

# The 2008 XC70 Saga

## Back Story:

Nine years ago, daughter dropped her children at school and proceeded down a two lane highway when an inattentive driver crossed the center line and struck the 2003 XC70 virtually head-on; a combined 110 mph impact. The Volvo crumpled: all passenger side airbags deployed. Dazed, she exited the Volvo through a rear door without broken bones or cuts. Since then, she "loves" Volvo and purchased the 2008 XC70 as a replacement.

In a previous article, "How I Spent My Summer Vacation", recall I spent quite a bit of time working on daughter's beloved 2008 XC70. Last Spring, the differential had a bearing whine. A local shop installed a donor differential and serviced the haldex AWD Active-On-Demand (AOC) unit.

## The Story:

Fast forward to December 2018, the family drove to an off-road mountain chalet in Stevens Pass for a post Christmas ski vacation at an off road mountain chalet. In the past, the Blizzak equipped XC70 confidently traversed the 18-20" powder snow maze to the chalet. This time the AWD failed. Concern that Jack Nicholson, driving a snow-cat, would soon cruise by offering a tow and a ride to the hotel, they dug the XC70 out from the drift and got under way.

I got the call; "What happened to the AWD? I thought it was fixed," she said. I suggested she return the car to Mack at the "*we fix it right the second time garage*" who performed the first differential swap. Mack reported he couldn't pinpoint the AWD failure cause; next she asked the Volvo dealer. Volvo reported a rear axle snapped and the differential was destroyed; hence, AWD failure and presented an \$11,500 repair estimate.

While was waiting for Volvo's damage and repair assessment, she test drove a XC60. She loved it. Upon receiving the repair estimate, she reasoned it'd be far more prudent not to trade up to the XC60, but ship the car to dad in North Carolina for repair and drive the 1999 AWD S70 he'd rebuilt; that was kept in the barn until she got her XC70 back.

The XC70 was loaded onto a transporter (\$1100) and arrived 12 days later.



The \$1100 Cross Country Transport

Meanwhile, it snowed and daughter reported the 20 year old AWD S70 traversed the snow covered slick roads easily, passing newer vehicles on steep inclines.



Alpacas Chest High in Snow

Forensic Analysis:

A week later I inspected the rear differential, instead of finding a snapped rear axle, I discovered the right rear axle had been spit out of the differential ~1" and no longer engaged the drive gear; no snapped axle.



Right Rear Axle at Differential

For fun, I tried to seat the axle without success. Subsequent post removal inspection revealed the axle gear spline, a rotating feature of mating gear assemblies, preceding the retaining ring

(see next photo) was distorted by torque twist thus, preventing the spline following the retaining ring from engaging the axle gear. The torque twist occurred when the gear froze and the rear wheels continued turning due to the vehicle's momentum.



Spline Tip Misaligned/Twisted by Axle Gear Torque.

Further inspection revealed the axle housing had been beaten severely by a hammer in a failed attempt to seat it in the axle gear. The repair shop likely gave up and believed the axle to be seated; their failure was not having sufficient curiosity to determine why the axle could not be fully inserted. *[By not rendering a diagnosis, the shop avoided the liability of a faulty repair. The damaged axle should have been replaced as part of the factory differential swap; thus negating the reoccurrence of another replacement.]*

The axle remained partially inserted and the oil seal open (see earlier photo) which resulted in oil loss and seizure of the pinion shaft and internal gears. The seizure of the pilot shaft did not damage the front angle gear because the haldex continued to rotate. Given the foregoing, it is no wonder the AWD did not function.

The Parts:

I ordered a used differential and axles from Erie Vo-vo (~\$1300) and set about developing a strategy to remove the haldex-differential from its cradle. I realized the cradle must be dropped to remove the unit. No small task. Thinking ahead, I decided to replace the rear axle hubs (\$150) as a preventive measure, new oil seals (\$30) and a jug of GL5 80W synthetic differential lube (\$15). Total ~\$2400 for transit, parts, and materials. Such a deal!

Differential Removal:

Disassembly commenced with axle removal. To remove the rear axles, the coil springs and support arms must be removed, the wheel/hub assembly tipped outward and upward, thus providing the clearance needed to remove the axle. Next, I removed the wheel bearing hubs.



My air 500 ft. lb. impact tool would not back out the hex fasteners. I purchased a 1280 ft. lb. Earthquake battery impact tool from Harbor Freight; it did. (It's a must have tool.) I also purchased the 480 ft. lb. battery impact tool. I use both: if the 480 doesn't loosen a fastener, I reach for the 1280, as there is no sense applying more power than necessary; bolts can snap and leave a big problem.

