

The following excerpts were taken from The Tech Brief prepared by the Federal Motor Carrier Safety Administration and Transportation Research Board (TRB) Paper #05-1234.

“Heavy Vehicle stability and control problems contribute to the “work” of driving a truck, inducing fatigue due to the often continuous amount of driver steering corrections needed to counteract the unstable behavior of the castered truck wheels. The physical workload associated with “fighting” the steering wheel in cross winds is particularly fatiguing to neck and shoulder muscles. There was a need to determine whether a technology that lessened this physical workload on drivers would result in less fatigue. The technology that best fulfilled this requirement and was tested in the pilot study was the Howard Power Center Steering system.”
(Precision Steer Wheel Control System). (TRB Paper #05-1234)

“Among all FMT technologies deployed however, drivers were significantly more enthusiastic about the benefits of the Howard Power Center Steering® and Safetrack®....”

(FMCSA Tech Brief)

Q. 84 Table: Raw Data Rating Scores for each FMT Device (1 to 10 scale)*

USA Driver Number	Fatigue Management Technologies			
	CoPilot PERCLOS	SleepWatch	SafeTRAC	Howard Power Center Steering
031	1	3	3	10
032	1	5	5	10
033	1	5	7.5	10
034	8	9	8	9
035	2.5	9	8	5
036	2	5	7	4
037	5	9	10	6
038	2	4	9	7
039	1	1	8	10
040	2	8	10	10
041	3	10	5	10
042	7	5	9	9
N=12	N=12	N=12	N=12	N=12
Average Rating	2.96	6.08	7.46	8.33
Percent ≥ 9	0%	33%	33%	67%

* Use the rank of “1” to mean “not good, don’t like or want it” and use the rank of “10” to mean “it’s a terrific idea,” and you would like to have one in your truck and/or think other drivers should want it too.

River City Products, Inc. - Comment:

It is obvious from the answers and comments that several of the drivers did not understand how to use the Howard Power Center Steering system. This situation may have occurred due to lack of adequate training or the time span between training and the commencement of the test.

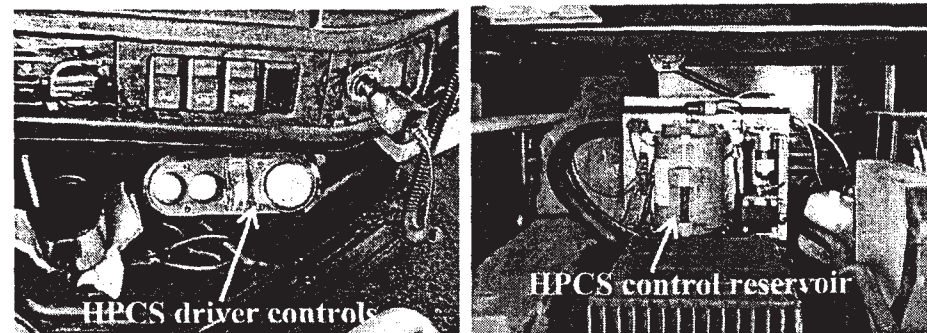
The trucks used in the test were taken at random from a fleet of in-service used trucks, and equipped with the Howard Power Center Steering System. This resulted in higher forces when turning around curves in the highway. This would not happen when the Power Center Steering system is installed on new trucks at the factory, because the new power steering gear would be produced to have lighter steering forces to compensate for the very effective on-center steer wheel stabilizing force of the Howard Power Center Steering System.

2.4 Howard Power Center Steering® system to reduce physical fatigue of driving

The technology selected for reducing the physical work of controlling vehicle stability while driving was the *Howard Power Center Steering® (HPCS)* system (River City Products, Inc., San Antonio, TX). Unlike the other FMT technologies that were designed to provide feedback to drivers on their behavioral alertness relative to fatigue based on sleep and circadian biology, the *HPCS* system was designed to lessen physical fatigue associated with drivers “fighting” the steering wheel in cross winds (i.e., driver correction of vehicle instability and control problems). See Appendix A-1 for photos of the *HPCS* technology, and Appendix B-1 for how instruction in its use was provided to drivers.

