

With This or Nothing:

The Automotive Differential, Central NY, and the Consolidation of General Motors

By

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December 20, 2020

The Standard American Automobile

I learned to drive 53 years ago on my father's 1963 white Pontiac Grand Prix with red bucket seats. The car had a water-cooled gasoline motor (389 cubic inch V8), a transmission, and a driveshaft connected to a bevel-gear differential housed in a rear axle assembly that powered 2 rear wheels.¹ Every turning automobile needs a device to divide power in just the right proportion to enable the inner wheel of the back axle to turn less, and the outer wheel more, to avoid slipping or scuffing of the tires. Without the differential, tires would have to be replaced weekly or sooner. With it, the rear wheels in a turn adhere to the road smoothly and last. The bevel-gear differential is used for any powered vehicle of the type described produced between 1905 and the early 60's, which we will call the Standard American Automobile (SAA).

Differentials and Differences

These facts are important because in 1916, more differentials were produced in a single plant in Syracuse, NY than in any place in the world.² Eventually, this plant, the Brown-Lipe-Chapin Co. (BLC), became a division of General Motors (GM).

This paper will cover the years 1900 to 1945, which saw the inception and growth to maturity of the mass-produced American automobile industry. It will use many sources but none more authoritative than the writings of Alfred P. Sloan Jr., the genius who developed the way to effectively manage the large, multi-divisional corporation. Through many years, first as president of Hyatt Roller

Bearing, United Motors, and then GM itself, Sloan lived it all and wrote it down. During the period from 1905 to 1963, with minor exceptions, all American automobiles were made with the SAA architecture. During this period, the challenge for industry was to produce increasingly more vehicles within each quality grade (say Chevrolet versus Cadillac) at constantly decreasing cost.

From 1900 to 1905 most cars had one or two cylinders and, possibly because early inventors had come from the bicycle world, it was found that a metal chain drive was sufficient to convey power from the transmission to the rear axle. We will call the architecture of cars made with this design the Chain Driven American Automobile (CDAA).

Beginnings

A young man named Charles Stewart Mott of Utica, NY had a bit of a problem. While his father John Coon Mott was eager for him to continue in the family cider and vinegar business, the Genesee Fruit Company (GFC), Charles took a degree in mechanical engineering from Stevens Institute of Technology, Hoboken, New Jersey in June, 1897. After brief but distinguished service in the New York Naval Militia during the Spanish-American War he returned to help the family businesses. While at Stevens his father and Uncle had bought I.A. Weston and Company, located in Jamesville, N. Y. outside of Syracuse. Weston had produced bicycle hubs and wheels since 1884. It had been reorganized as the Weston-Mott Co. occupying a new factory in Utica, NY. Apparently, John was willing to indulge some of his son's mechanical interests in real business.

The elder Mott suddenly died on June 2, 1899 and it was decided that an uncle would take over managing the GFC while Charles would become secretary and superintendent of Weston Mott.³ The former company evolved into the Motts Apple products business which is owned by Schweppes, Inc. and will no longer concern us.⁴ The Weston-Mott concern had suffered when the demand for bicycle wheels diminished. In 1908. father and son had branched out by converting to production of automotive wheels. Gradually, with the added responsibilities for sales and engineering of Weston-Mott, C. S. learned that the

new wave of auto mass producers wanted not simply wheels but complete rear axle assemblies. With sprocket-driven differentials built by Brown-Lipe-Gear (the predecessor of BLC) and roller bearings supplied by Hyatt, Mott-Weston gained the ability to market complete axle assemblies to the auto industry. The first mass order of 1500 axle sets came for the one-cylinder Cadillac version of the CDAA, the Model A, in 1903.⁵

The Brown Lipe Sprocket Differential

This same device found use in many CDAA automobiles, including the Winton, Mobile, and Locomobile.⁶ It was employed in the air-cooled Franklin runabout.⁷ The sprocket gear differential was patented (US No. 691,591, Jan 21, 1902) by Alexander T. Brown, the prolific Syracuse inventor of the L.C. Smith breech-loading shotgun and the Smith double-keyboard typewriter.⁸

At its 2014 Symposium, the German auto parts maker Schaeffler included a presentation by Thorsten Biermann entitled "Light, Compact, and Efficient: Schaeffler differential systems set the pace".⁹ Biermann describes how Brown's differential system works and how Schaeffler's latest designs make use of Brown's concepts. Thus, while from 1905 on, added horsepower caused the chain-driven sprocket differential to be replaced by the driveshaft-driven bevel gear differential, Biermann's paper resurrects Brown's ideas for light-weight application on all-wheel drive cars of today.

