

Memories of GMPG – the General Motors Proving Ground

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On September 25, 1924, the General Motors Proving Ground (GMPG) opened for business in Milford, MI. It was the world's first dedicated automotive testing facility, and was comprised of two buildings and 5.5 miles of test roads on 1,125 undeveloped acres about 40 miles west of Detroit. GMPG was the brainchild of General Motors' eighth president and second chairman, Alfred P. Sloan. An MIT electrical engineering graduate, Sloan fully understood the value of product testing and saw the need for a dedicated place to do it, rather than testing on public roads, which was the industry norm in those days. A unique property with widely varied terrain features was sought. This was located in 1923 by William J. Dawson, then Assistant Secretary of the Technical Committee chaired by Sloan. GMPG has been in constant use and perpetual evolution ever since. Today it encompasses over 4,000 acres and employs more than 4,500 people.

I joined the Noise and Vibration Laboratory (NVL) at the General Motors Proving Ground (affectionately known to its inhabitants as the "PG" or simply the "grounds") during 1969. I was a 26-year-young, hippie-cum-mechanical engineer with a few years of related vibration analysis and test experience, coming from Sikorsky Aircraft Corporation.

In that era, GM made an overt effort to recruit engineers with aircraft design and testing experience, hoping to infuse new analytic methods and dynamic testing insight into its own store of engineering knowledge. This was a wonderful opportunity for a young man, particularly for a "car guy," since the PG was a very unique place. Nearly 10 miles of chain-link fence surrounded its road system, buildings and three lakes. The 1969 testing facilities including more than 100 miles of specialized test roads and dedicated-purpose tracks, a 67-acre "black lake" of dead-smooth asphalt to examine extreme handling performance, and more than 100 purpose-built laboratory and facility buildings.

The Internet abounds with PG statistics and a few aerial and historical photographs. What you can't learn via Google is what it felt like to work at this unique facility at that time. In 1969, only 900 of us inhabited the grounds; none of us belonged to the UAW – we were each enthusiastic General Motors employees. The grounds employed engineers, technicians, mechanics, secretaries, bookkeepers, cooks, waitresses, heavy-equipment operators, landscapers, security officers, photographers, programmers. You name a job, and the PG employed at least one.

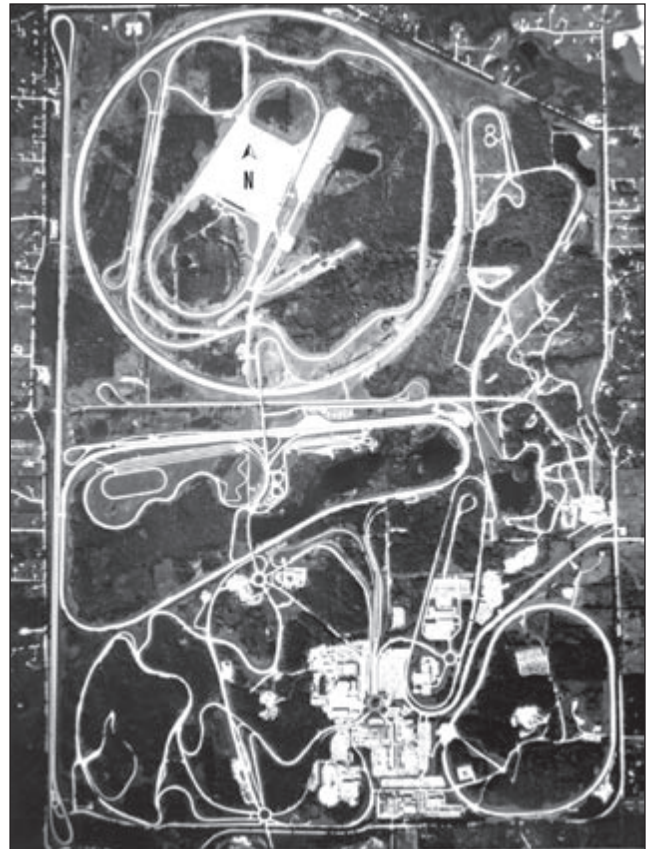
GMPG was really a small autonomous city hidden in the weeds and trees of rural Michigan. It was dedicated to only one thing: assuring the superiority of General Motors' products by testing all aspects of their use. It was a mission that everyone, whether a salaried professional or hourly worker, took seriously, and we all labored toward this goal collectively and enthusiastically. In the process, we had a lot of fun, and foresighted management made certain good people chose to stay. Working at the grounds had an absolutely familial feel about it.

The PG was and is a most unique place, technically rivaled only by NASA's largest and finest facilities and now faring better than most of those. Each of its dedicated laboratories focuses on a particular area of technology, housing specialists and the latest support equipment.

