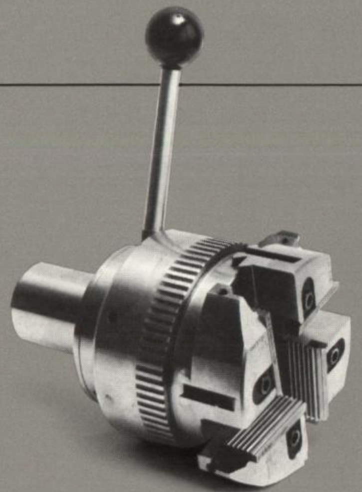
TeledyneReport

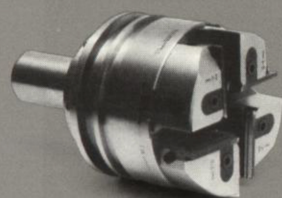
third quarter 1978

Screw Threading: An Ancient Idea Vital to Modern Technology

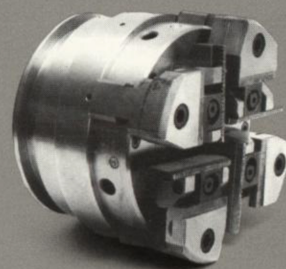
Teledyne Landis Threading Tools



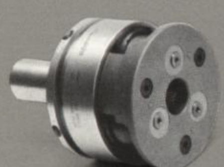
2" Landmatic stationary thread cutting die head



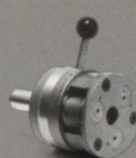
1-1/4" Landex revolving thread cutting die head



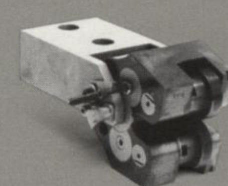
1" Lanco revolving thread cutting die head



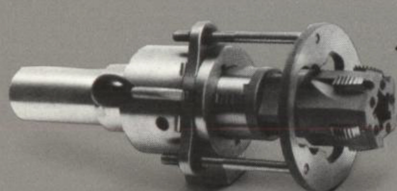
Revolving thread rolling head



Stationary thread rolling head



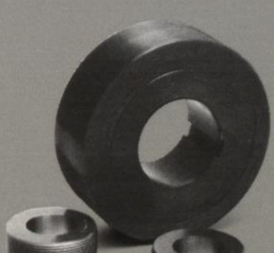
Lanroll thread rolling attachment



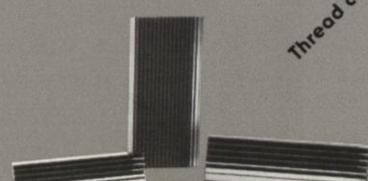
Receding chaser stationary collapsible tap

Stationary collapsible tap

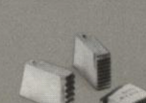
Solid threading taps



Thread rolling dies



Thread cutting chasers



Collapsible tap chasers

Screw Threading

Machines for the high speed production of screw threads are a thriving segment of the machine tool industry.

Five simple devices and the principles they embody are generally accepted as the basic elements of all our modern mechanical machines—even the most complex. These devices, whose origins are shrouded in antiquity, are the lever, the wheel and axle, the pulley, the wedge or inclined plane, and the screw. Each in its own way allows man to multiply or otherwise control his own strength so that he can perform tasks that would ordinarily be beyond his capability.

The screw principle is one of the most useful. The most common example is probably the bolt. It is basically a rod with screw threads cut or formed into its surface. When mated with a metal piece such as a nut which has matching internal screw threads, the combination becomes one of the most useful and widely used means of fastening things together in our mechanized society. A few pounds of force used to turn the nut with a wrench while the bolt is held stationary can produce hundreds of pounds of compressive force on anything held between the nut and bolthead.

A major advantage of the screw fastener over other methods of joining parts, such as riveting or welding, is that the joint can be easily and quickly disassembled and reassembled many times. It is an advantage that is indispensable in the design of many kinds of products. Consequently, billions of screws and bolts of every conceivable size and type are produced throughout the world each year for products as diverse as watches, automobiles, appliances, buildings and heavy industrial machines.

Fasteners are only one application of the screw thread principle. In clamps, vises and presses it is used to apply pressure to various workpieces. In automobile jacks, agricultural and construction machinery and aircraft control surface actuators it transforms rotary motion into linear motion, transmitting force to accomplish various tasks. In micrometers it offers a precise method of measuring linear distance, and in machine tool leadscrews it accurately moves or positions tools or workpieces.

Even this does not exhaust the usefulness of the ubiquitous screw thread. One of the largest uses of this principle is found in joining pipes of all sorts, ranging from home plumbing and commercial electrical conduit, to specialized heavy-duty applications in the petroleum production industry. In these applications the thread form is tapered for a forced metal to metal fit so that fluid and gas tight joints are created.

On the Cover:
An illustration from Diderot's Encyclopedia of Trades and Industry shows the technique of producing screw threads in 18th Century France, just prior to the Industrial Revolution.

The demand for the mass production of large quantities of identical, interchangeable screw threaded parts in a variety of types and sizes has created a thriving segment of the machine tool industry devoted entirely to the manufacture of high speed, precision threading machines and accessories. Teledyne Landis Machine, a leading producer of this type of equipment, celebrates its 75th anniversary this year.

Teledyne Landis Machine now produces about one hundred different machines for generating screw threads of various sizes and types and for varying production requirements. The largest machine is capable of cutting threads on pipe up to twenty inches in diameter. At the opposite end of the size scale are small production machines that will produce threads in the 3/16″ to 5/8″ diameter range.

Another related company, Teledyne Oster, specializes in small portable threading machines for maintenance and construction, and production-type threading machines for medium production quantities. Machines of the portable type are often seen in hardware stores where they are used to thread pipe for the homeowner.

In addition to complete threading machines, Teledyne Landis manufactures over 200 types and sizes of thread generating tools such as die heads and thread rolling attachments for lathes and automatic screw machines. This is supplemented by a wide range of expendable thread production tools.

HOW THREADING IS DONE

Screw threads can be produced in many ways. At the simplest end of the scale is the hand die and tap method. A hand die is very much like a hardened nut which has its threads interrupted at several places to form cutting edges. When this is rotated on the end of a rod or pipe, the die cuts a matching thread as it screws itself onto the workpiece. A tap is similar to a bolt of hardened steel with longitudinal grooves interrupting the thread to form cutting edges. It is used for making internal threads.

Another old and universal machine method of producing screw threads is single point threading which is usually done on a lathe. A single cutter is used to produce the proper thread form. As the workpiece rotates, a precision leadscrew that is part of the lathe mechanism moves the tool along the workpiece to generate the thread.

TANGENTIAL CHASERS

The high speed production of screw threads to keep up with the needs of modern mass production requires more specialized equipment, such as that embodied in the Teledyne Landis line. One of the first products introduced by Landis Machine Company, when it began business in 1903, was a self-opening, tangential chaser die head that had been developed and patented in 1889 by A. B. Landis, one of the company's founders. A chaser is a cutting tool that is formed with multiple grooves and cutting points shaped to match the thread that is to be produced. In the tangential system, four or more of these chasers are held in a die head (see inside front cover) that resembles a lathe chuck. The cutting edges touch the workpiece at four or more points, tangent to its circumference—hence the name tangential. Teledyne Landis manufactures two basic types of tangential die heads and thread cutting machines. With one type the head remains stationary and the workpiece is rotated, and with the other the reverse is true.

To improve production, most Teledyne die heads open automatically when the thread is complete to release the chaser from the cut and eliminate the need to reverse the spindle and back off the die head. Some solid adjustable die heads which do not open are made, however, for special application reversing spindle machines.