But we are getting ahead of ourselves. In the 1880's, a Cornell-educated engineer named Charles E. Lipe opened a machine shop on South Geddes Street on Syracuse's West Side. In this "industrial incubator" Lipe helped engineers and technicians develop devices for insertion into production products. The first examples of the Franklin automobile were built in the Lipe shop. Here Brown and Lipe developed a two-speed device for bicycles called the Hy-lo Bi-gear.¹⁰ (I had a similar device by Bendix controlled by a lever on the handlebars of an early bicycle.) While this was considered too costly at the time, the partnership Brown and Lipe formed in 1895 went on to manufacture the sprocket drive differential just discussed. After the successful 1903 sale to Cadillac, the partnership became

a corporation named the Brown-Lipe Gear Company.¹¹ The Company soon added transmissions to its product line.



A sprocket gear differential mounted on an Franklin CDA at the Northeast Classic Car Museum, Norwich, N.Y. (Photo by the author)

Western Developments, Eastern Responses

Late in 1904, William C. Durant, a successful wagon maker in Flint Michigan, was persuaded to take over the faltering Buick Company. Buick production went from 35 in 1904 to 750 in 1905. In the latter year Durant, in order to insure an unbroken supply of axles to Buick, enticed Charles Mott and his partner William Doolittle to move Weston-Mott from Utica, NY to Flint. This they did by June, 1906 and their success grew when Buick production rose to 1200 in 1906 with

orders for 900 more.¹² In 1908, Durant combined Buick, Cadillac, Oldsmobile, and a host of auto-related companies into General Motors. By the pivotal year 1910, Durant had been forced out as president of GM due to bankers' fears that the vast loans that GM had taken out for expansion were uncollectible. Now the banks controlled GM. Also in 1910, BLC took over the differential business that belonged to Brown-Lipe Gear, which now strictly made transmissions. By then Mott-Weston of Flint, which was partly owned by GM, had for 6 or 8 years used Brown-Lipe differentials in the wheel and axle assemblies it supplied to GM.¹³ Indeed, Mott had become a major stockholder in BLC. Its officers were Alexander T. Brown, president, W.C. Lipe (the brother of C.E. Lipe, now deceased), and H. W. Chapin, secretary and treasurer.

The Rise of Alfred P. Sloan, Jr.

Coming from a well-to-do family in Brooklyn, NY, Sloan Jr. had graduated from the Massachusetts Institute of Technology (MIT) in 1895 with a BS degree in electricity.¹⁴ He began his career as a draftsman at the Hyatt Roller Bearing Company, soon to be moved to Harrison, NJ. The roller bearing had been invented by John Hyatt, who had previously invented celluloid, first of the industrially-made plastics. The roller bearing is a hollow cylindrical metal shaft, in the walls and along the length of which are inserted 6 or 8 solid but narrow metal cylinders which roll freely within their mountings. These provide a jacket around whatever shafting (like an automotive axle) that requires its rolling support.¹⁵ The early users of Hyatt Bearings were industries where line shafting was used to mechanically transmit power, such as factories where power was transferred by pulleys from a rotating ceiling shafts to a floor machine by means of wide leather belts. But these machines were now commonly being delivered with internal electric motors. At just the right time, however, the newly-developed automobile industry in 1900 demanded application of Hyatt roller bearings within axle assemblies delivered by C. S. Mott and others.

By the early 1900's, Sloan had become general manager of Hyatt. The roller bearings used in the axles of Cadillac, Oldsmobile, Elmore, Blomstrom and other car makes were shipped from Hyatt to Weston-Mott, now operating in Flint.¹⁶ As

time passed, Ford Motors also became a large customer for Hyatt roller bearings, as did Willys, Packard, Hudson, Reo, and others. As demand increased Hyatt had to invest more and more in machinery. By 1916, Sloan felt susceptible to competition from GM or Ford who might more cheaply manufacture their own roller bearings. To maximize and protect Sloan's equity in Hyatt, he looked for just the right suitor to take it over. At this point in 1916, William C. Durant came to the rescue.