Heavy vehicle stability and control problems contribute to the “work” of driving a truck, inducing fatigue due to the often continuous amount of driver steering corrections needed to counteract the unstable behavior of the castered truck wheels. The physical workload associated with “fighting” the steering wheel in cross wind is particularly fatiguing to neck and shoulder muscles. There was a need to determine whether a technology that lessened this workload on drivers would result in less fatigue. The technology that best fulfilled this requirement and was tested in the pilot study was the *HPCS* system (see footnote 5). The *HPCS* involves a hydraulic device attached to a truck’s tie rod and steering system to reduce the physical demands of driving. The system consisted of two components: the Hydraulic Power Centering Cylinder and the Air Activated Hydraulic Pressure Accumulator (see Appendix A). The normal operation of the system was automatic and required little attention from the driver. The driver controlled the desirable hydraulic pressure on a panel by adjusting air pressure, which increased or decreased effectiveness of the system. The system could be turned off by the driver via a simple switch pressed to release air pressure in the accumulator (Figure 5).

Unlike the *SleepWatch®*, the *Copilot®* drowsiness monitor, and the *SafeTRAC®* lane tracker, the *Howard Power Center Steering®* system did not provide numeric feedback. Rather, this system was turned on in the FMT FEEDBACK condition and it was off in the NO FEEDBACK condition. When on, drivers could feel the steering wheel stability relative to when the system was off. Steering wheel variability was recorded electronically in both the FMT FEEDBACK (*HPCS* turned on) and NO FEEDBACK (*HPCS* turned off) conditions. Figure 5 displays *HPCS* in project trucks.



Driver: Yes. Im going to be pulling triples soon. I think *HPCS* would take a lot of the trailer swing out of the 3 trailers.

Driver: Yes. Great on doubles (trailers) I believe it would be even better on triples.

Driver: Yes. Hate to do without it.

Q. 56. I would recommend *HPCS* to other drivers? ____ yes ____ no

Summary for Q. #56:

Answer Yes: 10 drivers

Answer No: 2 drivers

Q. 57. Driver’s overall comments or recommendations on the *HPCS*:

Driver: I found this system to help out considerably. At first I was expecting a very big change – but as I got used to adjusting the pressure and conditions I felt it was very beneficial and safe. It helped in controlling whipping of 2 trailers and keeping the unit very straight on center going down the highway. – I will miss not having it.

Driver: GREAT PRODUCT!

Driver: This piece of equipment should be standard on any truck that pulls doubles or triples (trailers) because of the control it gives you over wiggle in your lane.

Driver: I believe I would love this system on straight roads.

Driver: Lights need to be brighter and one put in trim button.

Driver: Only good on straight roads.

Driver: I could see where big trucks it would be useful. These Trucks are bottom of the barrel quality. Steering not so good. All around good product.

Driver: It works better on straight roads but with lower pressure on the curves.

Driver: Liked it very much would like to see *HPCS* installed on all new CCX trucks coming into service.

Driver: Should be put on market for all trucks.

Driver: Compressor little noisy when first airing up. Maybe a center gauge so you know exactly when the piston is Center or you have more pressure on one side or other. Top dead center- or top dead middle – indicator.

improved truck steering or helped maintain direction (Canada 69%, U.S. 75%), and most felt it “always worked in a helpful manner” (69% and 75%). While just 50% of Canadian drivers liked the location of the HPCS controls, 83% of the U.S. drivers liked the location in their trucks.