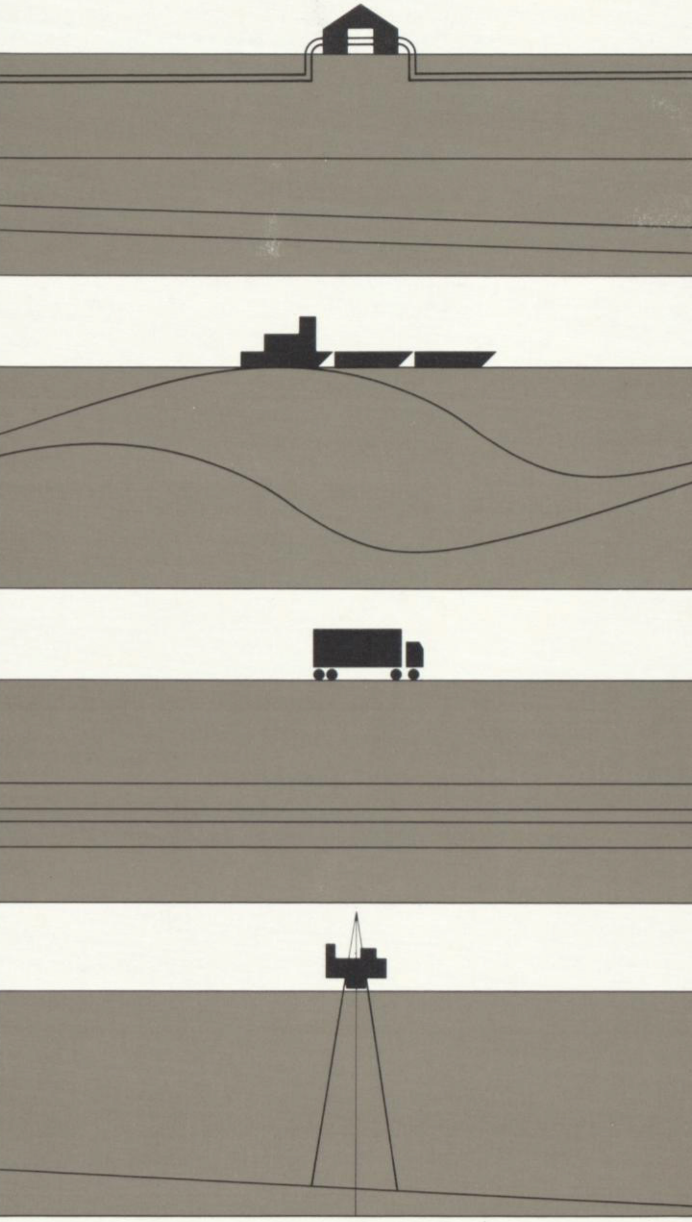
RADIAL CHASERS

One alternative to the tangential-type chaser is the radial chaser, which touches the workpiece radially rather than tangentially. The radial-type chaser offers quicker tool set-up than the tangential chaser but this is offset by shorter runs between regrinds. Radial chasers must also be reground in matched sets. The advantages of the tangential chaser include long chaser life because they can be reground individually until up to 80% of their original length has been used, individual adjustment for optimum cutting position, and consistent cutting angle for the life of the tool.

Teledyne Landis chasers are made from a variety of high speed tool steel alloys for various applications. The alloy for standard service is a 9% molybdenum high speed steel with a low percentage of tungsten known as an M-1 type such as Teledyne Vasco 8-N-2. Where greater strength is required for heavier cuts in a variety of metals an M-2

Texas Gas Transmission Corporation and Subsidiaries

Interim Report 3 1978



To the Stockholders:

November 9, 1978

Net earnings available for common and preference shares were $11,192,000, or $1.09 per share for the 1978 third quarter, versus $12,923,000, or $1.26 per share for the year earlier period. For the nine months ended September 30, earnings were $41,161,000, or $4.00 per share in 1978, compared to $37,197,000, or $3.62 for the same period in 1977. The twelve months ended September 30 comparison was $59,191,000, or $5.75 per share for the 1978 period, versus $55,805,000, or $5.42 per share for the 1977 period.

The Gas Transmission Services division earnings for the 1978 third quarter were $738,000 below those reported for the same quarter of 1977. Substantially all of the earnings decline was due to a concentration in the 1978 third quarter of the costs of a major maintenance program. Year-to-date divisional earnings continue to be ahead of last year. This improvement reflects sales volumes 21 billion cubic feet greater than those of the 1977 period coupled with modestly higher investment tax credits, and the write-off during the 1977 period of advances for exploratory drilling in the Arctic Islands.

A proposed settlement agreement, including the new rates which were placed into effect on April 1, 1978, is pending final approval before the Federal Energy Regulatory Commission (FERC). Reported revenues and earnings reflect the terms of the settlement, which included a 13 percent return on pipeline equity. The company filed an application with FERC on September 29, 1978, for an increase in rates to cover higher gas and other costs, to become effective April 1, 1979. The filing requests a return on pipeline equity of 13.5 percent.

Congress has now passed a national energy bill after an extended period of debate. Although this legislation includes some problems, on balance we believe it represents a positive step forward. In addition to providing an exploration incentive in the form of a higher price for new natural gas, it establishes for the first time price parity between the intrastate and interstate markets. The higher gas prices will stimulate more exploratory drilling, which should result in additional gas reserves. These additional reserves, plus the ability to be price competitive for intrastate supplies, are definite pluses for the division's gas purchasing efforts.

Consolidated Balance Sheet
September 30, 1978 (Unaudited)

	(Numbers in Thousands)
ASSETS	
Cash	$ 8,990
Temporary cash investments, at cost	4,549
Receivables	112,970
Inventories	108,365
Other current assets	10,185
Advances to obtain future natural gas supply	22,212
Offshore pipeline partnership	21,807
Coal properties and other investments	16,436
Plant (Less reserves $594,366)	815,101
Costs recoverable through rate adjustments	15,964
Other assets	22,219
	$1,158,798
LIABILITIES AND STOCKHOLDERS' EQUITY	
Current debt and sinking funds	$ 30,432
Accounts payable	88,194
Accrued taxes	7,029
Other current liabilities	55,717
Long-term debt	388,454
Deferred investment tax credits	20,742
Accumulated deferred taxes on income	124,418
Other liabilities	6,193
Total Liabilities	$ 721,179
Stockholders' Equity—	
Preferred stock	$ 8,600
Preference stock, $1.50 convertible series	2,031
Common stock, par value $5	49,408
Paid-in capital	54,541
Earned surplus	323,039
Total Stockholders' Equity	$ 437,619
	$1,158,798

Consolidated Statements of Income
Unaudited

Operating Revenues and Sales:
Gas transmission (Notes 1 and 2)
Trucking
Inland waterways
Oil and gas exploration and production
Other
Interdivision sales

Costs, Expenses and Other Income:
Operating expenses and cost of sales
Depreciation, depletion and amortization (Note 1)
Taxes, other than income taxes
Interest and debt expense
Allowance for funds used during construction
Equity in earnings of offshore pipeline partnership
Other income
Other income deductions
Federal income taxes—
Current
Deferred, net
Deferred investment tax credit, net
State income taxes

Net Income
Less preferred dividends
Net Income Available for Common and Preference
Earnings per Share, Primary and Diluted
Average Shares Outstanding

Income Available for Common and Preference:
Gas transmission
Oil and gas exploration and production
Inland waterways
Trucking
Other

Three Months Ended September 30, 1978	Three Months Ended September 30, 1977	Nine Months Ended September 30, 1978	Nine Months Ended September 30, 1977
(Numbers in Thousands Except Earnings Per Share)			
$132,296	$118,142	$443,181	$383,776
86,878	79,910	263,500	232,845
48,014	34,637	121,379	91,937
28,821	22,849	74,212	72,275
—	238	830	1,300
(11,922)	(9,865)	(29,035)	(28,504)
$284,087	$245,911	$874,067	$753,629
$231,136	$194,493	$703,028	$610,906
17,830	16,203	53,007	37,006
7,946	6,855	26,276	22,455
8,960	8,609	26,409	25,387
(714)	(290)	(1,930)	(524)
(542)	(600)	(1,635)	(1,800)
(1,452)	(1,975)	(3,283)	(4,862)
1,781	145	2,058	390
(4,076)	627	6,210	16,069
10,368	6,864	15,645	3,767
1,091	654	3,706	4,035
360	1,176	2,775	2,909
$272,688	$232,761	$832,266	$715,738
$ 11,399	$ 13,150	$ 41,801	$ 37,891
207	227	640	694
$ 11,192	$ 12,923	$ 41,161	$ 37,197
$ 1.09	$ 1.26	$ 4.00	$ 3.62
10,288	10,286	10,287	10,286

$ 4,116	$ 4,854	$ 21,787	$ 15,151
3,829	4,333	12,064	12,639
4,221	2,583	8,848	5,557
(655)	1,470	(811)	4,617
(319)	(317)	(727)	(767)
$ 11,192	$ 12,923	$ 41,161	$ 37,197

be recoverable. The division's automotive and truck hauler, Commercial Carriers, Inc., reported a modest profit during the quarter, which in 1977 produced a slight loss. New model changeover has now been completed and demand for new cars, except for imports which are suffering from the devaluation of the dollar, is strong. Terminal operations in the Detroit area have been consolidated into a new facility designed to improve efficiency and productivity in that operation.