For example, the Noise and Vibration Laboratory was home to about 80 engineers, scientists, technicians, mechanics and clericals. Our two-story building housed two active chassis dynamometers, an engine dynamometer, a shaker room standing on its own isolated foundation fitted with a myriad of electrodynamic and hydraulic shakers, including "four-poster" test stands that would support a car or truck while force-exciting its wheels, a large anechoic



Modern construction practices in 1924 – the birth of the General Motors Proving Ground.



An aerial view of General Motors Proving Ground, circa 1965. For scale, the North-South Straightaway shown at left spans 3 miles while the circular track at right is 4-1/2 miles around. The large paved area well within this is "Black Lake," some 67 acres of smooth, level and water-floodable asphalt.

chamber, a reverberation chamber, a semi-anechoic "listening room," a very complete machine shop, a strain-gage laboratory, a rubber formulation/fabrication laboratory, an instrumentation room, a metrology lab, an analog computer laboratory, a library, offices, meeting rooms and a high-bay garage with many hydraulic lifts and a huge tools inventory. "The Sound Lab" (Building 24) was actually NVL's second home; it opened in 1961 and served



The GMPG Weather Station built around 1928 provided data to the National Weather Bureau and NBS.



An early towed dynamometer measured the actual tractive effort delivered by an automobile.

the corporation for over 30 years.

All of our measurement equipment was up to date, calibrated and carefully maintained. We had the latest sound and vibration sensing, recording and analysis equipment available and our inventory was constantly updated with new commercial offerings as well as special instruments designed and fabricated in our instrument room or by the on-campus Instrumentation Lab. In-house training courses ensuring we knew how to profit from new technology were a frequent occurrence. All NVL equipment and the building itself were lovingly cared for. GMPG was a “spit-and-polish” kind of place, and every laboratory was expected to look its best at all times. While everyone was expected to pitch in and keep his work area neat and clean, the dedicated facility staff did a superior job of cleaning, refurbishing and updating the building. Our NVL was a place you could – and did – show off to visitors with pride.

Latest Technologies

The PG was an early adopter of many technologies, including high-speed cinematography. We had the on-campus ability to make slow-motion “movies” that would outclass any Hollywood studio offering of the era. I made use of this when studying “exhaust valve recession,” an engine problem that emerged immediately after the federally mandated introduction of unleaded fuels. I also called on it when loaned to the Safety Laboratory to develop new statistical analysis methods for crash testing.

That lab was centered upon an “immovable object” at its center. Test cars would be destroyed by being propelled into it in an astounding automated dance, caught in excruciating detail on high-speed film. A car would be attached to a track-guided tow cable outside the lab. A klaxon would sound, and red lights would rotate to signify a test in progress. The car was rapidly towed toward the building’s large overhead door, while a bank of Klieg lights came on inside to illuminate the crash barrier area. At what seemed like the last possible second, the door rose, the car entered, its speed stabilized, and the door closed behind it. (Michigan winters *are* severe.) Sensors detected the car’s approach to the barrier and cameras started whirring, data recorders spun up, the tow cable was detached and the inevitable happened with a loud “thump.” An expensive automobile was reduced to a pile of folded metal, its anthropomorphic “dummy” occupants tumbling and straining against the vehicle’s restraint systems without a whimper. The cam-



The GMPG Engineering Staff of the early 1920s, no dilettantes or middle-men in evidence. This was a “roll up your sleeves and get it done” kind of place – and it still is.



Attaching and adjusting a 1920s era “5th wheel” to accurately measure road speed during a noise test.



Some of the technicians, mechanics and drivers who worked at GMPG between 1924 and 1928.

era bank caught every nuance of the crash from multiple angles, and the data recorders captured the acceleration and strain at test points all over the vehicle in those last few hundred milliseconds.

Our photographic department also had some early expertise in digitizing high-speed photographic images. I got involved in a community noise issue requiring a means of measuring how rapidly inner city cars accelerated. We hoped to use aerial filming to gain an understanding of how often people raced their cars from a stop (and how violently).

I volunteered to be the test cinematographer for an “on grounds” confirmation of the method. The subject test car was fitted with multiple frame-mounted accelerometers with their output recorded by a 1-inch FM magnetic tape recorder in the trunk. The car would accelerate over a series of white lines painted on the surface



Bangin' a 1949 Buick on the Belgian Blocks – this loop, built in 1929, is one of the most severe suspension tests on the Grounds. The “blocks” can pound under-designed shock-absorbers, bushings and mounts into submission in very short order.



Bathing an early 1950s Cadillac in the Water Trough to verify integrity of brakes, ignition, starter, generator, door seals, and splash deflectors. Don't ever try this with your English sports car!

of Black Lake while I filmed it. The Photographic Department provided me with a beautiful 16 mm Bolex H-16, a professional camera of unimpeachable optical quality, but a rather heavy and bulky piece of equipment. The pilot was my flight instructor, an NVL mechanic. Our plane would be his redoubtable Piper J-3 Cub with its door panels and rear control stick removed.

Have I mentioned that Michigan winters can be severe? We performed this exercise in December with the two of us bundled up like the Michelin Man in thermal “dough-boy” suits. I placed a foot on the strut step, loosened my seat belt and hung out into the airstream as far as I could to get a clean downward shot. I suspect most of the acceleration the film analysts recovered was my shivering! The experiment was not a success, but I still smile when I think about it.

Analog Computers

Most of my hours were spent working with NVL's analog computers. These were unique machines designed specifically to solve differential equations and simulate dynamic events (vibrations or crashes). While a digital computer is programmed by entering a list of mathematical operations to be performed in sequence, an analog computer is programmed by wiring between the inputs and outputs of its various electronic components, causing their dynamic behavior to be governed by the mathematics of your interest.

In a digital computer, data are a series of on/off states retained by binary storage elements. In an analog computer, variables are simultaneously computed as time-varying voltages. The beauty of analog computation is that multiple-variable answers can appear in “real time,” permitting a physical test to be integrated with an analog simulation. For example, engine mounts were routinely tuned by simulating their stiffness and damping rate and the motion of a supported engine block on an analog computer. In the lab below, an automobile (less engine) was run on a chassis dynamometer. Accelerometers measured the motion at the mount points and fed it to the simulation. The simulation returned engine reaction force



Testing to assure safety – the defining last instant for one of the thousands of cars destroyed by crash testing in the GMPC's Safety Research Laboratory.



The only dummies who ever worked at the GMPC: the Anthropomorphic Testing Device (ATD) born and bred at GMPC's Safety Research Laboratory for crash testing. A “family” of about 100 ATDs spanning 6-month toddler to 234-lb male adult is always on active duty.

signals, which were applied to the mount locations by hydraulic actuators. This literally allowed the mount properties to be “dialed in” by rotating a few calibrated potentiometers on the analog computer. Analog computers are now considered passé, but it has taken fully 50 years for digital computer simulations to provide any semblance of such “hardware-in-the-loop” testing.

A Good Day at the Grounds

There was much more to “working” at the grounds than just working. Daily life there was very pleasant and “the General” provided some really nice perks. We all ate lunch in the “clubhouse,” an on-campus restaurant serving a variety of excellent hot meals at rock bottom prices. Some years prior, the clubhouse's second floor had served as a dormitory for young engineering “co-op” students. We drove to the clubhouse from the lab using one of the many service cars assigned to NVL. After lunch, we would often enjoy a drive around the grounds usually including an informal “gymkhana” along the “Seven Sisters,” a serpentine run with seven very tight turns. If the driver was really enthusiastic, this 0.4 mile passage could be made in 40-odd seconds. I was once privileged to be rear seat ballast for a blistering 38 second run followed by a short stop to collect the four wheel covers that flew off our Dodge Dart in the tight turns!

Of course there were strictly enforced rules about driving on the grounds. Only employees were allowed to drive on the PG, and they had to be indoctrinated and certified first. But once an employee was certified, he was allowed to use any of the facilities, and everyone respected the need for those noontime tours. In that era, you could sign up to bring your personal car into your laboratory on the weekend to work on it. This was a really nice benefit,



The original inhabitants of Building 24 were led by David Apps (standing front and center with his arms folded). Succeeding NVL managers Hugh Larson, Duane Bonvallet, Carl Talaski, and Gary Penn are also shown. Can you identify them? Old friends of SAE (circled) Ralph and Sharon Hillquist, were there at that time.



The Noise and Vibration Laboratory inhabited Building 24 from 1961 until 1998. The glass-enclosed walkway connected to the Administration Building, housing Computer Services and Human Resources and the main facility entrance.



The Clubhouse, where hot lunches for up to 4000 were served every work day, also served as a dormitory for co-op engineering students in the 1940s and 50s.

because the lab had a bevy of vehicle hoists and a lot of tools the average home garage lacked. As the owner of an aged MG TF-1500, I really appreciated this perk, as British car mechanics were few and far between in rural Michigan. It was not at all unusual for a group of friends to gather in the lab on a weekend to collectively tackle a big repair as a team.

It was also possible to invite a friend or relative into the lab for a visit with preapproval. Such guests usually stayed for a clubhouse lunch and were than treated to a driving tour around the facility. It was great fun to take a young guy and tuck him into the back seat of a service car, then head for the North-South Straightaway to really stretch the car's legs. At each end of this high-speed multi-lane track were banked turnabouts; if you entered at the posted speed for your lane, the car would circumnavigate "hands off" reentering the straight track in the opposite direction. The favorite gag was to take a 120 mph run in the high-speed lane. Just as the car entered the turnabout, the driver would turn around to face the visitor, put



The Grounds runs its own gasoline service station. It's open day and night and it doesn't charge anything for the fuel it dispenses! Annually, the PG consumes nearly 2-1/2 million gallons of gasoline.

a cigarette in his mouth and ask for a light.

Another favorite was the "zero g" escape road from a hairpin turn on the hill route. This little road fell down a hillside with just the right curvature to match the descent of a car that exited the hairpin at 40 mph. An exiting car went airborne from the turn's apex, though its wheels were just scant inches above the ground as it fell about 20 feet. When a driver shouted, "I've lost it" and steered straight down the escape road instead of rounding the hairpin corner, the next very silent second was quite exciting to the unsuspecting. A British friend of mine confided, "I was on the third line of the Lord's Prayer when the wheels hit the ground."

The fleet of service vehicles contained both GM and competitive makes. Many of them ended up in experiments or were torn down for comparative analysis. Having a chance to drive these constantly rotated vehicles gave everyone a personal sense of who made the best cars and trucks at any point in time. Those service cars were also a special perk for supervisors and managers. Each of them got to take one home every evening after fueling it at the PG's gas station (and perhaps running it through the wash rack). This eliminated their need to buy, insure or maintain a family car – a really nice remuneration kicker!

Financial Perks

All PG professionals got to buy one new GM car every year at a steep discount under the "A-plan." You actually sent your car order directly to the factory and specified to which dealer you wanted it delivered. Dealerships loved to receive A-plan cars, as they got to count the vehicle on the "good side" of their monthly tally without any of the quota penalties associated with the more desirable models. A local dealership would normally kick something in (at-sale detailing, a luggage rack, etc.) to get specified as your delivery point. The local banks also understood the A-plan fully and offered "chattel mortgages," allowing you to take delivery of a new car without laying out any cash. The note's principle plus simple interest was due a year later. You made no monthly



When World War II fell upon us, GM went to war with a vengeance; building tanks, trucks, staff cars, bombers, aircraft and ship engines, machine guns, carbines, pistols, mess kits and more. Everything GM made for the US effort and things made by others were continuously verified by rigorous GMPG testing. The P-38s in the photo used very dependable Allison engines.

payments. If you chose your car carefully, you could sell it a year later for every penny the bank wanted.


The First Real-Time Analyzers

GM professional employment included a very comprehensive retirement package and other generous economic benefits. You became fully vested in all of these programs after completing five years of service. This caused me to make a very hard decision before those hooks were fully sunk. In the course of my work, I had become fascinated by a new electronic instrument, the constant-bandwidth, audio-frequency spectrum analyzer or real-time analyzer (RTA). I taught in-house classes about using our Federal Scientific RTA, and I was fascinated by the multichannel analyzers offered by Hewlett Packard and Time Data. These were based on a minicomputer and a new signal processing algorithm recently developed at Bell Laboratories, the fast Fourier transform (FFT).

While I knew I would use such instruments and their progeny throughout a GM career, I wanted to be more intimately involved in designing and marketing such devices. So I left GMPG and entered the electronic instrumentation business by joining Federal Scientific Corporation in New York City. For me, it was a good decision; I have enjoyed my life's work. But remaining at the PG would also have been a good decision. It was a serious place employing bright people who did good work and smiled while they were doing it.

Epilog

Building 24 where I worked is no longer home to the PG's noise and vibration effort. Instead, that sprawling building houses all the servers and support equipment that make up General Motor's presence on the World Wide Web. In 1999, a new NVL building was opened on the North (right-hand side) of the entry drive, General Motors Road. This massive structure has a 347,000-square-foot (7.97 acre) footprint and houses 62 test cells, including 10 chassis dynamometers. Clearly, noise and vibration abatement remains serious business at the Grounds.

The young co-op student who blew the hubcaps off that agile Dodge on the "Seven Sisters" was Mark Rodamaker, a former contributing editor for *Sound & Vibration* and life-long friend, who became a major contributor in the development and application of finite-element methods. Three fellow NVL "lab rats," Dave Formenti, Ken Ramsey and Don Kientzy, made the same tough career decision I did in the same time frame. They went on to Hewlett Packard to support that firm's FFT development and marketing and later partnered with Dr. Mark Richardson to form SMS, a small California business that cast the dominant technical shadow over the modal analysis market segment for decades. All of them have made serious contributions to the pages of *S&V* over the years. In 2008, the GMPG Retirees Club was formed. Its website address is www.gmpgretiree.com. 

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