Developments Without and Within GM

When forced out as president of GM in 1910, William C. Durant formed a company to manufacture a technologically advanced automobile named the Chevrolet.¹⁷ To quote Sloan's Adventures of a White Collar Man, Durant "placed the shares of Chevrolet on the market, continually boosted the price, then offered General Motors stockholders an exchange of five shares of Chevrolet for one of General Motors. On the basis of the market price, the exchange meant a certain profit. Durant turned up at a stockholder's meeting of GM with stock and proxies giving him control again - an amazing piece of manipulation."¹⁸ That happened on or about September 16, 1915.¹⁹

In the spring of 1916, Durant summoned Sloan to his office in Detroit. He offered to buy out Hyatt Roller Bearing (at a price later negotiated at \$13.5M) as part of United Motors (UM), a holding company of auto parts suppliers.²⁰ The makeup of UM would include Hyatt, the Dayton Engineering Laboratories, and others. Co-founder of Dayton Electric was Charles F. Kettering, who had invented the automotive electric starting system, which made the arm-breaking manual crank system obsolete. As part of the bargain, Albert P. Sloan now became president of UM.²¹

Syracuse: Actions for Growth

All the players in the next stage of the saga have now been introduced. Heading the lead column of the October 19, 1916 issue of *The Automobile* are the words "Brown-Lipe-Chapin Co. Sold - United Motors buys Biggest Maker of Differential

Gears in America".²² Quoting the article, "President Alfred P. Sloane (sic), Jr., of the United Motors Corp., is authority for the statement that the general policy of BLC will be continued as at present but that the capacity of the plant in the manufacture of differentials will be doubled as soon as additional buildings can be erected. " It further states that Messrs. Brown and Lipe both wealthy Syracuse capitalists, have owned about 50% of the stock of BLC, the rest being held by C.W.(sic) Mott and his General Motors associates." It concludes with a rundown of Dayton Engineering Laboratories and other components of UM and states that BLC employs upwards of 2000 workmen and is the largest differential-making concern in the world.

Inside Brown Lipe Chapin

In the December 31, 1914 issue of the *Automobile* appears an advertisement in which BLC outlines the process for building bevel gears used in differentials.²³ Blank gears, which were steel rings from a forge plant, were first tested for cracks and proper chemical composition. They went through a preliminary operation that made the gear blanks uniform in constituency and removed the forging or internal strains. Those blanks that pass were center-bored and drilled for attachment by rivets and bolts to the differential case. They were then sent through the largest battery of Gleason gear-cutting machines in the world.²⁴ The gears output by this method looked ready to use, except for one thing: their steel was of a low carbon content making it soft. In the carburizing/heat treating process the gears were bathed in a proprietary chemical compound that, over seven hours baking at temperatures varying from 1185 to 1600 degrees Fahrenheit, hardened the first 1/32 inch of the gears by a factor of 5. This enabled performance of the gears in use to meet BLC endurance goals. It is this care to detail that ripened BLC for buyout by UM in 1916.

Gleason and Daughter of Rochester

William Gleason was anxious. His daughter Kate had been helping him do bookkeeping in his Rochester machine shop since age 11 and later entered Cornell as the first female student in the Mechanical Arts Program. Without her,

the Gleason Works struggled and her father had to order her home to take over.²⁵ By 1880, she became Secretary-Treasurer of the firm. In 1893, as the tool business slowed in the US, she became an early participant of globalization by securing orders from England, Scotland, France, and Germany. After leaving the Gleason Works, she entered banking, becoming in 1917 President of the First National Bank of East Rochester, the first American woman in that role. In 1914, she had pioneered yet again as the first female inductee to the American Society of Mechanical Engineers (ASME). Today, the College of Engineering at RIT bears her name.



The Gleason Works, Rochester, NY in 2010 (Photo by author).

Sloan: Accession of a Management Pioneer

In 1918, GM acquired the assets of United Motors.²⁶ Not only did this mean that GM would now consume the vast majority of the parts made by the UM companies, including Brown-Lipe-Chapin, but Sloan joined GM as a vice president in charge of UM. He also became a GM director and a member of its executive committee.²⁷ In these roles, Sloan was able to closely observe GM president

William Durant as their offices adjoined at GM's building on 57th St. in New York City.

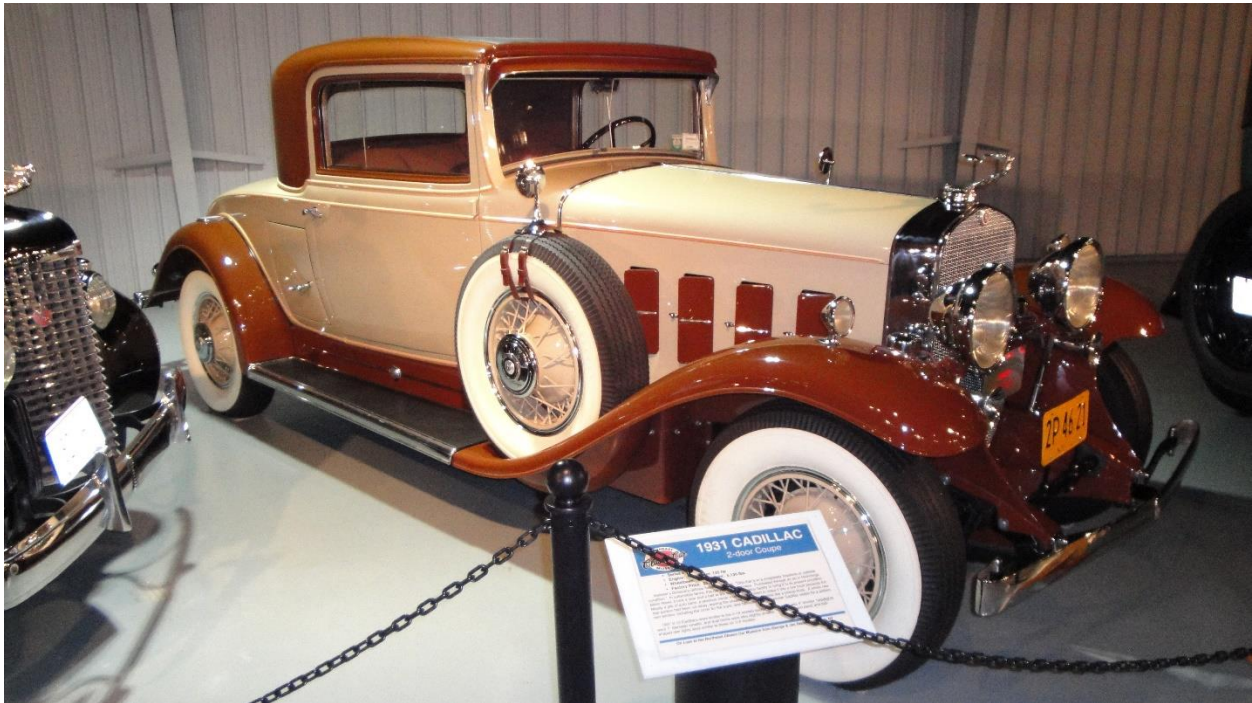
In 1919, Sloan suggested that because of the wide public interest in GM's shares, it should have its books audited by a CPA. Previously, Durant did not understand the value of accounting and its importance in administering a large corporation. Durant gave Sloan authority to hire the noted accountants Haskins and Sells which audited GM for the next 40 years.

Another instance of Durant's informality appeared in choosing the location of GM's Detroit headquarters. Sloan proposed the location of the old UM office on West Grand Boulevard in the less crowded North Side, intersecting Woodward Avenue, the main north-south rib of Detroit. Durant, Sloan, and others inspected the existing site, then Durant paced off additional residential yardage required and told Sloan to buy it for GM.²⁸ In other words, Durant decided without any formal study or negotiations. Having seen the four-tower colossus that resulted, I can't fault the location, although agents negotiating for small pieces of land required a poker face as to the GM use so as not to raise prices sharply.