The Oil and Gas Exploration and Production division reported earnings which were 12 percent lower than the third quarter last year. The decline is the result of higher exploration and development expenses, primarily the write-off of two expiring Federal offshore leases totaling $3.1 million. Natural gas production volumes were above last year's third quarter. Three new offshore platforms were on stream throughout the period, and two other platforms began production the last week in September. One of these latter platforms was Eugene Island 292B, one of the division's major producers which had been off production for more than a year for additional drilling. Higher prices for natural gas liquids, oil and condensate resulted in increased revenues despite slightly lower volumes.

The division participated in the drilling of eight wells during the quarter. Three exploratory wells resulted in two discoveries and one dry hole, all offshore, while five development wells resulted in three gas wells and two dry holes. The new national energy legislation mentioned earlier will provide for improved prices for natural gas discovered on offshore leases acquired after April 20, 1977, and on gas from reservoirs discovered after July 27, 1976.

The announced sale of one million shares of common stock has been postponed due to unsettled market conditions, and the registration of such securities with the Securities and Exchange Commission has been withdrawn. Reconsideration of the proposed common stock sale is not expected before the latter half of 1979. For the present, internally generated cash and existing lines of bank credit will be sufficient to accommodate the corporation's capital requirements.

Dennis Hendrix

Dennis Hendrix
President

Despite the positive step of the passage of energy legislation, gas supply will be a continuing challenge of the future. Supplies for the upcoming winter appear to be adequate to meet demand equal to last year's very harsh winter. However, substantial efforts are continuing to be directed toward insuring longer-term supplies. We have been formally notified by the government of Trinidad and Tobago that if their LNG project exceeds .5 billion cubic feet per day, as they expect, Texas Gas will be offered a position as purchaser and equity partner in the project.

The Inland Waterways Services division earnings were very strong—recording an increase of 63 percent above those of the 1977 third quarter. Barging revenues increased 21 percent over the prior year's quarter, reflecting increased demand for every category of freight other than nonbulk traffic. Demand for barging continues strong in the fourth quarter. Jeffboat, Inc., the division's inland shipyard, ended the quarter with a nominal loss, compared with a loss of more than $700,000 in the strike-plagued 1977 third quarter. Jeffboat's 1978 third quarter results included a provision for a loss of almost $1.3 million relating to construction of components for an offshore drilling rig, and a $460,000 aftertax credit resulting from the settlement of a prior year's state income tax matter. The shipyard's capacity is now booked for 1979, primarily for towboat and barge construction.

Legislation was passed by the 95th Congress which imposes a user charge on barging operations beginning in 1980 in the form of a four cent per gallon fuel tax. The division expects to recover most of this increased cost through price escalation clauses included in its various contracts.

The Trucking Services division continued to experience difficulty in the third quarter. American Freight System (AFS), the general commodity operations, showed operating improvements throughout the period. However, its third period operating results were significantly affected by the establishment of a $1.6 million reserve for probable losses on amounts due from a clearinghouse which collected a portion of AFS's freight bills. The clearinghouse, which served more than 35 carriers, filed bankruptcy late in September. It is not possible to estimate what portion of the reserve, if any, may ultimately prove to

Notes:

(1) In July 1977, the FERC issued its order approving a composite depreciation rate of 4.6% on the Company's gas plant and disallowing return and taxes on a coal gasification investment from April 1, 1974. The Company had been using a 5.25% composite rate since that date. This settlement had no material effect on net income. Reductions in revenues and depreciation for the nine months ended September 30, 1977, include approximately $9.6 million and $10.9 million, respectively, applicable to prior periods.

(2) The Company filed a motion for approval by the FERC of a proposed settlement of the rate increase for its pipeline operations which has been collected, subject to refund, since April 1, 1978. The offer of settlement will require a reduction in rates and a refund of $4,513,000 for the three months ending September 30, 1978, and $9,187,000 for the period April 1 through September 30, 1978, which have been reflected in the income statements.

type high speed steel such as Teledyne Vasco M-2 is used. This tough 6% tungsten-5% molybdenum steel with 2% vanadium has excellent wear-resisting properties as well as toughness. For threading harder space-age alloys which frequently have abrasive properties, Teledyne Landis chasers are made from an M-42 type alloy such as Teledyne Vasco Hypercut. This cobalt-type high speed steel can be heat treated to an exceptional hardness and offers great wear resistance.

Tangential chasers and tap chasers are typically hardened to a Rockwell "C" value of 62 to 64, while solid taps are hardened to a typical value of 61 to 63.

MAKING INTERNAL THREADS

Internally threaded parts are produced on tapping machines which use either solid, solid adjustable or collapsible taps. Solid taps, machined from a single piece of high speed steel, are most widely used for the smaller thread diameters. Taps with replaceable and adjustable chasers become practical for larger diameter threading. Both solid taps and solid adjustable taps are used on reversing spindle machines because the direction of rotation must be reversed to withdraw the tap from the workpiece.

Higher production rates are possible with the Teledyne Landis line of collapsible taps. These are designed so that the cutting chasers withdraw automatically into the body of the tap as soon as the thread is complete. This allows the tap to be withdrawn from the workpiece without reversing the spindle direction.

Other Teledyne collapsible taps known as receding chaser types are designed to produce precision tapered threads as well as straight threads.

THREAD ROLLING TECHNIQUES

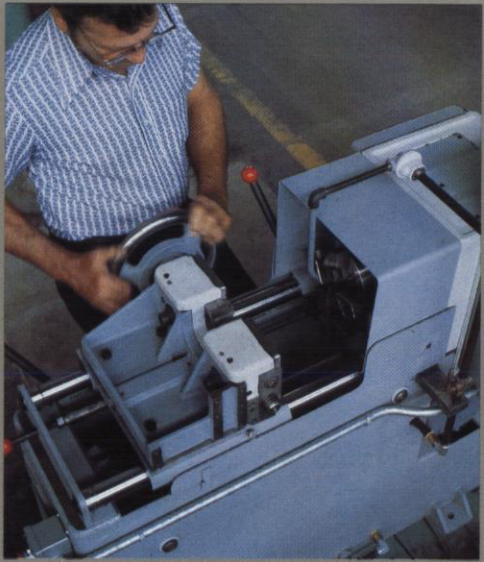
In the quest for higher speed production and longer tool life than is possible with thread chasers, Teledyne Landis developed a line of thread rolling machines and dies. Thread rolling is a mass production idea that dates back to the 1830's. The original idea was to form screw threads on rods by rolling the part between two flat dies that had grooves on their faces, matching the profile of the desired thread form. Under pressure the material of the part flowed and formed the desired helical screw thread on the part. A few years later another rolling process was patented that rolled the blank part between two grooved cylindrical dies to achieve the same result. Both types of thread rolling machines are made today. Teledyne Landis has specialized in the cylindrical die method as a more versatile forming technique. This is because the maximum length of the thread that can be made on a flat die machine is limited by the size of the dies. With cylindrical die rolling, threads of indefinite length can be produced by feeding bar lengths of stock longitudinally through the dies. Alternately, cylindrical dies lend themselves to the high speed production of parts with shorter thread lengths, as well.