On the critical question of whether HPCS reduced driver fatigue, 54% of Canadian drivers felt it did, compared to 75% of U.S. drivers. There were many positive comments on the HPCS from drivers (Appendices F-1 and F-2). *Most drivers indicated they would like the Howard Power Center Steering® system installed in their trucks (Canada 77%, U.S. 83%), and that they would recommend it to fellow drivers (Canada 85%, U.S. 83%). These were highest proportions of affirmative responses found on these two questions in both study phases for any of the four FMT technologies (see questions 55 and 56 in Tables 67 and 68).* It is noteworthy that as an already commercially available product, HPCS was built to specifically operate in the truck environment. This was not yet the case for some of the other technologies.

10.6 Drivers’ reactions to the *Psychomotor Vigilance Task* (PVT-192)

Tables 69 and 70 summarize drivers’ post-study responses to questions 58 through 63 from the Human Factors Structured Interview Questionnaire, which concerned drivers’ reactions to the *Psychomotor Vigilance Task* (PVT-192) test device (Appendices F-1 and F-2). It is important to keep in mind that the PVT was not utilized in this project as a fatigue management tool, but rather its purpose was to serve as an independent objective evaluation on drivers’ alertness/sleepiness at the midpoint and at the end of each trip. Relative to PVT normative data, drivers’ performances on the PVT-192 (see Sections 6.2 and 8.3, Tables 12 and 23, and Appendices D-1 and D-2) and their comments about it (see Appendices F-1 and F-2), indicate that they took the test very seriously and generally attempted to do their best when performing it. This conscientiousness was impressive considering that a majority of drivers (58%) in both study phases felt the PVT-192 was intrusive to their duty days (Tables 69 and 70). The intrusiveness is not surprising, since they had to stop driving and take 10 minutes to perform the task midway in a workday, and at the end of the workday, and do this on every workday for the entire month each was empanelled in the study.

The majority of drivers in both study phases felt the PVT matched their own perceptions of their reaction times (Canada 73%, U.S. 83%), and when their PVT reaction times were slower, most drivers felt the PVT times reflected their own overall assessment of fatigue (Canada 73%, U.S. 92%). Although the PVT was not discussed with drivers as a fitness for duty device, they were asked in the post-experimental questionnaire if it “could be used as a personal checking system on driver *fitness for duty* system (e.g., to check for a driver’s readiness to drive as he/she reports for duty, or at rest stops half way through a long trip)” (Tables 69 and 70, and Appendices F-1 and F-2). Surprisingly, a modest majority of drivers answered affirmatively to this question (Canada 54%, U.S. 58%). Since the Psychomotor Vigilance Task was not one of the Fatigue Management Technologies used in the study, but rather, purely an assessment tool for drivers’ behavioral alertness, drivers were not asked if they would like their own personal PVT device, or whether they would recommend it to fellow drivers, as was done for the four FMT technologies. One of the more frequent comments from drivers about the PVT was that the test was too long and

Driver: Yes. Very helpful.

Driver: Yes. Did not have to constantly over-correct steering to keep the truck going in the right direction.

Q. 51. HPCS always worked in a helpful manner? ____ yes ____ no

Summary of Q. #51:

Answer Yes: 9 drivers

Answer No: 2 drivers

Answer blank: 1 driver

Q. 52. How did HPCS affect my driving on curves?

____ helped ____ hindered ____ no effect noticeable

Summary for Q. #52 (HPCS on curves):

Answer helped: 2 drivers

Answer hindered: 7 drivers

Answer no effect noticeable: 2 drivers

Answer: both helped and hindered: 1 driver

Driver comments:

Driver: helped and hindered, a little of both. Lower pressure seemed to help.

Q. 53. Was HPCS helpful driving in straight-aways?

____ helped ____ hindered ____ no effect noticeable

Summary for Q. #53 (HPCS on straight-aways):

Answer : all 12 drivers (100%) indicated it helped their driving in straight-aways.

Q. 54. HPCS reduces driver fatigue? ____ yes ____ no

Canada Study Phase 2 results

Table 67. CANADA Study Phase: Summary of drivers' responses to questions 44 through 57 concerning the *Howard Power Center Steering@ (HPCS)* monitor. Responses were derived from the Human Factors Structured Interview Questionnaire administered during debriefing following the FMT FEEDBACK Condition at the end of their 4 weeks of participation (see Appendix F-1 for detailed responses).