More generally, Durant did not have a grasp of the GM divisions, like Cadillac and Chevrolet, who had their own accounting systems, their own uncoordinated requests for corporate appropriations, and no way of balancing production goals against inventories on the dealers lots. Also, there were divisions like Scripps-Booth, where products overlapped the GM goal of a line of cars with a single model in each price range. (The Scripps-Booth roadster with passenger seat slightly staggered from the driver's, was the car in which the antihero Julian of John O'Hara's Appointment in Samarra first dated his wife). In short, GM during Durant's rule was a symbolic box of broken toys.

It all came to a head in the stock market slump of 1920.²⁹ Then it was found that Durant had 2.5 million shares of GM stock purchased on margin accounts, all of which came immediately due. The Dupont family, already large GM shareholders, paid off Durant's brokers and assumed ownership of the 2.5 million shares under his name. Durant resigned shortly thereafter in humiliation.

Pierre S. Dupont became the new president of GM in November 1920.³⁰ A paper written by Sloan, “The Organization Study” in 1919 became the organizational scheme for GM. What this boiled down to was a scheme for a corporation of decentralized divisions under centralized control of functions logical to the organization.³¹ Sloan deservedly assumed the role of principal assistant to Mr. Dupont. Soon this responsibility morphed into executive vice-president in charge of all operations.



A Cadillac made during the period when the Brown-Lipe-Chapin Division supplied differentials to GM cars. (Photo by the author taken at NECCM, Norwich, NY).

Nothing Without This and the Fate that Followed

We have seen how the automobile itself was incapable of being realized without the differential, much of whose development was pioneered in Syracuse, NY. A blow for Syracuse came on Nov. 22, 1932, when it was published that production at BLC would transfer to Flint, Michigan.³² Alfred P. Sloan gave two reasons for this: “One is that it is more economical to manufacture gears at or near the center of the automobile industry., and the other is that taxes in Syracuse are considerably higher than in the average locale in which GM operates.” The last reason was rebutted by Syracuse’s mayor. A later pronouncement by James

Pratt, GM vice president, stated that "the taxes alone were not sufficiently high to have brought about the closing of the plant. For example, we had to make forgings in Flint and castings in Saginaw (Michigan) for use in the Syracuse plant and then ship them from Syracuse back to Michigan. The cost was prohibitive."³³ BLC, it seems, had finally become victim to forces that overwhelmed Syracuse.

New Beginnings

"Extra: Brown-Lipe Plant Employing 400 to Open In February" blared the 1936 headline.³⁴ The article goes on to say that "new machinery will turn out auto accessories made necessary by Increasing sales of GM cars." What these accessories turned out to be were light bulbs, red plastic rear light covers, and other automotive "trinkets". (The second page of the Herald article has a beautiful picture of the U-shaped BLC factory in its nearly original form with full floor-to-ceiling windows). BLC would never again turn out essential parts like differentials. Eventually moving out to a new factory in Salina, the plant continued until 1993 when it closed, its production having been probably shifted off-shore.

In August, 1945, Alfred P. Sloan, then chairman of GM, contributed \$4,000,0000 (\$55M in 2017 dollars) to the establishment of a Sloan-Kettering Institute for Cancer Research at the Memorial Cancer Center in New York City.³⁵ (C. F. Kettering was by then the GM Research chief). "Mr. Sloan explained" goes on the article "that his industrial experience had led him to appreciate the amazing possibilities of research when organized on a broad and comprehensive scale". He said that he and Dr. Kettering were convinced that "the same broad principles of organized industrial research can be adapted to bear effectively on this entirely different problem". The intent was to make Memorial–Sloan Kettering the chief international center in the fight against cancer and to a great extent, 75 years later, that goal has been achieved, in my view.

Back to the Beginning

After the Weston-Mott Co. moved to Flint, Michigan in 1906, its business growth was more than ever tied with the fast-growing Buick and Chevrolet divisions of GM. Eventually, C.S. Mott surrendered control of his business to GM and was rewarded with an ample amount of GM stock as payment. Increasingly he became interested in improving the lot of the residents of the fast-growing Flint. He served several terms as mayor, and created a foundation to help improve the lives of not just its citizens but of Americans in general. During my career in Owego, NY spanning four decades, I drove to work listening to National Public Radio, many programs of which listed the Charles S. Mott Foundation as a sponsor.