I discovered the 4 cradle support bolts were torqued north of 1300 ft. lbs. A 1/2" breaker bar equipped with a 15mm impact socket and a 3' pipe extension loosened them. When I believed one would snap; I muttered my mantra: don't jerk, just apply steady increasing pressure and the tightest bolt will loosen without snapping. They did!



Rear Differential/Haldex Cradle

So why does the cradle have to be lowered? Well, one of the three bolts fastening the differential to the cradle is installed top down, preventing the differential from being removed without lowering the cradle. A side or mount design would facilitate repair. But you think the manufacturer cares, NA-DA; because luxury car owners, as a class, are expected to pay exorbitant repair expenses or trade-up.

Next, the drive shaft had to be decoupled from the haldex. I could have performed this earlier, but decided to do so after lowering the cradle to more easily access the hub 6 flange hex bolts. I did not anticipate rust resulting from road salt would rust weld the coupler flange to the haldex hub. I poked, prodded and hit it with a hammer without success. I consulted an experienced Volvo mechanic, who advised use of a heavier hammer or an air hammer to persuade the two to decouple.

Instead, I decided to drop the differential and haldex cradle to the floor. Hitting with a thud, the driveshaft-haldex coupler separated spilling the 6 marble size ball bearings, the haldex clutch pack and mineral oil on the concrete. Problem solved.

Four bolts separated the haldex from the differential and three bolts separated the differential from the carriage. It was all apart.



This was an opportunity to inspect the clutch pack, a combination of clutch disks and stainless steel pressure plates. The fiber clutch disks (yellow) and stainless plates had no noticeable wear.



Haldex Has Alternating Clutch Disks and Plates.

After cleaning, reassembly and replacing the retaining ring, I set about to inspect the haldex oil pump filter, which had been changed. (I paid Mack to change the filter 9 months earlier.) Surprise, it was filthy. I thought to myself, the filter had not been changed.



Left: Old Filter and Cap - Right: Replacement

The pump was tested by applying 12 volts directly to the motor umbilical and it hummed.

Lubricant Filler Ports:

The filler plug on the differential's nose, which is where the clutch packs reside and the rear one is the differential oil fill port.





Photo of Uninstalled Differential

Refill Haldex with Mineral Oil:

To fill the Haldex, insert the oil tube 6" into the port (left) because it fills from above. Port on right is for GL5 differential oil. (See previous photo)



View of Haldex Clutch Pack Chamber and Oil Fill Tube

If the tube is not inserted upward about 6" into the clutch pack cavity, oil will run out the access port and you'll mistakenly believe the cavity filled, when it is not. Big problem, the clutch pack will burn out within a minute or two of driving and should it seize, do all kinds of damage to the driveline. Fill the cavity with .7 liters of mineral oil.

It is not possible to evacuate old haldex fluid with an external pump unless the suction tube is pushed to the bottom of the case. Alternately, remove the oil filter, use a jumper to apply 12 volts to the haldex pump and allow the pump to empty fluid from the clutch pack chamber.

If the haldex access hole plug cannot be removed, follow this procedure: Remove the filter, use a jumper to operate the pump to drain the haldex. To fill, shove a clear plastic hose the diameter of the oil filter neck into the filter receiver hole, reverse the polarity of the pump motor umbilical so it'd run backwards, stick the other end of the tube into a bottle of mineral oil, energize the pump and it should suck the fluid into the haldex. Either way, pump 0.7 liters of mineral oil into the haldex. Install new filter and cover plate.

#### Haldex Fluid:

Let's talk about "the-highly-refined" automotive hydraulic grade mineral oil. The hydraulic pump in my Mercedes' auto retracting hardtop was leaking. I purchased the "highly refined" automotive mineral hydraulic oil at \$26/liter. Over the course of a driving season and \$100 later, I reasoned a more cost effective solution was required. I knew human grade mineral oil was used in food preparation hydraulic systems so in the event of a leak, food is not contaminated. Furthermore, food grade mineral oil is highly refined. Wal-Mart pharmacy sells pint bottles of food grade mineral oil for \$1.98. You guessed it; the haldex is filled with food grade mineral oil. BTW, I fixed the leaking hydraulic pump in the Mercedes.

#### Mount Haldex to Differential:

I unpacked the donor differential I'd received from Erie Vo-vo, mounted the haldex and bolted it to the differential.



Differential and Haldex Mated

The haldex, differential and cradle weigh about a 100 pounds and the thought of lying on the ground, bench pressing the cradle to the XC's under body with one arm and installing the 4



fasteners with my other hand was 50 years beyond my capability. The standard 2 ton car jack did not offer a stable platform. I shoved a motorcycle floor lift (Harbor Freight \$89) beneath the cradle, rolled it in place and up it went. Perfect! Plus the motorcycle lift allowed the cradle to be easily jockeyed into position.

The rearward fasteners were installed first, about half-way, and then the jack was lowered tilting the nose of the haldex coupler downward. I reinstalled the 6 marble size bearings in the drive shaft coupler, then slid the coupler into the haldex receiver, lifted the cradle and replace the 6 hex coupler retaining bolts. If I'd not employed this trick, it'd been necessary to drop the mid drive shaft carrier bearing to gain clearance. The forward cradle fasteners were installed next. All fasteners were snug, but loose enough to facilitate placement of the remaining suspension components; as it's necessary to jockey components around to achieve component alignment.

#### Wheel Hub Installation:

The new rear wheel hubs were installed each marked with the installation date. I use a yellow paint pen to date replacement parts; should I return to a problem, I know when components were replaced or serviced.



Dated Hub

#### Axle Installation:

The replacement right axle arrived from Erie Vo-vo. I needed to resize the compression-lock ring in the axle tip because they become distended when jerked from the retaining ring of the axle gear upon removal. With the ring on the axle, heat it moderately with a propane torch and then crimping the ring against the shaft with a pair of pliers, hold until cooled. To install, first insert the hub end, then slide the other into the differential, give it a powerful shove to lock it firmly in the ring receiving slot in axle gear. Over crimping the ring will prevent the axle from locking; remedy by removing the axle and expanding the retaining ring slightly, then reinsert.

Don't strike the hub shaft end with a hammer; you'll distort the axle splines that engage the wheel hub.



Pointing to Replacement Right Axle

Axles in place, install coil springs, shock absorbers, torsion bar and its links, add GL5 rated gear oil to the differential, install the brake calipers and brake pads, tighten all fasteners, and mount wheels and road test. Anytime a rear cradle is removed, the rear wheels must be aligned. A shop with a 4-wheel laser alignment system is required.

Test Drive:

It is not unusual for hidden damage to be revealed in a test drive. I was prepared for the worst to emerge. Once the XC70 was on the ground, I hit the starter and the T6 sprang to life after a month of hibernation. Slipped it into drive and headed down the road. So far so good, at 25mph a strong vibration emerged. Not good. Returning to the garage, I grabbed my GoPro camera, attached to a 50# magnet, and stuck it to the undercarriage pointing at the right axle, another shaky drive to 30 mph. I repeated drives with the camera pointed to left axle and then the drive shaft at the haldex coupler. Returning to the garage, I reviewed the video and could see the left axle jumping a bit and the drive shaft a bit blurry (out of balance). I removed the passenger side axle and inspected it closely and observed that the knuckle at the hub had been hyper extended; hence, oscillated under power. I'd foreseen this eventuality and had ordered another axle. Replacement axle installed; another test drive and perceived a mild vibration, which I conjectured originated from the drive shaft coupler.

Upon removing the six hex bolts fastening the driveshaft to the haldex, discovered the black neoprene gasket, obscured inside by grease in the coupler, had become entangled in the bearings, preventing smooth rotation; hence vibration under power. Fixed that, reassembled and all is good.

Still have a slight vibration, possible U-joints, which likely took a beating during the attempt to extricate the XC70 from the snow drift. I'll address that issue in due course.

#### Forensic Analysis:

So, why did this series of catastrophes occur? Simple! The first differential lost lubrication and the pinion and axle gears ceased rotation which resulted in the right axle being spit from the axle gear and the left axle hyper extended. Why? Because the vehicle has rolling inertia and something has to give.

Why did the differential lose its lubrication? Because, the fluid level was never checked as part of the regular maintenance performed by various trusted shops; hence, the differential lost its lubricant and failed. Shops often advertise, "We check all fluid levels"; this is code for *only those fluids under the hood*. Transmission fluid, haldex, angle gear and differential fluids are ignored. Perhaps a thorough fluid check requires too much shop time to remove the inspection/fill ports to check the various levels, more likely, the lube guy is a low level poorly trained minimum wage technician. (This is a reason not to only patronize quick lube shops.)

This mechanical disaster, which included three differentials, two axles and countless labor, was completely preventable. Thousands of dollars were needlessly spent because the mechanics and shops trusted to maintain the vehicle failed.

The second differential failure was due to the reinstallation of a faulty rear axle which allowed the differential oil to leak, the differential seized, and the bad axle was spit out and the other axle hyper extended.

In normal circumstances a similar saga results in extreme repair costs and the owner sending an otherwise serviceable vehicle to the crusher. Such events are why "people" lament Volvos are too expensive to repair, because this type failure means correcting the mistakes of shops trusted to change engine oil and properly inspect the other systems requiring lubrication.

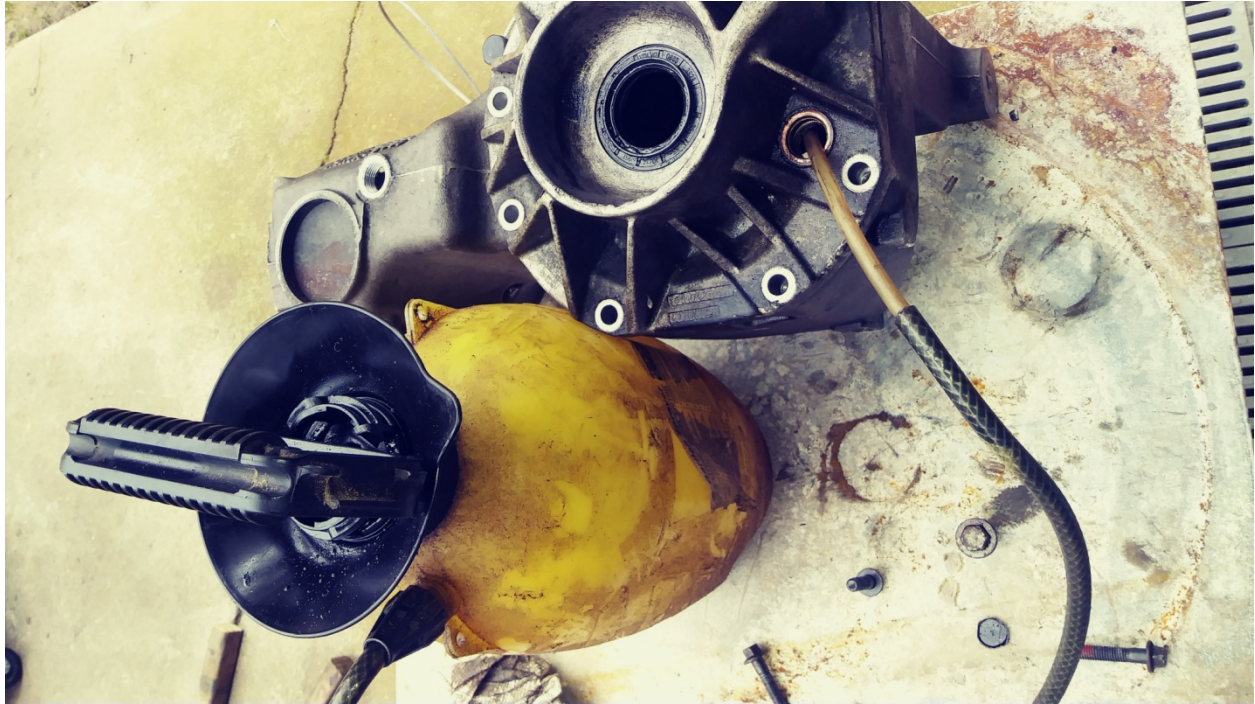
#### Take Away:

Each time a vehicle is brought to a shop for an oil change, INSIST the transmission, brake and if AWD, angle gear, haldex and differential fluid levels be checked. Make certain these checks are written on the work order. You may pay more for "full" service, but will save thousands of dollars in needless repairs, defer replacement vehicle costs and have reliable transportation for many, many years. Should a shop say they cannot check these fluid levels, find another shop. Plus you must verify these checks have been performed, ASK!! If possible, watch while the vehicle is serviced, don't just sit in the waiting room using your handheld device! Become involved in the care of your investment.



## Bob's Helpful Hint: Gear Lubricant Installation

Let's talk about putting heavy gear oil in a gear box from beneath a vehicle. Years ago, I found it impossible to use a squeeze bottle to push heavy gear oil into a gear box port. My solution is to pour gear lube in a plastic 1 gallon pump sprayer. Then pressurize the sprayer to push the oil up and into the gear box. Place a 1-foot length of clear plastic hose at the end to view fluid flow. Release pressure when oil drips from filler port to stop oil flow; then cap the opening.



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