No.	Question (n = number of respondents)	Yes	No	Y+N or no resp.	comment
44	Operation of the HPCS was consistent and understandable. (n=26)	88%	8%	4%	42%
45	The use and location of HPCS controls/displays were good. (n=26)	50%	46%	4%	62%
46	The HPCS steering assistance was helpful in my driving. (n=26)	77%	15%	8%	58%
47	HPCS made my driving workload easier. (n=26)	73%	27%	0%	0%
48	I felt comfortable using the HPCS. (n=26)	77%	19%	4%	10%
49	HPCS improved my truck steering or ability to maintain direction. (n=26)	69%	19%	12%	46%
50	HPCS was helpful driving in crosswinds. (n=26)	81%	15%	4%	38%
51	HPCS always worked in a helpful manner. (n=26)	69%	31%	0%	0%
52	How did HPCS affect my driving on curves? Yes = helped; No = hindered. (n=26)	38%	31%	31%	4%
53	Was HPCS helpful driving in straight-aways? Yes = helped; No = hindered. (n=26)	77%	12%	12%	0%
54	HPCS reduces driver fatigue. Yes = helped; No = hindered. (n=26)	54%	31%	15%	54%
55	I would like HPCS in my truck. (n=26)	77%	19%	4%	46%
56	I would recommend HPCS to other drivers. (n=26)	85%	12%	4%	4%
57	Driver's overall comments or recommendations on the HPCS.	na	na	na	85%

*Not applicable (na).

Driver: Yes. Made the truck much easier to keep in the lane and going down the road

Driver: Yes. Keeps rear trailer I drove from whipping. I predicted it would work well on triples; and double trailers.

Driver: Yes. I loved it Keeps me honest.

Q. 47. HPCS made my driving workload easier ____ yes ____ no

Summary results:

Answer Yes: 9

Answer No: 3

Q. 48. I felt comfortable using the HPCS? ____ yes ____ no

Summary of Q. #48:

Answer Yes: 9 drivers

Answer No: 3 drivers

Driver comments:

Driver: Yes. I had no problems with my truck.

Driver: Yes. After the first week it was very easy to operate, even in long turns.

Driver: No. It was not helpful due to curves and bends in road lucky to have 1 mile stretch.

Driver: No. I felt more control and a better feel of the road with the HPCS turned off

Driver: No. I had to fight too much steering wheel pressure in turns.

Driver: Yes. Very comfortable. Took about 5 trips to get comfortable

Driver: I don't believe HPCS will be that effective in our place of work. The turn button needs a light. Maybe make the trimming automatic, had to oversteer too much to set the trim where it needed to be causing me to zig-zag. I found out for myself best operating range for me with these road conditions was about 130 PSI.

keep low red lights on near the floor of the truck cab at night, but they don't "flash;" whereas PERCLOS did flash red lights at him and he found that to be a distracter. "Until perfected, it is just a horrible flashing neon sign on the dash."

Driver: The numbers seemed to be all over the scale. Sometimes I felt good, but the PERCLOS numbers were low. Other times the opposite. But not always.

Driver: This driver rated PERCLOS a "1" on a scale of 1 to 10. She said she has lazy eyes. The flashing red light was distracting - the reading stayed at 100 most of the time, and she found it not helpful.

Driver: This driver rated PERCLOS a "2" on a scale of 1 to 10. She indicated the PERCLOS scores did mean much. What do they mean? She wore light diffusion glasses and at night.

SECTION E: HOWARD POWER CENTER STEERING SYSTEM (HPCS):

Please rate the Howard Power Center Steering System (HPCS)

Q. 44. Operation of the HPCS was consistent and understandable? 23 yes 1 no

Summary of Q. #44:

Answer Yes: 23 drivers

Answer No: 2 drivers

Answer blank: 1 driver

Driver comments:

Driver: Yes. Great system.