There are a number of advantages to rolling threads rather than cutting them for certain applications. It is a very high speed process which can greatly increase production. While higher in initial cost, the life of a set of dies is much longer than the life of cutting tools and the dimensional tolerances of the finished parts remain more uniform during the life of the dies. One set of dies can produce as many as 1,000,000 threaded parts. Finally, the process of rolling creates a metallurgical change in the rolled part known as work-hardening. The metal near the surface of the rolled threads actually becomes harder than the original steel blank. The micro-grain structure of the thread is also improved, resulting in stronger, better finished threaded parts.

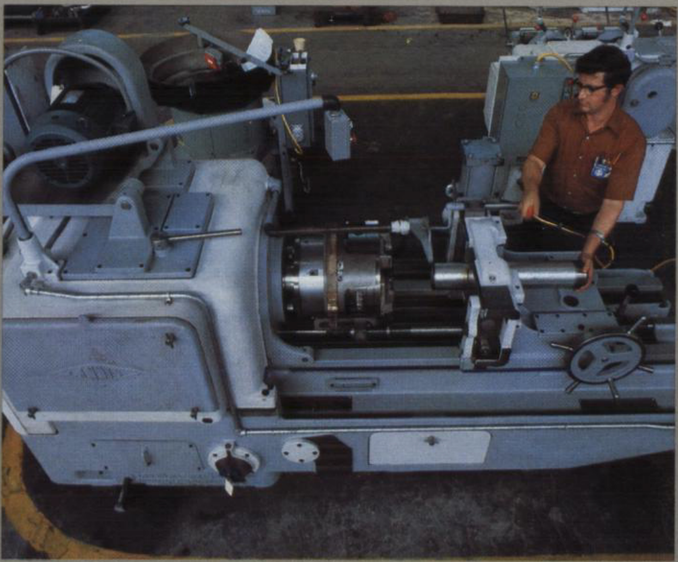
Teledyne Landis now produces a complete line of two-die thread rolling machines and the dies to use with them as well as a complete line of tangential chaser threading machines. Both types of threading equipment are necessary. Thread cutting is usually more economical for short or medium production runs of a variety of thread types and sizes. Thread rolling is usually faster and more economical for long production runs of 100,000 parts or more. Also, certain alloys are more easily threaded by cutting than by

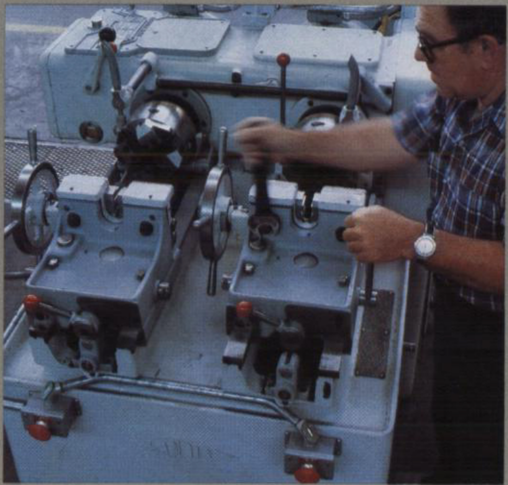
Teledyne Threading Machines

Among the smaller Teledyne Landis threading machines is this low cost unit designed for economy, efficiency and simplicity of operation. It uses a revolving, spindle-mounted tangential chaser Landex die head to cut pipe or bolt threads up to 2 inches in diameter.

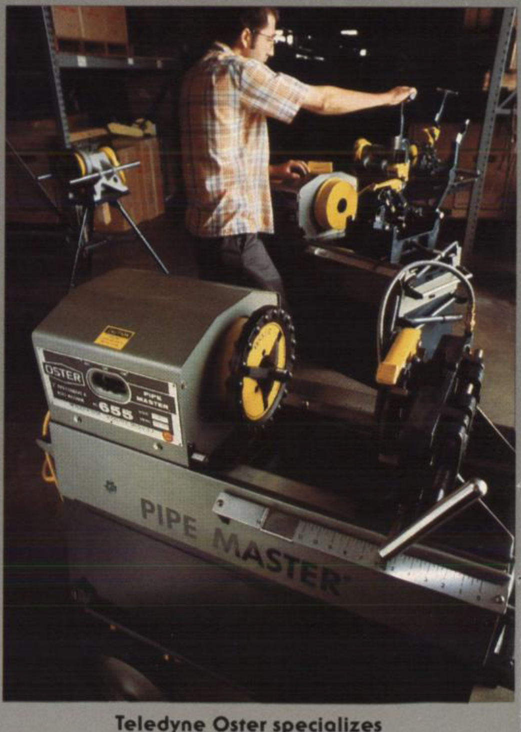


Designed for heavy duty precision threading of large diameter workpieces, this Landmaco thread cutting machine will handle work up to 6-5/8 inches in diameter. It is also available in a double spindle model and with or without leadscrew feed.





This Landmaco double spindle threading machine employs a leadscrew for each spindle to feed the workpiece into the die head. Leadscrew design is used where unusually heavy cuts must be made, or where maximum thread accuracy must be maintained.

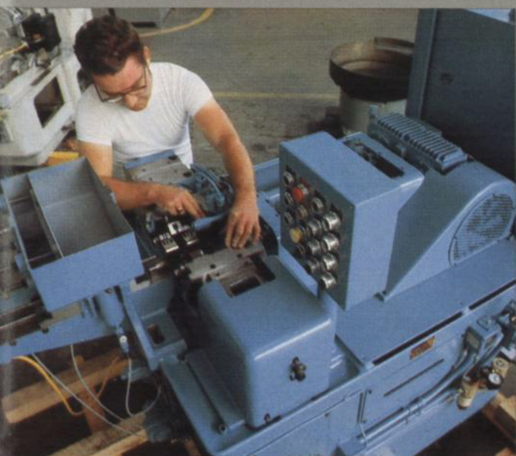


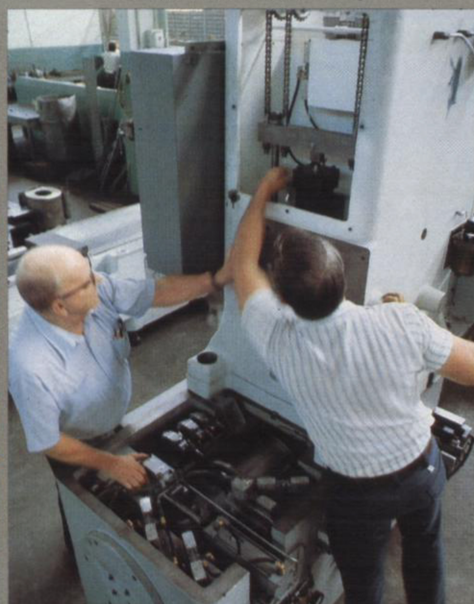
Teledyne Oster specializes in small portable threading machines for maintenance work and for use in the construction industry, such as these model 655 Pipe Masters available with either manual or automatic chucking. This Teledyne company also produces small production-type threading machines with radial chaser die heads.

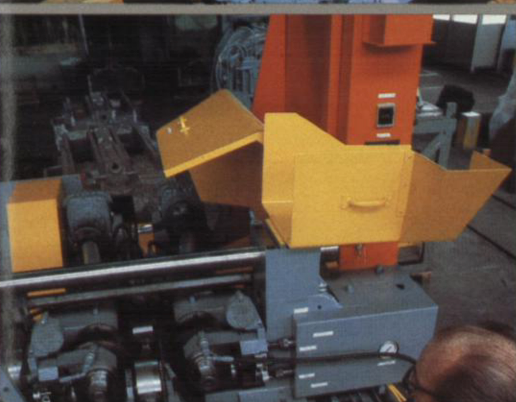
The two-roll cylindrical die method is used in this simple but rugged Lannurol thread and form rolling machine, suitable for jobbing or high production operations. Up to 60 parts per minute can be produced. Maximum thread diameter is 2 inches.

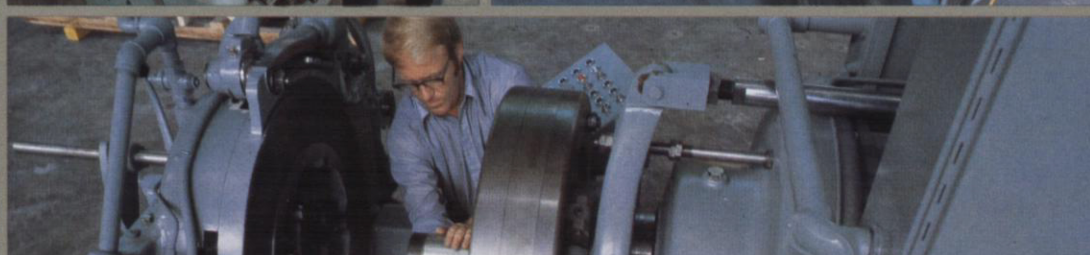
This Teledyne Landis coupling tapping machine is designed to produce precision internal threads for oil industry tubular couplings. Utilizing a receding chaser tap mechanism, the machine operates automatically so that one person can operate a number of machines simultaneously.

Pipe nipples are short lengths of pipe, threaded at both ends, that are widely used in the plumbing industry. This Teledyne Landis automatic nipple machine utilizes a hopper feed to produce completely finished 1/2 inch to 2 inch nipples at high production rates.







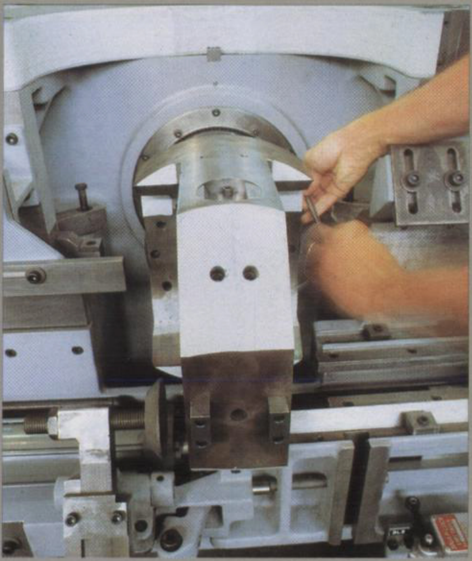


Gears, such as those for automotive transmissions, can be roll-finished to final tolerances on a mass production basis with this Teledyne Landis gear roll-finishing machine. The machine has a maximum rolling force capacity of 42,000 pounds and is typically used to produce gears in the 2 to 5 inch diameter range.

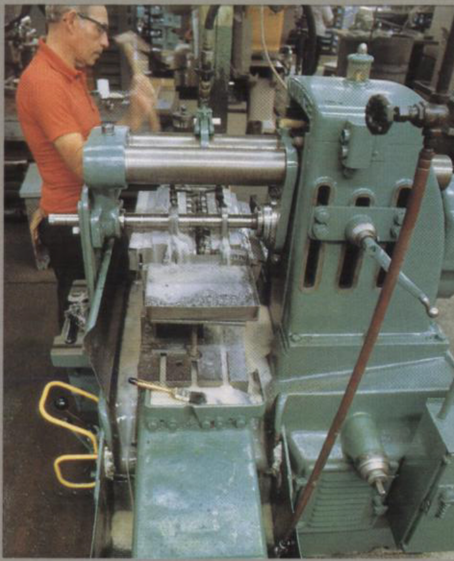
Precision tapered threads for oil industry tubular goods and high pressure pipe up to 8-5/8 inches in diameter are produced on this large receding chaser pipe threading machine. Other models are available with maximum capacities of 4-3/4 and 13-3/8 inch diameters.

Massive bed castings for one of the larger types of Teledyne Landis threading equipment are machined on a large planer that establishes the basic reference surfaces from which all other machining operations are measured and located.

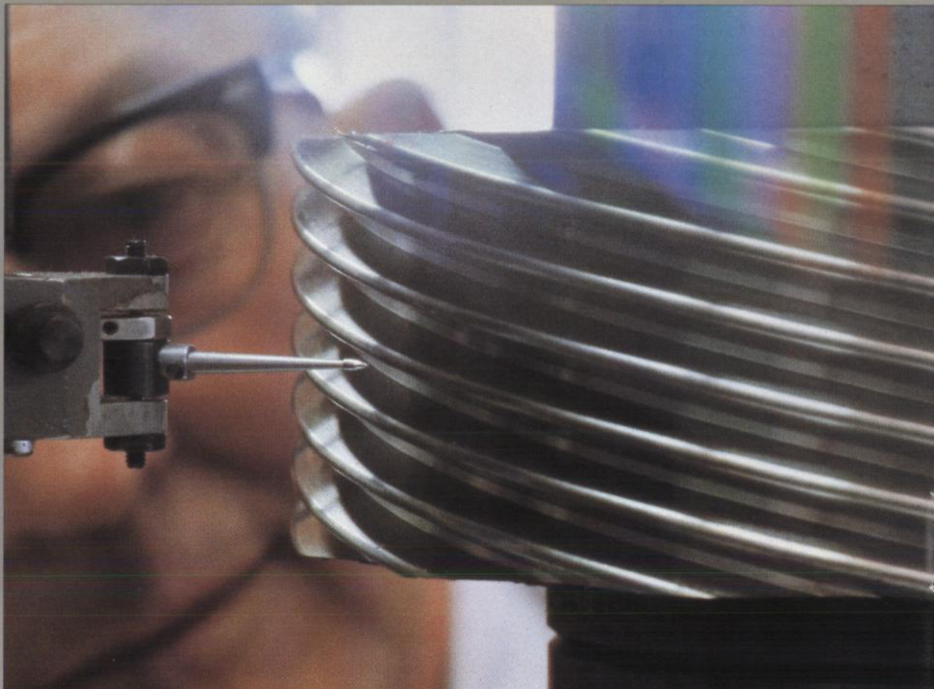
Many weeks of work are involved in assembling and aligning the hundreds of machined parts that make up a complete machine tool, such as this automatic coupling tapper. Since these machines must produce many millions of precision threaded parts, close tolerances are essential.



Perishable thread cutting tools such as tangential die chasers are produced from blanks of high speed steel. Angle surfaces that locate the chasers in the die head are first milled on one side of the blanks in this operation.



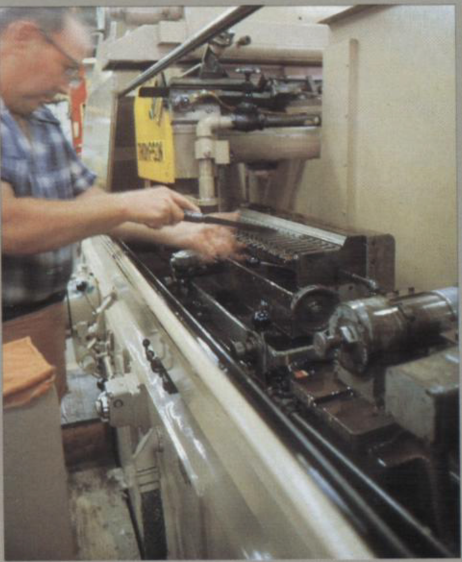
The headstock casting for an automatic coupling tapper is precision bored on this equipment which accurately positions and dimensions the holes that will locate the bearings, shafts and controls of the finished machines.

