

# Ford

## Automatic Transmissions

An Anecdotal History, 1951-2001



FORD

TRANSMISSION AND CLASSIC  
FAIRFAX PLANT



150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 100 200 300 400 500 600 700 800 900 1000

## Dedication

This brief, anecdotal history of the first 50 years of Ford automatic transmissions is dedicated to the thousands of men and women who have made Ford's Automatic Transmission business a success. Their talents, creativity, and dedication have contributed to making Ford Motor Company a leading world automaker.

## Ford's First Automatic Transmission: The Story Behind the Story

On the heels of World War II, America and Americans returned to living. As the country switched from wartime to peacetime, there came a torrent of new consumer goods. These inventions and adaptations reflected the welcome change from a military to a civilian economy. America was ride-hungry and car-happy and manufacturers vied with each other to produce cars that would take people wherever they wanted to go faster, cheaper, and smoother. Out of this fiercely competitive market came many new developments to make driving easier and safer. The single most important of these was the automatic transmission.

Oldsmobile had marketed the first fully automatic transmissions, called Hydramatic, in selected 1940 models. Buick launched its Dynaflo in 1948, as did Studebaker with its Commander. Packard introduced its Ultramatic in 1949.

By all indications, Ford was late to this party. Ford Engineering Vice President Harold Youngren was tasked with doing something about it. Having been hired away from independent transmission maker Borg-Warner, he wasted no time recommending to Ford that it license the very automatic transmission he had been working on when he left Borg. Tested extensively for durability and performance, it was pronounced superior to any other unit on the market. In the opinion of Ford engineers, this transmission was the answer to the Company's noncompetitiveness problem.

In the fall of 1948, long-term contracts were drawn up with Borg. Borg would fill half of Ford's anticipated automatic transmission needs for a period of five years, and Ford would be responsible to either make

the other 50% or subsource it elsewhere. Shortly afterwards, Ford broke ground in Cincinnati for a new plant to manufacture automatics. The Fairfax facility opened in 1950.

When the 1951 model year was introduced to the public, Ford-made automatic transmissions – Fordomatic and Mercomatic – were available for the first time. While initial volumes were small (Ford sold 11,135 units in MY 1951; Mercury sold another 7800), they climbed quickly.

The public approved. Enthusiasts recognized two distinct advantages to the Fordomatic product: 1) its inherent shift smoothness (due to influence of an integrated torque converter) and 2) its (then) radical détente/PRNDL placement, which put reverse next to park, and safely out of the way of inadvertent access! (Elsewhere in industry, the gear pattern was P-D-N-L-R.)

In making this technical leap to the automatic transmission in 1951, Ford belatedly caught a wave of customer preference. What was a mere wave in 1951 would become an overwhelming customer mandate, and the Company would ride it from that point forward.

## Kudos & Thanks

There have been many who have contributed to this anecdotal history of Ford's first 50 years of automatic transmission design and development. Through their suggestions, recall, viewpoints, enthusiasm, and written contributions, they have made this retrospective possible.

Chief among them are active employees Matt Lee, Bob Roethler, Tom Greene, Bruce Palansky, Paul Erlandson, Joe Sprys, Sandell Bennett, and Walt Muench. I am also indebted to outside author Philip Gott, whose excellent *Changing Gears* (SAE Press, 1991) is the authoritative history of automatic transmission development.



Contributing retirees: 220 years of Ford service!

Additional resources and information have come from Borg Warner, the City of Romulus, the Historical Society of the City of Cincinnati, and the National Automotive Historical Collection of the Detroit Public Library.

The project has also received wonderful assistance from Ford's Industrial Archives (Sandy Bialic, Bonnie Walworth & Jamie Myler), Ford Photographic (Dan Erickson), and Ford Creative Services (Chris Szetela).

Finally, the enthusiastic contributions of transmission retirees have been indispensable. I am particularly grateful to Karl Bornemann and Larry Burcz, and pleased to have had the counsel of Andy Paredes, Burt Jones, Sam Dabich, Clyde Juntunen, Stan Rosen, Marty Gabriel, Bruce Stapleton, John Schramm, Bob Thom, Stuart Maxwell, Frank Abar, Dick Byler, Paul Roberts, Bruce Simpson, Marge Lyons, and Jan Jandasek.

– Mike Imirie, Editor / ATEO Communications

## Shifting with Ease: The Early Days

In the early days of the automobile, the driver wore gloves, goggles and a long coat called a duster because the roads were dusty and handling the car was rough work. The toughest jobs back then involved keeping the motor running...and keeping the vehicle moving!

Keeping the motor running meant manually manipulating carburetor adjustments, speed controls, and ignition timing. Keeping the car moving meant working a clutch and manually picking an appropriate gear ratio to match road conditions.

In 1904, The Sturdevant brothers of Boston devised a system which automatically shifted the vehicle from low to high gear at 6 miles per hour. This was a great advance, but the shift always took place at the same speed whether the vehicle was going uphill, downhill, or on flat land. At that same time, others manufacturers were playing with planetary gear sets needing a manual apply but allowed flexibility of gear selection based on road or load conditions.

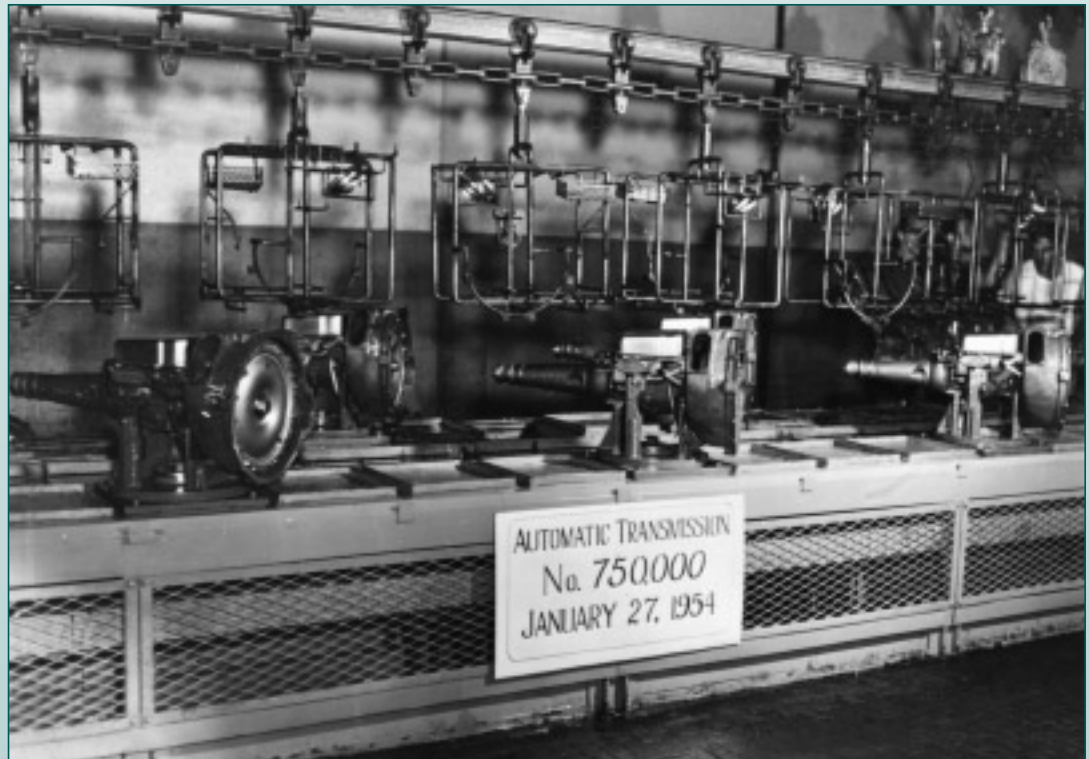
The most noted of these "almost automatic" transmissions was the planetary gear transmission used in the Model T Ford between 1908 and 1927. The use of pedal-controlled planetary gears made the Model T the "go anywhere" car. When mired in mud or snow, the car could be rocked free without clashing the gears, for low, high, and reverse were all functions of the planetary gear set. In all, over 15 million model T's were sold. Incredibly easy to drive by the standards of the day, the Model T was so popular that – by 1925 – one half of the cars on the road were Fords.

Improvements in manual transmissions forced Ford to adopt what Ol' Henry called "clash-gear transmissions" for a while. But automotive engineers remained fascinated by the possibility of self-shifters, and transmission developments continued in each succeeding decade.

In the early 1930's, an independent maker named REO – most famous for its line of Speedwagon trucks – developed a self-shifter transmission. The REO unit was the first truly automatic transmission. There was a clutch for stopping or reverse but all forward drive ranges were automatic. By the late 1930's, GM marketed the Oldsmobile Safety Transmission that eliminated the clutch. Due to engineering issues, it was only produced for two years.

The 1940's brought shifting innovations by Hudson, Packard, General Motors, and Borg Warner. Ford Motor Company kept a close watch in the development of the automatic transmission and decided to adopt a Borg design for the Ford/Mercury product lines and the GM's Hydra-Matic for Lincoln.

Early in 1950, Ford's Fairfax Plant (near Cincinnati) was chosen for initial transmission development and production of the first automatic transmission ("Fordomatic"). Early in the decade, Ford engineers strengthened and modified the unit for all Ford Motor Company applications. As horsepower increased and model proliferation expanded, Ford automatic transmissions met the demand for shifting with ease.



*Ford reached the milestone of 750,000 transmissions in the early days of 1954*

*by Matt Lee, Service Engineering*

# Reflections on Ford's 50 Years of Automatic Transmissions



Author Philip Gott

"History is more or less bunk." may be Henry Ford's most famous quote, but this founder of Ford Motor Company also built the Henry Ford Museum and Greenfield Village. He believed that one can best move forward if one is aware and respectful of his/her origins. It is therefore appropriate during the 50th anniversary celebration of Ford's automatic transmission operations to reflect on the past in order to move ahead with the efficiency, strength and knowledge that comes from understanding the heritage of ATEO.

Was the 1951 Fordomatic Ford's first involvement with automatic transmissions? Ford actually worked with Borg Warner to develop

two earlier automatic transmissions in answer to the "two-pedal driving" enabled by transmissions from General Motors and Chrysler.

For the 1942 model year, Ford worked with Borg to offer the Liquamatic Drive in the Mercury and Lincoln lines. Today this unit would be called a semi-automatic transmission: a "robotized" manual. It used a fluid coupling between the engine flywheel and a conventional clutch. It could be driven with the gear shift in "high" or 3rd gear position, but would start from a stop in second gear. It used a vacuum-powered actuator to upshift from 2nd and 3rd when the driver's foot lifted from the throttle, momentarily reducing driveline torque. Liquamatic was the first transmission to use the tang-in-slot method of constructing a fluid coupling or a torque converter.

For the 1947 model year, Ford was ready to offer another automatic transmission, the Livermore Automatic Layshaft Transmission. This Borg Warner development used a conventional countershaft layout, with a centrifugal wet-clutch for start up. Torque was interrupted by an automatic throttle-closer (forerunner of drive-by-wire in 1946!) to allow gear changes, eliminating the need for the driver to lift a foot to effect a shift.

Ford made an eleventh hour decision; its automatic transmission would have no interruption of torque. Instead, a torque converter must be used to be competitive with GM's Hydramatic. The Livermore program was scrapped despite sunk costs associated with production tooling, service training, tools, and manuals. Ford's 'no go' decision stressed the overriding importance of shift quality. It remains a governing industry-wide directive in automatic transmission development to this day.

So for the 1951 model year, Ford's 3rd production-tooled automatic transmission was introduced. Like its two predecessors, it offered a "first" that lives with us today. The 1951 Fordomatic was the first unit to use the now universal if somewhat modified "PRNDL" gear selector pattern. Placing neutral between reverse and forward gears helped to reduce the shift shock when changing from reverse and forward gears (or vice versa) and was a direct result of the mandate for smooth shifting. It also reduced the torque shocks to the driveline if one attempted to rock the car out of mud or snow by shifting rapidly from forward to reverse and back, etc.

Your predecessors were off to a great start. Early on they recognized the overriding importance of shift quality, and approached the transmission

development process in a very cost-effective manner. In fact, Ford's cooperation with Borg Warner could have been one of the earliest examples of the modern OEM-supplier partnership, with the supplier doing a major portion of the development work. Since then, Ford has shown a remarkable ability to evolve transmissions so that investments are minimized. In fact, the FMX, AOD, AODE, and the 4R70W can all be traced back to the original Fordomatic.

Ford has taken some technical risks to increase the value of the automatic to the corporation. The phenolic stator has long been heralded as a major victory for the plastics industry while providing cost and weight savings for the customer.

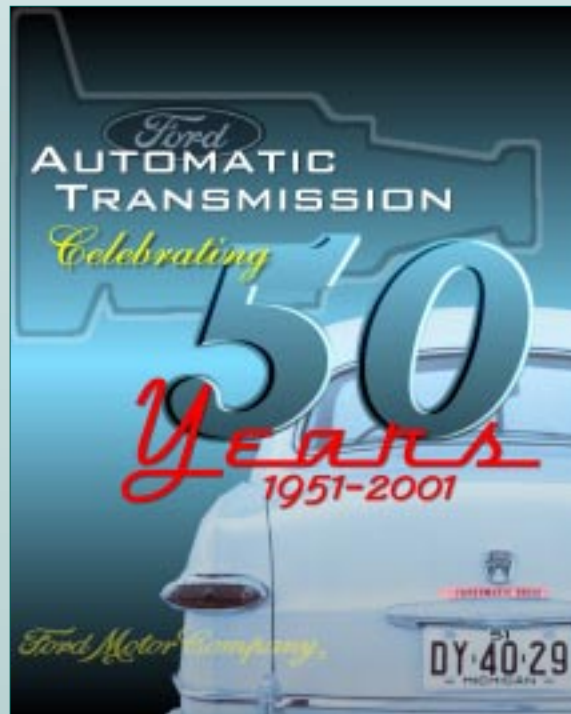
Another outstanding example of Ford's suc-

cessful use of new technologies to reduce costs is its 'C' family of transmissions. The first family of 100% Ford in-house designs, this transmission family incorporates the Simpson gear set, perhaps the lowest-cost planetary system ever designed. The C-series includes the C3, a 1974 offering that is the primary ancestor to the 5R55E and the 5R55N: one of the fastest-responding, manually "shifted" automatics in the world today.

The C6 is an interesting example of the robustness of thought that went into this

transmission family. Design goals for this transmission as stated by Ford's Greer and Schulz in SAE 66075 were:

- Should fit into existing and new model cars with minimal changes to surrounding components.
- Should have sufficient shift smoothness and low noise level to assure a competitive position for the foreseeable future.
- Durability should be good enough to be compatible with longer warranty periods at reasonable cost.
- Torque capacity should be great enough to handle future engine torque increases.



Reflections on Ford's 50 Years of Automatic Transmissions (continued from page 4)

- e) Transmission weight should be as low as possible yet consistent with cost, durability, capacity and installation requirements
- f) Design should provide space and compatibility to incorporate certain features under consideration for future units.
- g) Field or service adjustments should be accessible from transmission exterior.

It's interesting how these design goals focus on cost reduction. They embrace the cost-saving strategy of using C6 as the basis for current as well as future needs. To keep costs low, the C6 used more powdered metal than any prior automatic transmission, taking advantage of the low costs associated with its near-net-shape capabilities. A full 10 pounds of powdered metal was used in this unit, which was remarkable for the mid-1960s. It was the first transmission in the world to use Borg Warner's flexible shift band, thereby improving lifetime durability and shift quality. While C6 was the last of the C-series, many of its design goals are still valid today.

The AOD transmission was first conceived shortly after the C6 was launched. This development came before its time, however, as fuel economy was not a high priority on anybody's agenda in 1966. When it was launched in the 1980 model year, the AOD was the first of a new family of transmissions; it was the first 4-speed automatic to have an integral 4th gear instead of an add-on. Its split-torque converter was a creative, low cost means of offering efficiency approaching that of a lock-up torque converter. This transmission buoyed Ford's boast that it had perhaps the most fuel efficient luxury cars in the world.

North American Ford developed the company's first front wheel drive transaxle in the early 1960s: a manual unit. It was produced in Cologne for the 1962 Taunus and featured co-axial input and output shafts to reduce overall powertrain height. This design was the result of extensive reflection on prior art. In 1959, Ford engineers overhauled a front drive Cord and used it for testing and assessment purposes!

By modern standards, however, Ford's most pioneering achievements must include the CTX. Ford produced this metal-belt CVT, based on the van Doorne push-belt, for many years and probably has more experience with this type of transmission than anyone else. One design that became public due to Ford's use of government funds was the Forster CVT. It was configured somewhat like a bevel-gear differential, with rollers transmitting driveline torque via pure traction to flexible steel discs. The curvature of the discs was varied hydraulically, and determined the contact point of the roller on the disc – and hence the input/output ratio. With such a background, who better to partner with ZF to introduce the next generation of automatic transmissions?

What can we take away from this reflection on Automatic Transmission's past? From the outset, Ford had a focus on smooth shift quality. When Ford took up the challenge to "go it alone" in the field of automatic transmission design, cost reduction and interchangeability with current and future designs were added to program objectives. More recently, specific references to customer satisfaction and parasitic loss reduction have undoubtedly been added as well. Achieving all of these objectives simultaneously requires maintaining a very delicate balance. The past 50 years provides an excellent foundation on which to build. Clear objectives, proper balancing of priorities, optimal use of suppliers and calculated technical risk taking appear to be the hallmarks of Ford's automatic transmission successes.

**Congratulations on the first 50 years!**

*by Philip Gott, Author of Changing Gears*



1951 Ford

*"Every car has a transmission. It is the collection of gears and clutches and/or other devices that connect the engine with the final drive. Above all other vehicle systems, the transmission tames the spinning fury of the engine, born of internal fire, and allows it to be harnessed by the most novice, frail, or delicate of drivers."*

*– Philip Gott, Changing Gears*

# Romulus: ATEO Origins

The building even *smells* old.

Located at the dusty intersection of Huron River Drive and Northline Road in Romulus, this industrial complex seems a place forgotten by time. For sale since 1999, it has an air of quiet delapidation about it. Weeds grow in the parking lot. Tatters of sun-bleached cloth hang from the three flagpoles in front. Paint flakes from wooden surfaces. A glimpse inside the administration building windows reveals only emptiness. Clearly, it's a place where significant "activity" no longer takes place.

But it hasn't always been that way...In fact, this long ago industrial site in Romulus was the very first home of Automatic Transmission Engineering, way back in 1954. Employing upwards of 800 Ford people, in fact, it was once an engineering heartbeat for Ford Motor Company.

The post-war years were growth years for Ford. As the Company and its product lines expanded, so did its engineering workforce. While it was once easy to contain staff growth within Dearborn, it became increasingly difficult in the years after World War II.

When the Company had the option in mid-1954 to lease a suddenly surplus Navy site in Romulus commissioned to build jet engines for the Korean War, it took the option. Not only would that facility be a brand new and typically accommodating

Albert Kahn structure, it would permit Ford to strategically group certain engineering staffs together.

Ford Engineering Vice President Earle MacPherson explained the prospects succinctly in a 1954 interview: "Ford's expansion and our accelerated engineering programs make it necessary that we have additional space.



*A deserted security check point*



*The lobby entrance*

Transmission, Axle Engineering, and Advanced Transmission.

Another was the very first Transmission Engineering group under H. G. 'Doc' English. That embryonic group had formed in the red brick Research Building along Oakwood Avenue in late 1951. By mid-1953, the team had grown to between 25 and 30 engineers. "Everything was expanding," observed retiree Burt Jones. "We were growing out of our shoes!" The public's enthusiastic response to the automatic transmis-



*The forlorn employment office*

While construction on new Engineering Staff buildings in Dearborn will soon begin, it will be some time before they're completed. In the meantime, the Romulus Plant will provide us with a modern facility only a short distance from the Research and Engineering Center. It will help relieve crowded conditions here." Ford's lease would run for three years with an option to renew. Under its terms, the Company would operate a portion of the site and have custodial responsibility for it all...even the jet engine test cells



*Watch tower, complete with gun port*

(continued on page 7)

*Romulus: ATEO Origins* (continued from page 6)

sion suggested far greater growth in the years ahead.

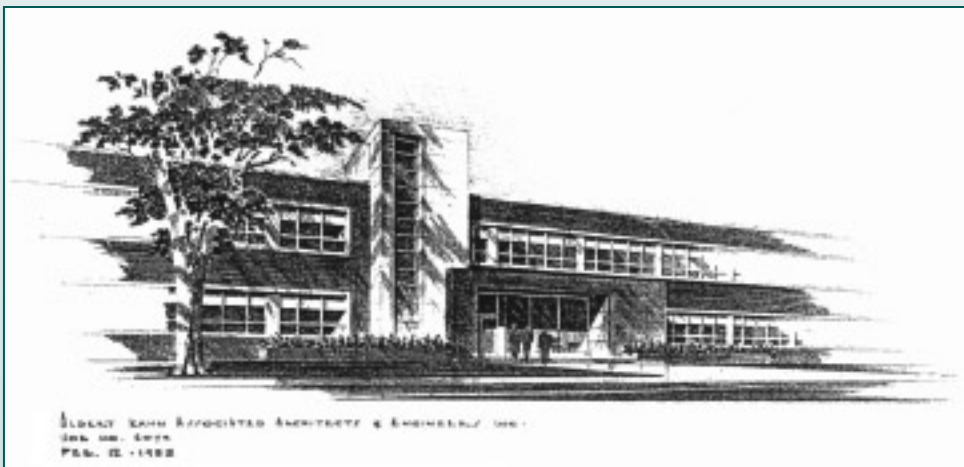
The move to Romulus was formative for Transmission Engineering. To begin with, the site permitted necessary growth for Transmission's fledgling staff. It also carried the convenience of on-site garage, build up, and machine shop facilities. And – with the still young I-94 freeway (then called 'the Willow Run Expressway', after its World War II purpose of moving employees quickly from their Detroit homes to the plant) only moments to the north – there was a built-in, very robust test track not far away! Engineers saw the ten mile distance between Dearborn and Romulus as ideal for putting even the most untested transmission through its paces. Door to door, it was said to be no more than a fifteen minute ride for the 'determined' driver!

Retiree Dick Byler had this description for the new Automatic Transmission team in Romulus: "The automatic transmission was so new that Ford didn't have much collective knowledge. But we were good engineers, and it didn't take us long to learn." He pointed out that this Ford group sometimes referred to itself as "the Little League (of Nations)" because more than a few of its engineers had emigrated here from Europe after World War II.

Retiree Marty Gabriel viewed the transmission team as "a multi-talented research activity." It was a fast-paced operation," he remembered. "We had our own shop, which gave us the freedom to design and deliver."

By 1957, the wisdom of collocating with manufacturing at the nearby Livonia Plant had become increasingly clear. Livonia's on-site dynamometer and test track facilities made such a move more attractive still. Over a period of months beginning in April, the Transmission engineering staff migrated. It took up quarters on both floors of the southwest corner of what's now called the ATO Building. The Romulus site reverted to the U.S. Navy, which ultimately sold the entire site to Kelsey Hayes for – it is rumored – pennies on the dollar! It served as Kelsey's World Headquarters for more than forty years.

*by Mike Imirie, ATEO Communications*



*Romulus site ground-breaking ceremony in 1952. Henry Ford II is at right.*

### Romulus Recollections from Retirees:

- "Those roads near the airport were great for wide open throttle shifting!" – **Clyde Juntunen**
- "We were given a lot of responsibility, doing development work well beyond Borg-Warner." – **Burt Jones**
- "It was a small place. You knew where everything was." – **Marge Lyons**
- "Morale at Romulus was terrific. We knew we were working on the product of the future." – **Stuart Maxwell**
- "In the early days, our 'transmission culture' grew from within." – **Bob Thom**
- "When we parted company with Borg Warner, it was a non-event. We'd been adding capacity – and smarts – all along." – **Sam Dabich**

## Fairfax Plant: Fordomatic's 1<sup>st</sup> Home

Ford's 'greenfield' Fairfax Plant occupied a 51-acre site in Hamilton County, Ohio, east of Cincinnati. A former property of the Pennsylvania Railroad, the site would contain a 635,644 square foot manufacturing facility. Groundbreaking took place in 1949.

After a total investment of \$17,500,000, the plant was dedicated on May 23, 1950. Press releases of the time boasted of "an air conditioned final assembly section, up-to-date industrial medical department, modern locker and shower rooms, non-skid floors, glare-reducing windows, and fenced and paved parking areas." In August, Ford Manufacturing Vice President Del Harder predicted: "When completed and in manufacturing production, it will stand as Ford's most modern plant and will serve as a pattern for the design and construction of future manufacturing facilities."

Using a design licensed from Borg-Warner, Ford began initial production of its Fordomatic three speed automatic transmission at Fairfax in August of 1950. During the Korean War (1950-53), Fairfax was tooled up in part to manufacture aircraft engine parts.

In January of 1953, a memo from Manufacturing Staff noted "...the Company now has transmission capacity at its Cincinnati Plant for 1000 ...units per day." Another memo reported that about 400,000 3 speed automatic transmissions were made annually from 1950 through 1971.

The Fairfax Plant was officially closed in October of 1979. Given its fully utilized real estate, the age of much of its machinery, dated heat treating facilities, and limited floor space, it proved more economical for Ford to build a third Cincinnati-area factory than to renovate its oldest. Employees transferred either to Sharonville or the newly opened Batavia Plant, and the building was ultimately sold to a firm called Red Bank Distribution.



*Fairfax Plant: bird's eye view*



*Extension housings being machined, late 1950s*



## 1951: The Anniversary Year in America

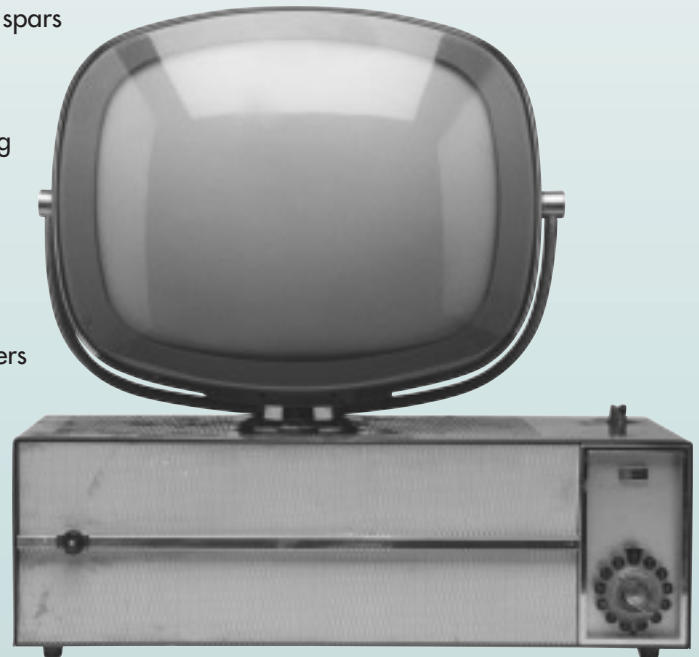
1951. On tiny, snowy black and white television screens, Lucy spars with Desi, Sgt. Joe Friday tracks down bad guys, and Perry Como, Dinah Shore and Eddie Fisher reach for the high notes. Kids play with the latest game – ColorForms! Young vets are getting on with their lives – going to college on the GI Bill, building families, buying houses. The mood is optimistic. After years of want brought on by the Depression and WWII, a wave of expanding affluence is sweeping the country.

Tagged as bland and boring, the early 50's seem comfortable and conformist. Yet beneath the surface of these placid years are many quiet beginnings. Some will stir the water in years to come.

People want to buy. In the years right after the war, auto workers make about \$60 a week, and they want homes and cars and the latest appliances. Mass production techniques are applied to home building, bringing the dream of a house within reach of many. Roads improve. Farm land opens up. Suburbs sprout. And what better way to get to the 'burbs than a brand new automobile?

With new cars, Americans are on the road. In 1951, the idea for the first motel chain, Holiday Inn, is envisioned, its very name reflecting the buoyant spirit of the era. And even the working class guy can take his family out to dinner; after all, the McDonald brothers are applying mass production theories to the hamburger!

Television takes big steps in 1951 with the first transcontinental broadcast, a speech by President Harry Truman. Later, Senator Estes Kefauver's investigations into organized crime transfix the entire country. Color is transmitted for the first time – a 4 city broadcast of Arthur Godfrey's show – but it ultimately fails and it is several years before it catches on.



*by Sandell Bennett, Technical Library*

### Another Impact: Appeal For Women

**B**efore she died in 2000, I asked my 85 year old grandmother for her view about the kind of change that the automatic transmission represented.

The biggest change that came to her mind was how the automobile market opened up for women. To begin with, driving with a manual transmission in the years before 1940 was a physical chore! Not only that, many in American society viewed it as unladylike. The availability of automatic transmissions made driving and even owning an automobile much easier for women.

My grandparents were one of the very first couples in their north Chicago neighborhood to have a car with an automatic. It was a 1940 Oldsmobile, and were they tickled! Grandma was the envy of all her neighborhood girlfriends because she could now drive a car every bit as well as her husband. This innovation was the very first to bring women into new car showrooms in large numbers. It would begin a profound marketing change for automakers; soon, they'd begin designing more and more – styles, colors, and accessories – for American women who were making their way into the marketplace.

It's easy for me to agree with my grandmother's view. In more ways than one, the automatic transmission was the device that got 'em there!



**1940's OLDSMOBILE**

*by Steve Partlow, ATDL*

Research and Layout by **Bob Roethler**  
 Graphics by **Sally Juenemann**

# Ford Motor Company 1951 -

"X"  
FAMILY



1951 Fordomatic



1958 Cruise-O-Matic



1969 FMX



1973 CW  
Borg Warner FMX



1958 Fordomatic 2-spd



1964 C-4



1977 Jatco

"C"  
FAMILY



1966 C6



1974 C-3

1950

1955

1960

1965

1970

1975

FWD  
IN-LINE

FWD  
U-DRIVE

M/T &  
OTHERS



1962  
Cardinal



1959 Select-O-Speed  
Tractor 10-spd  
Powershift

NO PICTURE AVAILABLE

1963 3.03 CD  
Fully Synchronized  
3-spd M/T

1964  
3.25 CD  
4-spd M/T



1977 Mod-4



1979 S  
Aluminum  
ATF in

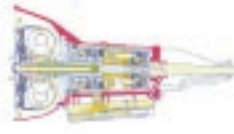
# Many Transmissions - 2002



1980 AOD 4-spd



1992 AODE



1993 4R70W



6R



3N71B



1982 C-5



1989 E40D



1999 4R100 w/PTO



5R110W



1985 A4LD



1997 5R55E



2000 5R55N



2002 5R55W

1980

1985

1990

1995

2000

Future



1981 ATX



1987 CTX CVT



1994 CD4E



1999 4F27E



ZF-Batavia  
CFT 23



1986  
AXOD



1993  
AX4S



1995  
AX4N

NO PICTURE AVAILABLE



1981 MTX I  
4-spd



1983 MTX 3  
5-spd



1986 MTX 4  
HD 5-spd



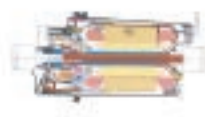
ROD  
in Case  
M/T



1981 M5OD



1988 M5OD-R1 & R2  
By Mazda



1991 Ranger  
EV Prototype



Escape Hybrid

# Automatic Transmission Eras at Ford

**A**s we celebrate the 50-year milestone of automatic transmissions at Ford, a short review of the advances and adaptations that this essential device is more than appropriate. This novel option of the 50's, after all, is now the dominant choice for getting engine power to the wheels. In the United States, automatics have an installation rate above 90%. Japan has a similar preference for automatics, with only Europe and the other developing markets still deferring to manual transmissions.

This five-decade history can be described through five distinct eras. These eras defined changes taking place at Ford and – indeed – throughout the entire industry.

## 1939 – 1955: Early Development

The history of automatic transmissions actually begins some time before the Ford introduction. General Motors introduced the first fully automatic transmission. Called Hydramatic, it was a four-speed with fluid coupling installed on the 1940 Oldsmobile. Several other automatic designs were produced by the industry, but – by 1951, when the Fordomatic was introduced – it contained features still recognizable in most of today's automatics. This inaugural Ford automatic – a 3-speed designed and licensed by Borg Warner – had a three-element torque converter and planetary gearing. Drivers noticed the now familiar “PRNDL” detent arrangement, which was introduced by Ford. (Industry experts later conceded that Ford's new gear positioning improved upon the [then] current industry standard, in which reverse was located at the bottom right.)

This transmission later evolved into the FMX and is the fore bearer of today's 4R70W. This lengthy, successful genealogy might lead one to believe that old transmissions never die; they just shift gears!

## 1956 – 1976: Standardization of a Maturing Technology

During this twenty-year period, the industry adopted the three-element torque converter, the Simpson set of simple planetary pairs, and aluminum casing. All of these innovations were found in the C3, C4, and C6 introduced by Ford in this era. This “C” series of transmissions was marketed under the name ‘Cruiseomatic.’ These 3-speed transmissions formed a family spanning all available Ford engine sizes; they afforded an automatic option on almost every Ford product.

The C3 was Ford's first international automatic. It was manufactured in Bordeaux, France. This design was also the basis of the first automatic from JATCO in Japan.

The C6 became an industry standard for automatic transmission durability. It put credence in the Company's long-running “Built Ford Tough” slogan. Production of the C6 continued well into the 1990's due to the popularity of this robust transmission.

## 1977 – 1988:

### Fuel Economy Emphasis and Front Wheel Drive Introduction

The drive for improved fuel economy had no single cause. It gradually followed the environmental awakening of the 60's and ensuing legislation. It was given voice by the oil embargo of the mid 70's. It gained momentum via competitive pressure from the emerging Japanese automobile juggernaut. All of these forces worked together to make the need for fuel-efficient vehicles a veritable mandate. Transmissions of the time contributed significantly to this need. The AOD was the industry's first integral 4-speed transmission with an overdrive gear. It provided over 20% improvement in fuel economy, and customers noticed! The C5, ATX, A4LD, and AXOD introduced during this period all provided fuel improvements. ATX and AXOD were additionally designed for the front wheel drive powertrain.



1951 Ford dashboard

Introduced in Europe, CTX was one of the first steel belted Continuously Variable Transmissions (CVT) on the market. First installed on the 1988 Fiesta, this transmission was a leading edge technology. Fuel economy was once again the impetus for bringing this product to market. Our ZF-Batavia products are descendants of the CTX.

## 1989 – 2000:

### Electronics and Computer Controls

While fuel economy was still the major motivation for new transmission designs, electronics put its mark on every new product. Electronics offered the opportunity to more precisely and accurately control powertrains, which might also be simpler and less costly. E4OD (now 4R100) was Ford's first electronic shift schedule and hydraulic pressure controlled transmission. The AXOD-E (now AX4N and AX4S) soon followed along with the 4R44E, FN (4F27E) and CD4E. The 5-speed 5R55E and subsequent ‘N’ and ‘W’ designs were also introduced in this time frame.

## 2001 & Beyond: More Fuel Economy

Opportunities for further fuel economy lie ahead, and new Ford transmissions will leverage these opportunities. The designs being explored today include 6-speed automatics, belt and traction drive CVTs, automated manual transmissions, and hybrid power trains. Each of these approaches has its own set of compelling reasons for being used.

Which one you'll find on your next vehicle remains to be seen. With all the technology choices now under study, it is no less an exciting time to be working on transmissions today than it was in 1951, when the Automatic Transmission Engineering arm of Ford Motor Company was in its infancy.

*by Walt Muench, Scientific Research Lab*

## The Emergence of Electronics

Over the last 10 – 15 years, Automatic Transmission Control systems have migrated from Hydraulics to Electronics. Anyone who buys computers knows that every year, prices drop while function and quality improve. In order to provide the sophisticated controls necessary to deliver customer, regulatory, and corporate requirements in our products, electronic controls are becoming a larger part of things automotive, just as in all major consumer goods.

In addition to the cost benefits, today's new electronic control systems improve control; they are much more sophisticated. The old hydraulic control system senses output speed, engine vacuum (or throttle opening), 'kickdown,' and shifter position in order to determine when and how to change gears. With today's in-vehicle networks, the control system has dozens of inputs available to help determine the best gear to be in...and the best way to get there. Think of yourself as a system like the transmission, with your brain as the computer, your muscles as the actuators, and your senses as the inputs. Consider the job of controlling a bicycle. If you only had sight, you could do a reasonable job of getting from one place to another. Adding hearing would improve your safety and let you get there faster since you wouldn't have to be constantly looking around for things

like approaching vehicles. Add feel and you can better adjust to changing road conditions. Even small can help; it might direct you to select a more enjoyable route! In the same way, additional inputs (senses) help the electronic controls deliver improved transmission function.

Finally, electronic controls have increased the number of calibration changes which can be made and evaluated in the shrinking time available for vehicle development. It used to take a time-consuming trip into the garage and a valve body R&R to make a simple change to a shift schedule. With today's electronic controls, the same change can be made in a matter of seconds while evaluating the vehicle.

by Bruce Palansky, Transmission Electronics

## Ford's Tranny: The Name Game

Good names don't just happen. Instead, they're articulated, explored, tried on for size, and practiced. Finally, a well-placed group of stakeholders makes a binding decision. The result of this extended process? A good name!

The case of Ford's first automatic transmission was no exception. Through the combined efforts of Ford Merchandising, the Office of General Counsel, Ford Division, the J. Walter Thompson Advertising Agency, and even *Time Magazine*, more than 1,500 names were volunteered. In June of 1950, after hundreds of hours of formal discussions, informal water cooler chats, and focus group deliberations, the "Fordomatic" name was selected, with Mercomatic being chosen for the companion Mercury carline. Interestingly, the Fordomatic name was actually suggested by one Eleanor Knapp, an employee of Industrial National Bank in Detroit.

The many other suggestions generated along the way typify the times. Each sounded more colorful and tried to be more purposeful than the next. Among the best of these also-rans were:

Superflow	Plantetron	MultiMagic
Aeroflite	Velvastream	Silentking
Facilitron	Economatic	Econodrive
Flitestream	Firstaway	Wonder Drive
Rythmatic	Easodrive	Pleasure Drive
Instamatic	Cyclodrive	MelifoDrive

The unusual "MelifoDrive" suggestion was very democratic. Its first six letters abbreviated all three of Ford's circa -1951 carlines: Mercury, Lincoln & Ford!

**VELVASTREAM**  
**FIRSTAWAY**  
**MultiMagic**

One of the failed ideas called for the name "Youngren Drive." As Ford's Engineering Vice President was named Harold Youngren, I'll presume it was the fawning handiwork of an overzealous employee!

## Transmission Fluids: The First 50 Years

This article provides a brief overview of the transmission fluids Ford has used in its first 50 years. While engine oil cools, lubricates, and cleanses, its transmission counterpart does all of those things while serving as a robust signal medium in the hydraulic controls and – at the same time – playing a major role in torque capacity and shift feel!

In the early days of the automatic transmission, from 1949 to 1960, most cars used Type A or Type A/Suffix A transmission fluid. Since General Motors brought the first automatic transmission to the mass market, it was no surprise that its Type A fluid was the basis for fluids used by other carmakers. Ford was no exception; its earliest fluid – M2C33A – was derived from GM's technology.

From our earliest physics classes, we learned that the static coefficient of friction is higher than the dynamic coefficient. This type of fluid comes under the classification of a friction-modified fluid; this means that the static friction characteristics have been modified (reduced) to come closer to dynamic coefficients.

In 1958, "lifetime fill" became an objective at Ford for fluid development. Ford's earlier fluids were not lifetime; they used short drain intervals to maintain the properties of the fluid during use. The need for more robustness was brought on by greater stress, increased traffic, growing customer trailer towing requirements, and more powerful engines. All contributed to the demand for a better fluid.

Ford's next generation fluid was released in 1960. Designated M2C33D, this fluid improved on its Ford predecessors and other transmission fluids available in the marketplace. This fluid was not friction-modified; its static coefficient was higher than the dynamic coefficient. In addition, it had increased oxidation resistance and tended to prevent sludge and varnish formation. This specification also introduced a test using a full sized transmission for oxidation resistance: "the Mercomatic Oxidation Test." This test raised the test temperature from 275F to 300F. The final improvement of this technology resulted in the last two specifications of non-friction modified fluids, M2C33F and M2C33G. In fluid terminology, "Type F" came to mean "Ford unique."

Because of an engagement clunk problem in some transmissions, a return to friction-modified fluids occurred. It was released as M2C138CJ in



*Mercon transmission fluid*

1973. Many friction-modified fluids were released after CJ. With each new release, the purpose was to improve the technology or eliminate a problem. The succession of fluids involved M2C166H (1980), M2C202B (1995), and – the latest – M2C919D (2001). M2C166H was developed to eliminate a shudder problem with the centrifugal lock up converter. The B fluid was developed to improve anti-wear performance and reduce torque converter shudder on piston type lock up and modulated converters. The D fluid is being used to improve fuel economy and eliminate some dermatological problems.

Over the past 50 years, transmission fluid development has been anything but a stagnant science. Although each change has required considerable effort, each new fluid level has uniquely supported new levels of transmission performance.

*by J.W. Sprys, Fluid Controls*

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## Impressive, Time-honored Pedigree: C3 to 5R55

Did you know that the highly-regarded 5R55 used in Lincoln LS and the new Thunderbird had its origins in the early 1970's in Advanced Transmission? At that time, Ford needed a small size 3-speed for its 1974 Mustang II and Pinto applications. Beyond those specific needs, future 4-speed versatility was desired. We investigated numerous 3 and 4 speed gearing arrangements. A scaled down version of the C6 & C4 using the tried-and-true Simpson gearset was selected and a production group was formed in 1970 for a Job #1, 1974 program. Thus was born the Bordeaux-built C3.

Concurrent with production of C3, an Advanced Group worked on a 4-speed version of this transmission. A simple planetary gear set was

added to the front of the C3 with a band and clutch arranged to give an underdrive ratio. The case, pump, and controls (among other key C3 parts) were designed to easily accommodate the 4-speed version in production at some future time with minimal facility changes. When the A4LD finally went into production in 1985, the basic advanced design was used except the functions of the add-on band and clutch were reversed to give an overdrive rather than an underdrive ratio.

*by Karl Bornemann, Retiree*

## Fuel Crisis: Transmission Responds

The public probably believes that gasoline shortages in the 1970's led to industry requirements for more fuel-efficient powertrains to meet CAFE standards. In fact, Ford Advanced Transmission Engineering was working on several fuel-efficient designs in the early 1960's. Examples? Powertrain matching of gear ratios and torque converter characteristics to engine torque output and vehicle applications, for one. And C6 add on overdrive with lock-up converter, for another! At Advanced, such ideas were investigated early and concept feasibility was demonstrated via prototype hardware.

One such circa-1962 program was called the XT-LOD (extension lock up overdrive). Based on the 3 speed FX/MX transmission, it was a four speed unit using a Ravigneaux gear set with overdrive top gear and a split torque input in third and direct drive in overdrive with no provisions for a damper. Several units were built and tested to demonstrate concept feasibility before the program was shelved in 1968. The program was revisited in 1974 when the fuel economy crisis became apparent. Several additional units were built from scratch and tested to demonstrate the fuel economy potential. This success led to the approval of the FIOD (Ford integral overdrive) program for Job #1, 1979. Prior to production, this transmission became known as the AOD (Automatic Over Drive) and evolved into today's 4R70W. The only major conceptual difference between the 1979 AOD and the 1962 XT-LOD was the addition of a damper in the torque converter.

Another notable program that came out of Advanced Transmission and was a direct response to CAFE requirements was the ATX. Job #1 for ATX was the 1980 Escort program. Advanced had investigated numerous 3 and 4 speed designs. Some had split torque and/or direct drive; some didn't. From a cost, weight, and package standpoint, one promising design was a 3 speed compound planetary gear set design with a simple planetary



*Gasoline shortages caused long lines at the pump*

located in the converter to give a split torque input in second and third gears. (This bypassed some converter slippage.) Concept feasibility and fuel economy potential were demonstrated during the 1976 C/Y using a highly modified Opel RWD transmission as a test bed in a RWD Maverick vehicle. This program was approved. The ATX Department was formed in November of 1976, leading to a successful Job #1 when the Escort launched in 1980.

*by Karl Bornemann, Retiree*

## Borg Warner Déjà Vu

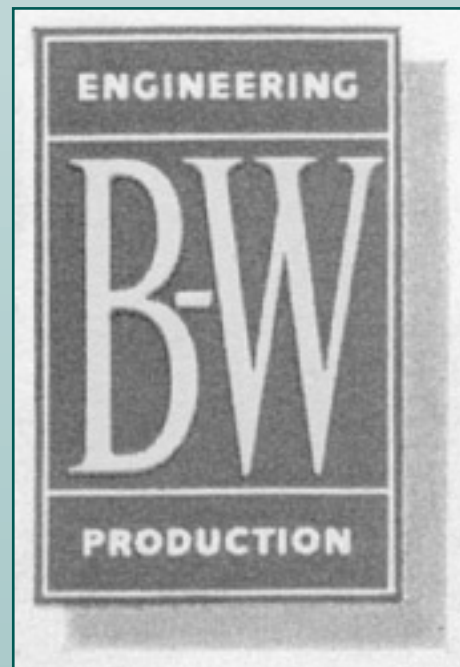
In the late 1960's and early 1970's, Ford faced a production capacity shortfall in several of its automatic transmission applications. The planning community's solution was to release what was termed "swing applications": different transmissions for the same application. Thus, a customer ordering a 302 Mustang might get a C4 or FMX and a 400 2V Ford customer might get an FMX or a C6. The customer had no choice; usage was dependent on sales and transmission plant capacity.

In 1971, planners recognized that – even with these so called "swing applications" – Ford would face an overall automatic transmission capacity shortfall of about 200,000 units for the 1974 model year. The solution was to return to our 3-speed automatic transmission "roots." Borg-Warner was given a multi-year contract to supply 200,000 units/year of its successful 3-speed Model 12. This was for a single application: the 400-2V Ford LTD for 1974.

A separate section was formed in the FMX Department to work with Borg to adapt this transmission to the Ford application. The flywheel, converter, linkage, speedo, vacuum system, calibration, and mountings all had to be changed. The Ford group also conducted a complete DVP&R on the base transmission and converter assemblies.

It is interesting to note that many of the parts between the BW built unit and the Ford built FMX were interchangeable. In fact, many of the drawings were identical except for the company name in the title block. A solid, robust design hadn't changed much in all those years!

*by Karl Bornemann, Retiree*



## Little Known Story: Automatics Went Racing!

Automatic transmission technology is seldom thought of in the context of the "24 Hours of Le Mans" GT class racing or the "Indy 500." In the mid-to-late 1960's, however, T&C Division's Advanced Transmission group was involved in major design and development efforts supporting Ford-powered entries in both of these world class racing arenas.

The local venue for both projects was in the southwest corner of the Livonia Transmission Plant. The Advanced Transmission Engineering Department was located in bay R-32 along the west wall right next to the dyno test labs where these rear engine racing transaxles were tested. Experimental build-up, machine shop, inspection, component test, and procurement were all just a stone's throw south of our engineering offices.

In 1965 and 1966, T&C Division provided prototype automatic transaxles for a 7.0L V8 version of the GT40. After a brief 6-week development effort at Sebring, Florida, the prototype unit ran in the Daytona 24 hour GT endurance race. The car was very competitive until it was sidelined after 13 hours by a failed impeller hub bushing. Manual transmissions were ultimately the transmission of choice for the Company's successful years of 7.0L GT racing at Le Mans, Sebring, and Daytona. Some of that era's more prominent drivers took part in Ford Motor Company's GT racing program. They included Ken Miles, Richie Ginther, Dan Gurney, A.J. Foyt, and many others.

In November of 1967, the Company's racing leaders again requested a unique automatic transaxle from Advanced Transmission Engineering. This time it was for A. J. Foyt's planned entry in the 1968 Indy 500, a race which would take place only 7 months after the request! Foyt came to Livonia, detailed the Indy track's powertrain duty cycle, and clearly explained his vision of how an "automatic" could work to enhance his car's performance. Our design, development, and testing led to a flawless 500 mile verification run by Foyt in April, 1968, at Arizona Proving Grounds. Early May testing by the Ford Racing Team at Indy revealed a need to switch to a new and more powerful Ford engine to compete with the hi-powered Offenhausers our competition had just developed. That 11th hour engine upgrade was not compatible with the automatic, and Foyt ran with a manual transaxle.

Both the GT and Indy racing projects went from concept to the race track in less than ten months. The need for teamwork in all facets of the design/development process was a challenge well met by all supporting organizations. CAD, CAM, and CAE were not yet part of the engineering methodology, so slide rules and mechanical calculators were the design analysis tools of that time. And did we make those tools work!



*A.J. Foyt's 'Coyote' Indy car at Arizona Proving Grounds during automatic transaxle tests. Foyt is kneeling, second from left.*

The hardware we deployed was all prototype with the exception of a few handy production components such as clutch plates, seals, and rings. As a result of the experience, we advanced transmission design technology in areas such as fluids, pump design, centrifugal clutch ball check valves, shift solenoids, one-way clutches, the use of magnesium, and many more subtle design areas.

It was a unique, high energy time in motor sports history, and – brief though it was – our automatic transmission engineering organization made important contributions along the way.

*by Larry Burcz, Retiree*



## The "Strange" Ones

While most of Ford's automatic transmissions have been mainstream boxes which sold in the hundreds of thousands of units over many years' time, a few have been anomalies, and short-timers, too!

### Liquamatic

To support its 1942 Lincoln, for example, Ford commissioned Borg Warner to manufacture the unusual "Liquamatic Drive." The so-called Liquamatic transmission was a three speed gearbox with a freewheeling clutch. It featured a fluid coupling between the engine and a conventional clutch. To operate the unit, drivers placed the gear shift in what would normally be third gear. Once that gear was engaged, the driver could motor on without clutching until he wanted to back up or shift into low. With the gear selector in third, Liquamatic could launch a Lincoln from a stand-



### New Lincoln Liquamatic Drive<sup>®</sup>

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\*Noted at road-test cost.



Compact and insular, the Lincoln-Zephyr Club Coupe has a full-width rear seat driving sedan capacity when desired.

ing stop...in second! Driver impressions of the time indicated that the car was unimpressive when downshifting to passing gear...and very slow in moving away from the proverbial stoplight. Production began in October of 1941, but was discontinued almost immediately after the attack on Pearl Harbor later that year. While competing wartime materiel demands are given as the official reason, it's widely believed that Ford was not displeased with this terminal development. Hands down, the Liquamatic production run was the shortest in Ford's automatic transmission history.

### Pushbutton Boxes

Two other Ford transmissions which proved unusual by the Company's standards were the pushbutton boxes available in selected 1957, 1958, and 1959 Mercury and Edsel models. In each case, pushbuttons took the place of the work that the shift lever normally did. The Mercury transmission had buttons integrated within the dashboard to the driver's left. Called "Mercomatic with Keyboard Control", this pushbutton transmission was advertised as "the one which does so much more: starts the engine, releases transmission lock, controls neutral, drive, low and reverse, locks the car in gear for parking, and even releases the parking brake!" Its Edsel sibling ("Teletouch") had its five selector buttons located a cluster in the center of the steering wheel hub. Both push button versions operated three speed automatics.



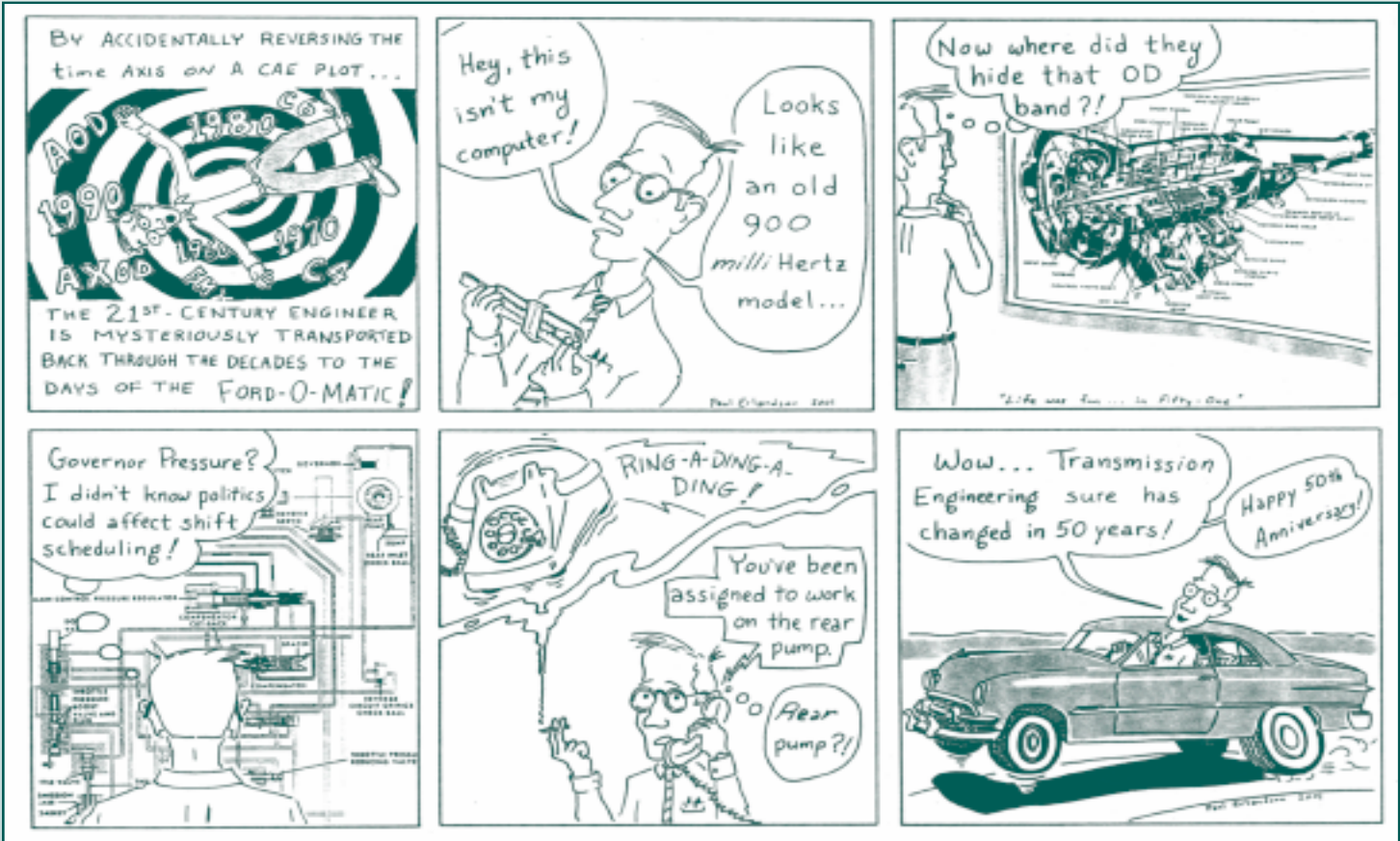
Pushbutton Mercomatic



Edsel's Teletouch

This anniversary history is a stand-alone publication of "ATEO Team Review", the bimonthly newsletter of Ford's Automatic Transmission Engineering Operations.

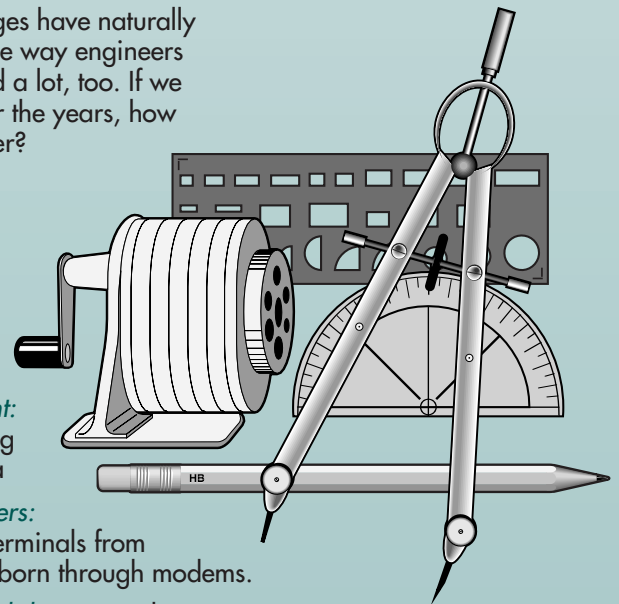




## The Way We Were...

Much has changed at Ford in the past 50 years. Many of those changes have naturally involved developing and advancing transmission technology, but the way engineers and supporting personnel have worked over the years has changed a lot, too. If we step into the "Way Back Machine" to get a glimpse of Ford office work over the years, how many of these once prominent items and/or positions would YOU remember?

- *Real carbon copies*
- *Bullpen seating:* When someone was added to the department, desks were pushed closer together to make room!
- *Rotary dial telephones*
- *Group phones:* Phones on swing arms supporting a "nest" of 4 desks
- *Slide rules*
- *Typewriters*
- *Secretaries*
- *Senior Engineers:* A level of management between supervisor and product engineer
- *Draftsmen*
- *Pencils*
- *Steel walls ("Hauserman partitions")* with upper windows bordering a central aisle
- *Smoking Environment:* clouds of smoke rising above the office area
- *No personal computers:* Instead, we shared terminals from main-frames in Dearborn through modems.
- *Limited copying capabilities:* Graphs were done by hand and "ship curves" and then printed as blue lines for those who needed copies.



## The More Things Change...

In March of 1950, numbered and registered copies of a confidential document were sent out to the Ford Motor Company engineering community. This document bore the title, "Principles of Operation of the Automatic Transmission." Distributed by the Service Engineering Department, its purpose was to explain the operation of the new automatic transmission introduced in 1951 model year Ford and Mercury cars.

Swinging open the three-ring binder which houses this piece of the automatic transmission legacy, you are instantly gripped by the undertow of history. The smell of fifty-one year old paper rises to greet you. Carefully rendered blueprints showing schematics of Fordomatic transmission elements delight your eye with their indigo hue. The mechanically produced typeface brings to mind an image of your grandfather at his old black Underwood, complete with the ring of the carriage return bell.

What a different world it must have been! You gingerly turn the pages, sniffing the contents with your engineering instincts. You look for something familiar to your refined – not to say 'jaded' – 21st century sensibilities...some fragile thread of commonality with the automatic transmission engineers of half a century ago.

*Surprise!* It is all familiar. Every page contains some familiar diagram, functional explanation, or theory of operation. Why, with a few minor changes, this thing could be used to teach today's Automatic Transmission Design course!

Beginning with the mysteries of torque converter operation, the brown-edged pages patiently take the reader through areas familiar to us all: the planetary gear set (Hey, that's a Ravigneaux! Just like in the 6RXX!), the powerflow in each gear, clutch and band actuation, selector lever positions, pump operation, hydraulic control, and shift scheduling.

Little groups of words gather together in their familiar coteries: "regulator valve", "band apply pressure", "manual control valve" & "coupling point," among others.

Explanations of shift maneuvers also have a ring of familiarity: "When the transmission is in HIGH ratio at road speeds below approximately 55 MPH, a ratio change to INTERMEDIATE is possible by depressing the accelerator past its normal full open position."

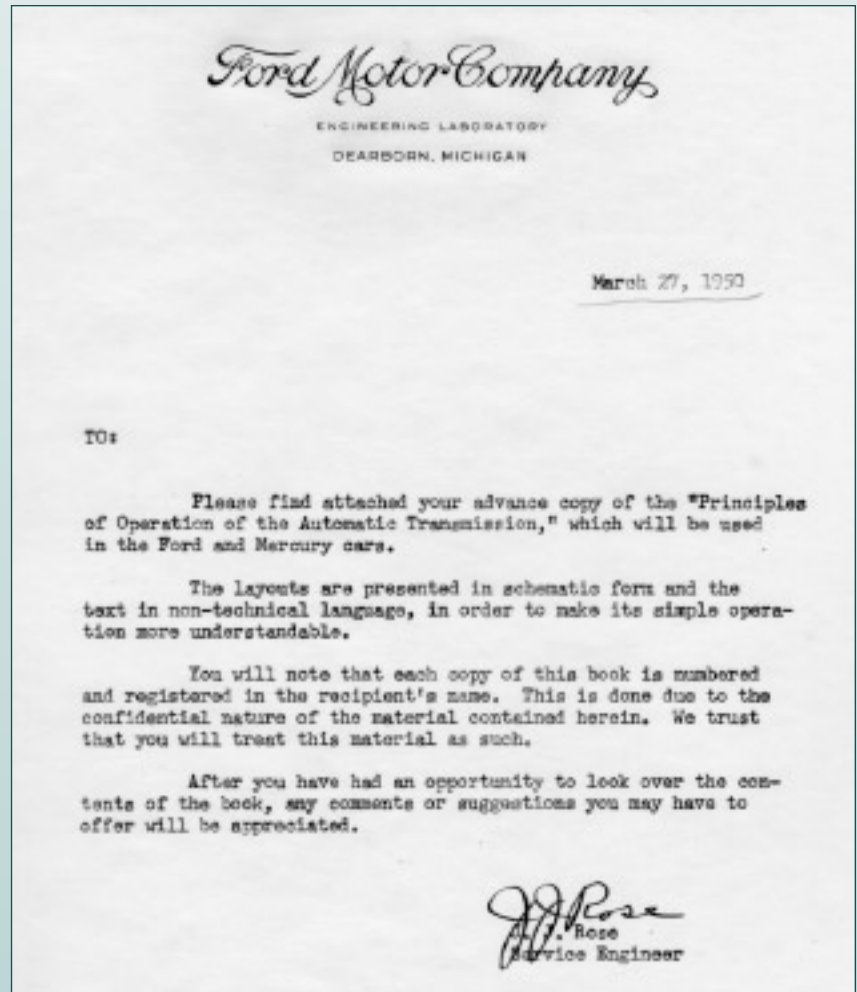
*Hey!* That excerpt describes a "kickdown!"

Granted, your eye does occasionally fall on an archaic phrase. In the Ravigneaux gearset diagram, for example, you see the description "primary pinion" where it should say "short pinion," and "secondary pinion" where "long pinion" would appear today. And it has been a while since we've dealt with 'governor pressure.' But, in the main, you are impressed with the familiarity of it all. You can easily imagine yourself explaining to

your predecessor from 1951 how a modern 4, 5, or 6-speed transmission works. In turn, he might explain the challenges faced in those early days. Within ten or fifteen minutes, each of you would understand the engineering world of the other, with a fair amount of depth.

Now, to explain Outlook, the Internet, word processors, and Digital Buck...*that* could take a while!

by Paul Erlandson, Vehicle Transmission Interface



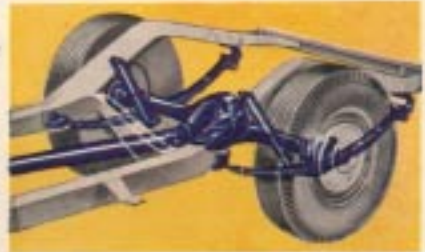
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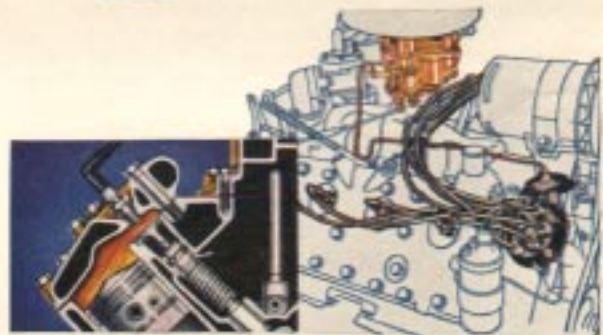


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Touch a lever and the front seat moves forward automatically—rising and tilting forward for shorter drivers. Move it back—it adjusts for taller drivers. And for comfort, the non-sag seat is cushioned with foam rubber!

When you buy for the future...

buy **FORD**