Driver: Yes. It is the best invention that was made to reduce fatigue and stress, and be able to be more relaxed.

Driver: Yes. It performed pretty well as explained.

Driver: Yes. He was a rally driver, close ratio rack & pinion. Lot of rain & wind past 2-3 days. Close ration rack and pinion 1 1/2 turns uses 2 1/2 times less turning of wheel with HPCS.

Driver: Yes. When the truck was "heavy," it did not hold it as much; so then he upped PSI to 140 PSI.

Driver: Yes. He loves the HPCS, as it made steering and driving a lot easier. He took his hands off the steering wheel and the truck stayed true and straight. Even going through

SECTION E: HOWARD POWER CENTER STEERING SYSTEM (HPCS):

Please rate the Howard Power Center Steering System (HPCS)

Q. 44. Operation of the HPCS was consistent and understandable? _____ yes _____ no.

Summary of Q. #44: All twelve (12) drivers answered this question "yes."

Driver comments:

Driver: Yes. Very simple to operate. Another driver said: Very easy to operate.

Driver: Yes. I had 1.5 weeks with it turned on, before it came apart. It was aligned and it still needed some adjustments.

Driver: Yes. Several drivers pointed out that when they had a repetitive driving route from the border between Ohio and Pennsylvania, eastward to Milesburg, PA, they encounter winding roads, with lots of curves in the road. So this they declared is not a good test of HPCS. We had to "overcome" HPCS on curves just a bit.

Q. 45. The use and location of HPCS controls/displays were good? _____ yes _____ no

Summary of Q. #45: Ten (10) of the 12 drivers answered this question with a "yes," whereas two (2) drivers answered "no."

Driver comments:

Driver: No. Trim button should be lit. I had trouble finding it in the dark.

Driver: Yes. Trim button needs a light.

Driver: No. My right knee hits the control box.

Driver: Yes. It really took a lot of "play" out of the wheel and very much complemented "SafeTRAC."

Driver: Yes. Reflections on the windshield.

Driver: Yes. It could use a point of center type meter or gauge.

Q. 45a. On average, at what pressure level did you set the HPCS to drive? _____ PSI in crosswinds? _____ PSI in more normal conditions?

**Driver #031: 145 PSI in cross winds
145 PSI in normal conditions**

**Driver #032: 140 PSI in cross winds
120 PSI in normal conditions**

**Driver #033: 150-160 PSI in cross winds
120 PSI in normal conditions**

Driver #023: ___ PSI in cross winds
 ___ PSI in normal conditions

Driver #024: 160 PSI in cross winds
 140 PSI in normal conditions

Driver #025: ___ PSI in cross winds
 160 PSI in normal conditions

Driver #026: ___ PSI in cross winds
 ___ PSI in normal conditions

Driver #027: ___ PSI in cross winds
 ___ PSI in normal conditions

Driver #028: ___ PSI in cross winds
 120 PSI in normal conditions

Q. 46. Was the HPCS steering assistance helpful in my driving? ___ yes ___ no

Summary of Q. 46:

Answer Yes: 20 drivers

Answer No: 4 drivers

Answer Blank: 2 drivers

Driver comments:

Driver: Yes. more free

Driver: Yes. Because it saves fatigue on my shoulder and neck, when you got a cross wind.

Driver: Yes. Very helpful once it was set good.

Driver: Yes. Only in winds. But on very rough roads it did not work -- too much bouncing. When roads have grooves in them, or potholes, it's less effective.

Driver: Yes. It helped more with light loads.

Driver: Yes. Worked good in crosswinds.

Driver: Yes. It takes time to relax and trust it.

Driver: Yes.. It really controlled truck while driving.

Q. 55. I would like HPCS in my truck? ___ yes ___ no

Summary for Q. #55:

Answer yes and no: 1 driver

Driver comments:

Driver: Yes. More comfortable ride (no body roll) -- meaning the cab of the truck. He was really sold on HPCS.