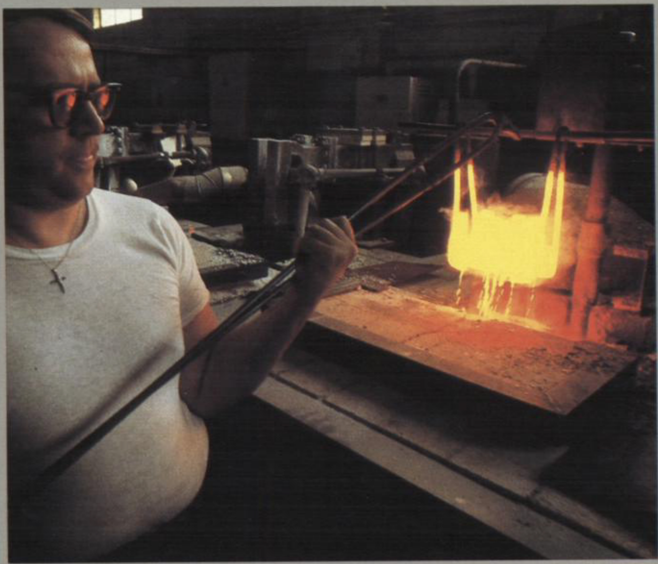


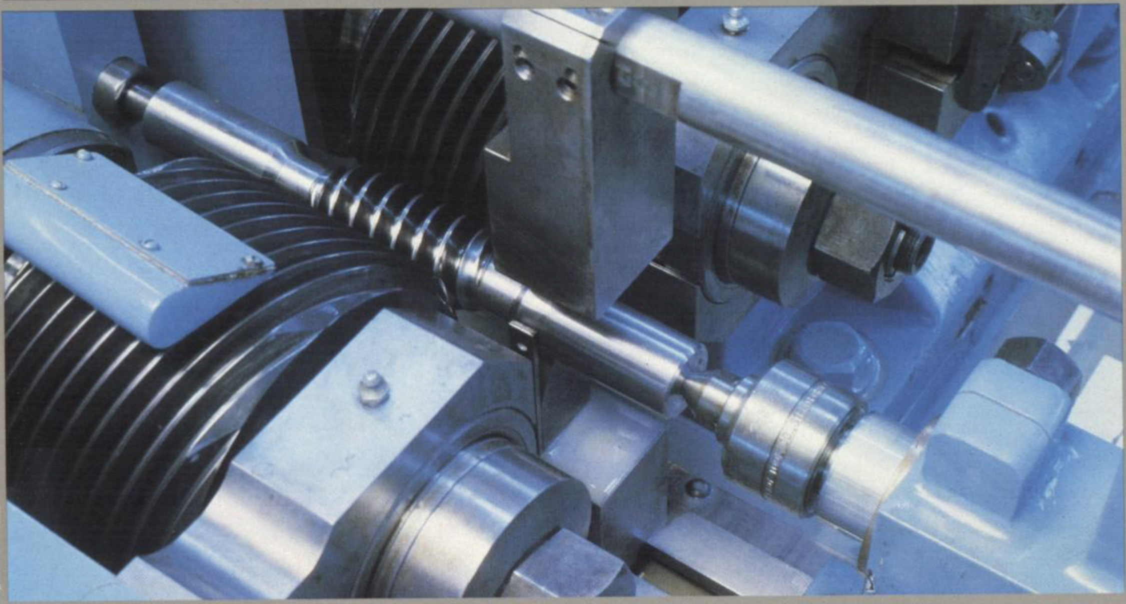
Special automated instruments are used in the quality assurance laboratory to measure the dimensional accuracy of complex geometric shapes, such as the surface of this worm rolling die which will ultimately be used by the customer to produce large volumes of precise parts.

Milled tangential chaser blanks then have the desired thread form ground into the blank with a multiple rib grinding wheel. The thread form extends for the full length of the tangential chaser permitting the cutting edge to be reground by the user until about 80 percent of its length is used up.

The final step in producing tangential die chasers is the careful heat treating of the machined blanks. This is done in a series of molten salt baths which bring the finished chasers to a typical hardness of Rockwell "C" 64.







Teledyne Landis Machine carries on extensive testing in its research and development department to assist customers in special applications of Teledyne machines, and to further the refinement of its own equipment. This 4-inch thread and form rolling machine is shown here testing a set of rolling dies that produces worms from a solid blank.

Making Threading Machines and Tools

rolling and vice versa. Thread rolling is not generally suitable for thin tubular material since the high die pressures may distort the workpiece.

OTHER THREADING METHODS

Another method of producing screw thread parts is by grinding. The grinding wheel can be a single rib wheel which grinds a single thread groove as the part is rotated and traversed against it, or it may have multiple ribs formed on its surface that grind several thread grooves at one time. Grinding is a slower and more costly way of producing threaded parts, but it is necessary for very hard materials and when precision threads are needed for parts such as machine tool leadscrews.

Thread forms may also be produced by casting, though this method is little used except for plastic pipe and fittings and some die cast parts.

FORM ROLLING

The same roll forming techniques that are applied to producing threaded parts can be used to make parts for power transmission and speed reduction gear boxes. One component, known as a worm, which resembles a coarse threaded shaft can be routinely mass produced on Teledyne Landis roll-forming machines, using specially designed dies. The parts involved range in size from small worms used in automotive windshield wiper drives, seat motors and power steering to extremely large ones used in industrial speed reduction or power transmission equipment.

ROLL FINISHING GEARS

The technique of roll forming has application in the mass production of precision gears as well. Gears are usually produced by rough-cutting the gear tooth form on a circular blank in a process called hobbing. The rough cut gear tooth forms are then machined to precise final shape and tolerance by a cutting process known as shaving.

The shaving process can be replaced with a roll finishing operation that is faster and produces closer tolerances over long production runs. Even though this roll finishing operation only moves or shapes a few thousandths of an inch of the gear's surface metal to bring it to finished tolerance, it produces a work-hardening effect and an improved surface finish on the gear teeth that makes a superior gear.

Teledyne Landis produces double and single die gear finishing machines. Two major U.S. automobile manufacturers, one manufacturer in France and one in Japan are currently using Teledyne gear roll finishing machines to produce automotive gears. Typical parts produced are helical pinions and sun gears for automatic transmissions and the entire gear train for manual transmissions. A U.S. manufacturer of heavy agricultural and earth-moving machinery is also producing tractor engine gears with the same type of equipment.

One Teledyne Landis 32TFG gear finishing machine replaces four shavers and in addition greatly reduces tooling costs. One set of gear finishing dies, for example, can produce about 10 times as many gears as one set of tooling for a shaver. Roll finishing pinion gears results in a typical cost saving of 30 percent compared to shaving.

THE MARKET FOR THREADING MACHINES

Most Teledyne threading and gear finishing equipment is heavy duty, high production, precision machinery that is used by industries that must produce parts in high volume. Consequently, the automotive, agricultural and construction machinery industries are large users of these machines, accessories and perishable tools.

Machines for threading pipe, electrical conduit and other tubular goods, on the other hand, are widely used by the construction industry and those industries that provide the pipe fittings, nipples, couplings and valves used.

The recent expansion in exploratory and production oil drilling in the United States and throughout the world has also greatly stimulated the demand for large capacity machines that can produce the exacting American Petroleum Institute threads required on the large diameter tubular goods used by that industry. This special thread standard was developed by the petroleum industry to provide improved strength, sealing effectiveness and accuracy.

INTERNATIONAL ACTIVITIES

Teledyne Landis supplies all these industries on a world-wide basis. In addition to its facility in Pennsylvania, the company operates manufacturing plants in England, Germany, Canada and Mexico.

The English facility produces perishable tools such as tangential chasers, tap chasers and solid taps, as well as certain models of die heads and threading machines that are sold world-wide. In Germany a line of equipment is produced that is complementary to the U.S. line. This line consists of high-speed machinery for finishing and threading long lengths of pipe in pipe mills, as well as pipe coupling tapping machines, pipe handling equipment and cut-off machines. This equipment is sold to pipe manufacturers in Europe, Asia and South America as well as in the United States. The Canadian and Mexican facilities manufacture tangential chasers only.

IMPROVING THE BREED

A continuing program of product development, in close coordination with present threading equipment users, is carried on by Teledyne Landis to improve existing machine designs and to fill out the product line with new machines that meet changing customer needs. Because of the size and complexity of some of this equipment, the production of a new machine from preliminary concept to the first completed machine may take two or three years. After some months of testing this prototype and with the attainment of satisfactory performance, the machine is officially introduced.

THE COMING WORLD OF METRICS

No discussion of the threading industry would be complete without reference to the world-wide movement toward a metric system of measurement standards. The first attempts at standardization of thread forms and dimensions began in the 1800's. The technique of mass production that depends on interchangeability of parts would not be possible without certain standards for screw threads. In 1841 the Whitworth 55-degree thread was proposed in England, and later became widely used. In 1864 the Sellers 60-degree form was proposed as an American thread standard because, according to Sellers, it could be made on one lathe while the Whitworth required two lathes and three kinds of cutters to produce. The Sellers thread was adopted by the U.S. Navy in 1868 for naval service and later became a generally used American thread standard. By the time of World War II there was a great drive to make the United States and British thread forms compatible which resulted in the Unified thread standard. This was a 60 degree thread form, very similar to the American National form. It was approved in 1948 by Canada, England and the United States, primarily for military need, and later became a widely used industrial standard.

Today, thread systems include the American National, coarse and fine series, the American National Acme, the Unified, coarse and fine series, the American National Pipe standard, and the American Petroleum Institute standard. Overseas are found the Whitworth and several variations of the metric including the French S.I. and the German DIN standards.

It is probable that certain specialized thread standards will remain in use, particularly pipe threads such as those used in the petroleum industry. Most other thread standards will gradually be phased out in the next few decades in favor of the I.S.O. (International Organization for Standardization) metric standard. This change will make little difference to the threading industry, since thread cutting tools and thread forming dies can be made to one standard as easily as another. Ultimately, the change will benefit manufacturers and consumers alike, through lowering of parts inventories, faster, simpler repair service and stimulated world trade. In any event the screw thread promises to be an important part of our lives for a long time.

Teledyne, Inc. and Subsidiaries

Consolidated Statements of Income

	Three Months Ended September 30,		Nine Months Ended September 30,	
	1978	1977	1978	1977
Consolidated Sales	**$588,487,000**	$550,710,000	**$1,787,920,000**	$1,621,206,000
Consolidated Costs and Expenses:				
Cost of sales	**431,990,000**	404,045,000	**1,328,911,000**	1,202,443,000
Selling and administrative expenses	**67,502,000**	66,765,000	**211,647,000**	200,336,000
Interest expense	**3,768,000**	4,218,000	**11,843,000**	12,749,000
Interest income	**(2,508,000)**	(2,400,000)	**(9,494,000)**	(7,348,000)
Provision for income taxes	**44,400,000**	39,400,000	**125,600,000**	108,700,000
	545,152,000	512,028,000	**1,668,507,000**	1,516,880,000
Income of Consolidated Companies	**43,335,000**	38,682,000	**119,413,000**	104,326,000
Equity in Net Income (Loss) of Unconsolidated Subsidiaries, after allocated interest expense and income tax items (excludes equity in unrealized appreciation (depreciation) on marketable equity securities)	**(1,402,000)**	17,604,000	**40,988,000**	26,163,000
Net Income	**$ 41,933,000**	$ 56,286,000	**$ 160,401,000**	$ 130,489,000
Net Income Per Share	**$3.24**	$4.29	**$12.29**	$9.91

Note—The consolidated statements of income for the nine months and three months ended September 30, 1977 have been restated to reflect the use of equity accounting for certain investments owned by the Company's unconsolidated subsidiaries. The use of equity accounting decreased equity in net income of unconsolidated subsidiaries and net income by $20,275,000 ($1.56 per share) and $27,874,000 ($2.15 per share) in the nine months and three months ended September 30, 1978, respectively, and increased equity in net income of unconsolidated subsidiaries and net income by $8,303,000 ($0.64 per share) and $3,501,000 ($0.27 per share) in the nine months and three months ended September 30, 1977, respectively.

Consolidated Balance Sheet

	September 30, 1978
ASSETS	
Current Assets:	
Cash and marketable securities	$ 201,761,000
Receivables	291,659,000
Inventories	170,547,000
Prepaid expenses	5,707,000
Total current assets	669,674,000
Investments in Unconsolidated Subsidiaries	482,577,000
Property and Equipment, less accumulated depreciation of $321,416,000	274,203,000
Other Assets	34,959,000
	$1,461,413,000
LIABILITIES	
Current Liabilities:	
Accounts payable	$ 101,019,000
Accrued liabilities	165,569,000
Accrued income taxes	37,400,000
Current portion of long-term debt	6,689,000
Total current liabilities	310,677,000
Long-Term Debt	277,483,000
Other Long-Term Liabilities	67,852,000
Shareholders' Equity	805,401,000
	$1,461,413,000

Review

QUARTER AND NINE MONTH RESULTS

Net income for the third quarter ended September 30, 1978 was $41.9 million compared to $56.3 million for last year's third quarter. Per share net income for the quarter was $3.24 versus $4.29 last year. Consolidated quarterly sales increased to $588 million from $551 million in the 1977 period.

For the nine months ended September 30, 1978, net income was $160.4 million or $12.29 per share versus $130.5 million or $9.91 per share for the nine months ended September 30, 1977. Consolidated sales for the nine months increased to $1.79 billion from $1.62 billion for the first nine months of 1977.

Teledyne's unconsolidated subsidiaries contributed a loss for the third quarter, as indicated in the consolidated statements of income and the related note on the opposite page. Insurance operations of the subsidiaries were satisfactory. The loss recorded was primarily the result of the use of equity accounting for certain investments of the subsidiaries, including an investment in Litton Industries, Inc. which reported a loss for its fourth quarter ended July 31, 1978.

During the quarter there were 12,944,216 average shares outstanding compared to 13,026,693 during the third quarter last year. During the nine month period there were 13,018,551 average shares outstanding versus 13,033,753 in 1977.

TELEDYNE FETRON DEVICE FINDS WIDE USE

Some five million Teledyne solid state devices called Fetrons have been sold to telephone operating companies to date as long life replacements for certain types of vacuum tubes in electronic equipment. Introduced by Teledyne six years ago, the major advantage of the device is that it can be plugged directly into existing tube sockets in the equipment without modification to the circuitry.

Because of their solid state nature and low operating temperatures, the estimated life of a Fetron is over one million hours, as compared to about 10,000 hours for the vacuum tubes they replace.

Fetrons are junction-field-effect devices specially designed for high breakdown voltages ranging from 300 to 400 volts. This permits them to be used in conventional vacuum tube circuits where high plate voltages exist.

Commercial telephone networks, where millions of vacuum tubes are used, provide a natural market for these devices. The maintenance cost for one major telephone system's tubes are estimated to be many millions of dollars per year. These tubes can be replaced by Fetrons for less than half of one year's maintenance bill, thus eliminating this recurring cost.

Millions of other tubes that could be replaced by Fetrons are still in use in all types of communications and radar equipment, where similar savings in maintenance costs could be realized because Fetrons do not show major drift or aging effects that are common to vacuum tubes.

Other areas of improved performance include lower noise and higher amplification factors than many types of tubes.

DOPPLER NAVIGATION SYSTEM TO BE PRODUCED BY TELEDYNE

Teledyne Ryan Aeronautical has been selected to produce a high performance Doppler Radar system for U.S. Air Force Fixed Wing Aircraft. The system is designated the Common Strategic Doppler Navigation System (AN/APN-218). It utilizes new state-of-the-art technology and is designed to withstand the nuclear environment.

The program will provide for the ultimate production of more than 900 Doppler Radars for installation in U.S. Air Force Tanker aircraft and B-52 Bombers.

This program is the latest addition to a series of Doppler Radar Navigation systems now being delivered by Teledyne to the U.S. Air Force and the U.S. Navy.

CRUISE MISSILE ENGINE ACTIVITIES

Teledyne CAE was chosen recently by Williams Research Corporation as the licensee to co-produce the Williams F107 turbofan engine which will be used to power various U.S. Navy and Air Force cruise missiles. The selection, which was made under the supervision of the Joint Cruise Missile Program Office in Washington, D.C., was made from competitive proposals submitted by most of the major U.S. jet engine manufacturers. An important factor that led to the selection of Teledyne CAE is the company's experience in developing and manufacturing jet engines of similar size.

Teledyne will thus share in the production of engines for the cruise missiles that are planned in sea, air and ground-launched versions.

The concept of a second source for the F107 engine as well as for all other components of the cruise missile is seen as a way to provide price competition as well as emergency capacity for the program.

Teledyne CAE was also selected recently for a second project that involves building a compressor, combustor and turbine components for a new turbine engine design concept that is eventually intended to be used to power a future generation of advanced cruise missiles some time in the late 1980's.

To be built for a project jointly sponsored by the Defense Advanced Research Project Agency and the U.S. Air Force, these engine components will incorporate advanced technology design techniques and state-of-the-art materials.

The concept called EXCENTRIC Turbine Engine was originated by Teledyne and is now in the early planning stages. The initial program will take approximately three years and could be followed by the assembly and test of a complete demonstrator engine.

TELEDYNE LAARS INTRODUCES NEW HEATING CONCEPTS

Teledyne Laars has introduced three new energy-efficient concepts in the spa, restaurant hot water and home heating fields.

The new spa and hot tub water heater, named the Spa/Mark, is available in two sizes that cover the majority of residential spa and hot tub needs. The 175,000 BTU per hour input unit will heat a 500-gallon spa from 70 to 100 degrees in about 50 minutes while the 125,000 BTU per hour input model will do the same in approximately 70 minutes.

The Spa/Mark comes with a new safety feature called Safe-T-Lok which allows the user to set the maximum safe water temperature desired and lock it in. This prevents the possibility of over-heating. Spa/Mark is available in an indoor model with a draft hood that vents gases to the outside, an outdoor low profile version with a non-corroding low maintenance aluminum grate top and in an outdoor model with a vent cap stack.

Teledyne Laars' Commercial Division is utilizing swimming pool heating technology in its restaurant hot water machine, which is obsoleting tank-type water heaters that are susceptible to liming and corrosion and require frequent replacement. By using the same proven thermally efficient copper tube heat exchanger that is used in Teledyne Laars pool heaters to heat very large volumes of water, the restaurant machine provides 180-degree sanitizing water and 140-degree potable water simultaneously.

The design principle involves moving small quantities of water through the heat exchanger at a calculated velocity—a velocity that prevents liming and scaling. The hot water machine, which has no storage tank to corrode, relies on its self-scrubbing heat exchanger and water recirculating throughout the system to keep it free of lime build-up. Besides greater reliability and efficiency, the Teledyne Laars hot water machine lasts up to 10 times longer than traditional tank-type heaters.

Teledyne Laars is entering the home heating field for the first time with its new Modutherm boiler. This unit offers an energy monitor control which automatically controls the operation of the circulation pump. When the heat is turned off, the pump remains on until all the heat in the boiler is carried into the heating system. No heat is allowed to go to waste.

Also featured as standard equipment on the Modutherm is an automatic flame modulation system which allows the gas valve to adjust the boiler input to match the heating load requirement. The boiler will only burn the amount of gas needed, thereby using energy as efficiently as possible.

The new Modutherm boiler weighs less than its competitors, which permits faster, easier installation.

NEW TELEDYNE JOB CORPS CENTERS

Teledyne Economic Development has opened two new Job Corps Centers, one located in Jacksonville, Florida and the other in Tucson, Arizona.

The Tucson facility can accommodate 250 students and offers courses of study in automotive skills, culinary arts, welding and electronics. Of the 250, about 200 students live at the center while the remaining commute from their homes.

In Jacksonville, there is also an enrollment of 250 students, with about 150 of them living at the facility. A broader range of vocational studies are offered at this facility because the community college and high schools in Jacksonville have offered to open up their classes to the Job Corps youths.

With the addition of these two new facilities, Teledyne now operates six Job Corps Centers around the country. Teledyne's activities in the Job Corps field are described in detail in the Third Quarter 1975 Teledyne Report.

PRECISION STEEL MOLDS COMPLETED

After one year of skilled machining, fitting and hand finishing, Teledyne Efficient Industries has completed one of the largest sets of precision steel molds ever manufactured for the production of sheet molding compound plastics. Each weighing from 80,000 to over 100,000 pounds, the five molds will be used to fabricate panels for a new line of large trucks to be produced by a major U.S. truck manufacturer.

Truck manufacturers are increasingly utilizing sheet molding compound fiberglass reinforced plastics for large truck cab parts, because of their light weight, corrosion resistance and lower cost.

1979 ART AWARDS

Awards totaling $8000 were made this year to winners of the seventh annual Calendar Art Contest for high school students, sponsored by United Insurance Company of America, a subsidiary of Teledyne, Inc. First place award of $1000 went to Delores Watkins of Vincennes, Indiana for her painting entitled "Summer Solitude," shown below. In addition to the cash award, her painting will appear on United Insurance Company calendars for the year 1979.

In addition to the first place prize, four $500 and fifty $100 prizes were also awarded.

This Teledyne Report features specialized Teledyne machine tools and accessories designed for high volume end finishing of pipe and other parts requiring cut threads, as well as for rolling or cold forming screw threads and power transmission worms, and roll-finishing gears for automatic transmissions and other machinery.

Teledyne Landis Machine produces about a hundred different models of threading and roll-forming machines with capacities from 1/8 inch to twenty inches in diameter. These machines are used for heavy-duty high volume precision threading or forming of parts used in the automotive, agricultural and construction machinery industries, for threading pipe and conduit for industrial and commercial construction, and for the production of specialized precision threads on large diameter tubular goods used by the petroleum industry.

Teledyne Oster produces a line of small portable threading machines designed primarily for the maintenance and construction industries, and small to medium size stationary machines used in medium volume production applications.

Teledyne Report featuring subjects of particular interest from Teledyne activities, is issued on a quarterly basis. Previous topics include:

Urban Waste:
Recovering energy and materials.

Aerial mapping:
Applying advanced digital techniques.

The Water Pik Story:
Innovative consumer product designs.

Dental Health:
Instruments, supplies and equipment for the dentist.

Space Navigation:
Computers that guide space launches.

Analytical Instruments:
Chemical detection for industry.

1776-1976:
Technology then and now.

Life Insurance:
Financial security and investment capital.

The Refractory Twins:
Producing tungsten and molybdenum.

The Instrument Makers:
Surveying instruments and optical encoders.

Industrial Engines:
Developments in small piston engines.

Job Corps:
Teaching young people marketable skills.

Friendly Explosives:
Aircraft emergency escape systems.

Microelectronic Hybrids:
The step beyond integrated circuits.

The Energy Options:
Nuclear fuel versus coal.

Workman's Compensation:
Extending the coverage.

Drilling for Offshore Oil:
Getting the oil out.

The Search for Oil:
Finding new oil deposits.

High Speed Steels:
Premium alloys for machine tools.

Energy Crisis in the Computer Room:
Controlling power quality.

Raydist:
Super-precise radiolocation system.

Welding:
Advanced alloys for joining metals.

General Aviation Engines:
Piston power for aircraft.

Rubber:
Diverse products for automobiles and industry.

Loran:
Improved all-weather navigation system.

Seismology:
Instruments for understanding earthquakes.

Casting:
Precision production of metal parts.

AIDS:
Monitoring commercial aircraft performance.

Thermoelectrics:
Direct conversion of heat to electricity.

Thin Metals:
How they are made and used by industry.

The Reproduction of Music:
Speakers for high fidelity sound.

The Crowded Spectrum:
Technology of microwave traveling wave tubes.

Science and Cinematography:
Motion pictures for scientific analysis.

Superalloys:
High temperature metals for the space age.

Jets of Water for Dental Health:
The Water Pik Oral Hygiene appliance.

The Last Eight Miles:
Doppler radar for moon landings.

TELEDYNE, INC.
1901 Avenue of the Stars
Los Angeles, Calif. 90067