If I keep driving an hour past Owego, I come to Elmira, New York, original home of John North Willys, whose large automotive enterprises culminated in the WW 2 icon and still popular Jeep. Each community I come to has its own list of risktakers who put everything they had into advancing the modern world. Many of their experiments led to failure, but enough have succeeded to make the overall effort worthwhile. Let it ever be true.

A Final Anecdote

After his 2nd dismissal from GM in 1920, the always optimistic William C. Durant made a final attempt at building a comprehensive car company called Durant Motors. Its products included cars such as the Locomobile (a Cadillac analog), the Flint (Buick standin) and the Star (a Model T competitor).³⁶ The company was liquidated in 1933 and Durant declared personal bankruptcy in 1936, with the only assets his clothes. He ended up running a drive-in diner in Asbury Park, New Jersey. And so one Saturday, goes the apocryphal story, a young couple was looking over new cars at the local Chevrolet dealership. As noon approached, the affable salesman said to the couple "Let's break for lunch. I'll take you to a joint where your burgers will be flipped by the president of GM!"

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- ¹ To see how a bevel gear differential operates query How a Differential Operates at Youtube.
- ² The Automobile, October 19,1916, p 650.
- ³ Young, Clarence H. and Quinn, William A. A Foundation for Living - the story of Charles Stewart Mott and Flint, New York (1963) p. 19.
- ⁴ This is described at the website <https://www.motts.com/about>.
- ⁵ Young and Quinn, p. 22.
- ⁶ Pound, Arthur, The Turning Wheel: The Story of General Motors Through Twenty-Five Years 1908-1933, Garden City (1933), p 485.
- ⁷ Powell, Sinclair, The Franklin Automobile Company (Second Edition) Cazenovia (2014), p. 62.
- ⁸ Powell, p. 9.
- ⁹ To obtain, Google the phrase Schaeffler Symposium 2014 light compact and efficient
- ¹⁰ The machine shop building is now the City True Value Hardware store at 214 S. Geddes St. On the south side of the building, on a white background, is painted a large bicycle about 10 by 20 feet, no doubt in tribute to the machine shop.
- ¹¹ Pound, p. 485.
- ¹² Young and Quinn, p. 28-29.
- ¹³ Motor World, January 20, 1910, p. 221.
- ¹⁴ Sloan, Alfred P. Jr. with Boyden Sparks, Adventures of a White-Collar Man (New York 1941), pp. 4-5.
- ¹⁵ Sloan and Sparks, p. 15.
- ¹⁶ Sloan and Sparks, p. 45.
- ¹⁷ Sloan and Sparks, p. 85. The Chevrolet 4-cylinder engine in 1916 had overhead valves as did every Chevy through 1963 and beyond, including my first car, a 1968 Chevy Nova. Overhead valve (OHV) engines, also used by Buick, breathe and exhaust more freely than the cheaper-to-build valve-in-block engines of most competitors. By the 1950s, almost all cars had adopted OHV.
- ¹⁸ Sloan and Sparks, pp. 85-86.
- ¹⁹ Kimes and Clark, p. 282.
- ²⁰ Sloan and Sparks, pp. 91-99.
- ²¹ Sloan and Sparks, p. 100.
- ²² See ref 2.
- ²³ The Automobile, Dec. 31, 1914 pp. 145-60.
- ²⁴ The Gleason Works of Rochester NY, maker of gear cutting machines, will be described in the next section.
- ²⁵ As described by the Kate Gleason College of Engineering at the Rochester Institute of Technology at <http://www.rit.edu/kgcoe/about/about-kate-gleason>.
- ²⁶ Sloan, Alfred P. Jr., My Years with General Motors (New York, 1963) p. 24.
- ²⁷ Sloan, p. 24-25.

²⁸ The upper middle-class homes of West Grand were stately and set back from the street. Years later, one became famous as the home of Motown Records.

²⁹ This paragraph follows Sloan & Sparks, pp. 123-126.

³⁰ Following Sloan, p.52-56.

³¹ Sloan, p. 53.

³² *Automotive Industries*, Nov. 26, 1932, p. 687,

³³ *The Syracuse Herald*, November 1, 1933, p. 1.

³⁴ *The Syracuse Herald*, January 6, 1936, p. 1.

³⁵ *The New York Times*, August 8, 1945, p. 1.

³⁶ Kimes and Clark, p. 503.