Driver: Yes. Yes. Yes.

Driver: Yes. On A Long run it was helpful.

Driver: Yes. It gives more control with less effort on highway. Don't feel any winds from passing trucks or large units.

Driver: Yes. Mainly for long straight roads.

Driver #010: Yes.. I was amazed as to how it made driving easier and better to control the truck.

Driver: Yes. Sometimes I liked it, sometimes I didn't. I would need more time with it now. I never adjusted the pressure once and that could be a problem.

Driver: Yes. and no Driver said it works good in strong winds. Other drivers were wandering on road. while I was not because of HPCS.

Driver: No. I would like to test it in a steer blowout situation.

Driver: No. Stiffening of steering wheel response, and length of time to re-center. caused extra work.

Driver: No. A close ratio steering box would do as much better job.

Driver: No. When necessary to steer over solid line I need and I want to know that I have the control to prevent possible accident w/o fighting for steering control.

Q. 56. I would recommend HPCS to other drivers? ___ yes ___ no

Summary for Q. #56:

Answer yes: 22 drivers

Answer no: 3 drivers

Answer blank: 1 driver

Driver comments:

Driver: No. I was still trying to fight it.

Driver: No. Felt I had to correct steering more often. Had to reach for the controls.

Driver: No. Due to extra pressure on steering wheel at parameter of setting – arms & shoulders fatigued earlier.

Driver: Yes and no. On the highway, yes. In the city, no it's useless.

Q. 49. HPCS improved my truck steering or ability to maintain direction?

_____ yes _____ no

Summary of Q. #49:

Answer Yes: 18 drivers

Answer No: 5 drivers

Answer both yes and no: 2 drivers

Answer blank: 1 driver

Driver comments

Driver: Yes. You go straight all the time when there is a crosswind. It's easier to drive with it.

Driver: Yes. It worked pretty good in ruts on the highway.

Driver: Yes. It improved my truck steering or ability to maintain direction, -- but mainly on very long straight roads

Driver: Yes.. More so when tired.

Driver: Yes.. Sometimes, a few times, I was fighting it when I was tired.

Driver: Yes. On smooth roads like interstate highways. On state routes you need more attention.

Driver: Yes. and no Depending on how bad the conditions were.

Driver: Yes. and no In the city or in a parking lot I turned it off; too much force is required to steer in small places.

Driver: No. He said when you're driving in a straight line you're okay, but when you need to change lanes you gotta fight it. He calls this the "wall of resistance concept" He

left the HPCS "off" the second and last week of his participation, didn't want to challenge it?

Driver: No. It stiffened steering a bit.

Driver: No. Fought to compensate for other drivers crossing over my side of road.

Driver: blank I often felt like I was fighting steering.

Q. 50. HPCS was helpful driving in crosswinds? _____ yes _____ no

Summary of Q. #50:

Answer Yes: 21 drivers

Answer No: 4 drivers

Answer blank: 1 driver

Driver comments:

Driver: Yes. Very helpful in strong crosswinds.

Driver: Yes. Go straight all of the time.

Driver: Yes. He kept HPCS set up higher than 140 PSI most of the time. He said he hopes his employer, Challenger, will buy HPCS.

Driver: Yes. Except in excessive strong crosswinds but still better than without it.

Driver: Yes. Easy to hold straight line. However in inner city driving he turned it off.

Driver: Yes. Did not have a lot of crosswinds, but when it did it seemed to work okay.

Driver: Yes. In extreme condition it did not help. I drove in crosswind of 25-30 mph with peaks of 40-+ and I had to turn HPCS off.

Driver: Yes.. Less moving of steering wheel.

Driver: Yes.. Adjusted it and was amazed how it controlled truck.

Driver: No. Any disturbance in the crosswind (trees- underpasses, passing trucks) and I had to trim HPCS, or hold wheel to outside of "rut."

Q. 51. HPCS always worked in a helpful manner? _____ yes _____ no

Summary of Q. #51: