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May 1995

STAHL HEADERS/CAMS NEWSLETTER

ISSUE # 13

NEW PRODUCTS

DYNO CONTROLLER

See the section labeled Stuska for an announcement of our dyno controller system.

"STAHL LITE" DYNO PROGRAM

We have decided to offer a stripped down version of our Dyno program called "Stahl Lite". It is aimed for those users who want fewer choices which results in less to learn and reduced confusion. The programs will be priced at $195 for the Depac and Superflow .SD9 versions and $345 for the version to receive data from a Superflow not now connected to a computer. The files will be the same so any one who wants to upgrade to the "Regular" fully featured version will still be able to use all the data files. This "Lite" version will be available sometime in June. The Stahl Regular version that receives data will soon have the ability to issue commands to the dyno just as a terminal or terminal mode of the Superflow program will now do. Present owners will be able to upgrade for $45.00 unless you've purchased within the past 6 months then it will automatically be sent to you at no charge.

STAHL RAW PROGRAM

We have just started to ship our time based analysis software called "RAW'. Now it is possible to **look at data from any source** with even more power and flexibility than our regular Stahl Dyno Program. One version reads data from Racepak car data acquisition files and a dyno file (Depac, Superflow or homebrewed) and displays torque on the screen at all RPM data points displayed on the screen graph. By reading in a dyno test file with the data corrected at the time of the dyno test and then uncorrecting it for the weather as exists right now at the race track it is now possible to do clutch setup based upon a actual numerical torque value rather than guessing at the weather effect upon a power/clutch setup. In addition it is now feasible to put together your own data acquisition system with off the shelf components and have the most powerful software analysis tools available. In fact those with a SF901 can add a external data acquisition system to the 901 by connecting to 2 pins on the 802 card socket to pick up torque and rpm. Then use all your own sensors etc for laboratory fuel flow measurement, throttle opening, oxygen sensors or whatever. You can still have all the Superflow data if you want it in addition to the data from the new source. One acquaintance collected data on his SF901 from both the Superflow system and from a Depac. By using our software he was able to look at the data from both sources at the same time and compare the differences. He has now sold his Depac and is connecting a time based data acquisition system to the SF901. Think about how he will be able to see how the engine responds as he opens the throttle. If it stumbles, lays down or whatever, he'll see it.

STUSKA OWNERS

The following is intended for Stuska absorber owners however most of the information applies to a Gopower absorber or a Dynamic Test Systems brake. As most operators have discovered it very difficult to control engines below 5000 rpm. There is no simple solution other than a properly designed computer-driven valve controller to do the job if the water in/out system is plumbed correctly.

Experimentation by several people indicates the greatest improvement comes by increasing the size of the pump. Although it is not technically correct to classify pumps by HP rating it is the only practical way to address the situation in this newsletter. In any event the best recommendation appears to use a 7-l/2 to 10 hp pump. One customer claims to have gone from 5 to 7-l/2 to 10 to 15hp. Apparently this increases the pressure drop across the load control valve(s) and it appears brake response is proportional to pressure drop. The larger pump permits using larger outlet restrictors to reduce sensitivity and the combination significantly reduces the "over correction" problem many of us get into below 5000.

Many dyno's have been installed without regard for the outlet water drain requirement. It is absolutely necessary that water not back up in the outlet lines after the restrictors. All outlet control must be done by the restrictors and not from restriction caused by water backing up in the outlet lines. In fact, putting 3/4 to 1" hose on the outlet restrictor fittings no more than 12" long and dumping into a tank or sump built into the floor will help considerably. If the water can back up in the outlet hoses it will create control problems.

As with engines on the race track, the better the driveabilty, the easier it is to control. The better control, the easier and more precise the job can be accomplished. We video taped a number of tests done with a Depac equipped Stuska and found the most difficult part of the control problem appears to be from 3900 to 4800. When you combine that with many small block torque curves increasing 60 to 120 ft lbs over 300 to 700 rpm range in the 4000 to 5000 range it becomes obvious why the control problems appear so difficult with a Stuska brake below 5000. However, it is possible to achieve sufficient control to test from very low rpms with carburated oval track engines and, in fact, most of the majority of carburated engines will pull power fine from 1500 to 1700 although some are very difficult if you start in a severe torque hole. Kevin Enders constantly tests carburated oval track engines from 1500 rpm up and mechanical FI engines from 2500 to 3500 up on a Stuska. He has also tested several NHRA pro stock engines from 5000 up and even ran one from 3500 to 9000.

Using sufficient water boost on a SF901 makes it possible to start low on a Superflow and due to the design of the brake and water system it offers measurably more potential for testing from very low to very high rpms. In fact I doubt that the available water/load control systems for the Stuska will work from ie. 1500 to 8000. There should be few problems controlling from 5000 up. Certainly the solution to achieving repeatable data from a Stuska is by using some form of controller on the water inlet valve.

Because of all the time and effort that has gone into the development of our software and data acquisition system for our own dyno, I now see many issues much clearer than ever before. Without exception if the objective is to operate the engine on the dyno as close to the way it is operated in the car, then the dyno inlet water temp needs to be as cold as is practical to achieve it. This means water storage will have to be underground and in multiple tanks (3) with gravity refill by varying tank height. (A customer recently purchased three (3) 1000 gal fertilizer tanks for less that $1000.) The next requirement will be to have the ability to measure torque and some other variables considerably faster than is presently being done. (20 times p/second is like using a tape measure to measure a cyl bore.) We must be able to "see" (graphic representation) the data because the sheer volume of numbers is beyond anyones ability to numerically analyze.

The ability to have the engine accelerate the same load each test is paramount. This last sentence says so much I offer it as a brain teaser. A complete explanation will take several pages and I'm curious as to how many people want to think about what it means and call me. We **have just completed a prototype computer controlled load control system** which maintains the existing load control valve for Stuska systems. Presuming it works to suit me, we will offer to build a few v for sale. It appears the first few units will sell for $3500 to $4500 including software and will actually be able to control 3 devices based upon engine rpm and valve position read from a data file. It will require a computer that has no other function and may be an old 8088,8086,80286, or any 80386 type. A monochrome monitor is acceptable as it will be floppy drive only. We will need one (1) ISA 8 bit bus slot vacant to do the job.

ELECTRONIC DYNO DATA ACQUISITION REPEATABILITY

Is poor data repeatability caused by the engine, the dyno, the operator or the facility? After studying data from Superflow dynos, from numerous Depacs and several home brewed data acquisition systems the reasons could be any one of the above and we have addressed many of the potential problem areas previously. Regardless of the system being used I have come to the conclusion that all tests must be repeated once and to check repeatability this means comparing the torque at each RPM data point. Some engines run so poorly or are tested at such a fast rate that it may be necessary to repeat the test over again and again until useable data is collected. Obviously I am not proposing an engine be run in such a poor state of tune that damage will result from repeating tests.

The Stahl Dyno program has negated the greatest advantage a Depac equipped dyno had in that now a Superflow can have even more powerful data analysis tools. With a computer connected to a Superflow, it is now possible to graphically analyze any number of tests for repeatability in less than 1 minute, combine the useable tests in another minute and know what happened before the engine cools.

We think the best record system is to write down the pertinent information such as engine combination on the first test and use the word "repeat" for any duplicate tests. When you have changed components only write down what was changed. For example, "Changed intake manifold to xxxxx" or "changed timing to 38 deg" right away on a test data printout or in a notebook and type the notes in later. It is possible to use a high school or college kid to type in the notes but there will be no substitute for teaching yourself how to type using one of the touch typing learning programs. I know two (2) men over 40 who work 60 to 70 hrs per week who taught themselves how to touch type using a computer program. There is no free lunch. If you believe it is not necessary to document the testing you are doing then please help me to understand why you are doing the testing.

The data produced from testing air movement on a flow bench or torque produced by a engine on a dyno is relative in 2 ways. First it answers "Where am I right now?" and whether it's 3 months or 3 years down the road you'll want to be able to look back (presuming you've got valid relative data) to see what happened when you changed a cam on a specific engine and if you have easy access to the data you will be able to reconstruct that engine in your mind so long as you have port molds and flow/dyno data.

Based on the data I've received over the past 15 years it appears the following situations occur too frequently. Poor facility due to air ventilation and/or exhaust system problems results in data not relevant to anything. Please note the word relevant. In this application it is being used to mean that the engine will not produce the same results in the race car as it did on the dyno due to the environments being so much different. Good facility/poor records... invalidates the real reason for testing.

The majority of understanding and resulting insight comes from going back and reviewing the data to see the differences and whether engines react differently to different parts. I know a guy who very thoroughly tested 5 cams on a competitive race engine and flowed the cyl heads 12 months after the dyno tests. He discovered the heads had such poor high lift intake flow the cam tests were a total waste of time because all the other engines he builds of that type have much better high lift flow. If you make the proper notes, make cyl head port molds and have relative cyl head/manifold flow data you will always be able to "go back'. If you don't agree with the need for "looking back" today, then please start doing it. As time passes and you find yourself referring more and more frequently to your notes the insight will come. If you are like most people and have difficulty assimilating information from a bunch of numbers, then do it anyway (drawing the correct conclusions from, analyzing the data to make proper judgments).

These statements presume you are working with data. If the data is not valid then it will mislead you into making the wrong conclusions. There are other issues that confuse me such as I'll never understand the people who use the same set of headers on small blocks ranging in power from 350 hp to 600 hp.

As time passes, computer software is getting easier and more efficient to use. The more keystrokes a program requires the less value it has as an analysis tool. Users are becoming more knowledgeable which results in the time and effort required to do work with a computer is reduced. In case you don't agree with me as to how important it is to understand where you are today, then visualize yourself in the middle of downtown New York City, with no street signs and no map. Then visualize yourself with street signs and a map. Makes one hell of a difference. How do you know where to go, if you don't know where you're at ???

I wish I were willing to devote more time to

studying military history because I find people like Patton, Rommel and Schwarzkopf fascinating. From what I have read they were great history buffs. They literally memorized all the great battles. Their records of being successful warfare leaders are without peer as far as I know. I suspect that they were able to develop excellent understanding and thus make decisions and develop strategies that produced the results for which they are famous.

I find studying torque curve shapes to be fascinating. Certainly studying this type of information results in many questions. Sometimes the lack of data or the data proves to not be valid and thus prevents answering many of the questions. Several of the best engine builders I know are great fans of race engine history and they prize their early Harry Miller books among their prized possessions. We have proven it is easier to test pieces than it is to study the results and make conclusions from the test data.

ANTIQUES

Detroit's practice of doing steady state testing in 400 rpm increments is a travesty. It is my opinion they should gather data in 50 rpm increments and test in throttle opening increments of ie 10%. By using software such as our dyno program it is easy to see what went on and they certainly would be approaching more elative situations. I understand the need to simulate the rpm and throttle opening a vehicle encounters when traveling highways so as to ensure there are no holes in the torque curve to promote poor fuel efficiency or cause driveability problems. Perhaps someday they'll discover most holes in torque curves can be cured with exhaust system and they'll stop permitting cars to be designed around junk exhaust systems such as the 82-92 Camaro-Firebird among others.

From the pictures I see in many magazine articles of tests being done on street type engines after market people are continuing to make the same type of mistakes.

WORDS OF WISDOM

It is unwise to pay too much, but it is worse to pay too little.

When you pay too much, you lose a little money--that is all.

When you pay too little you sometimes lose everything because the thing you bought was incapable of doing the thing it was bought to do.

The common law of business balance prohibits paying a little and getting a lot--it cannot be done.

If you deal with the lowest bidder, it is well to add something for the risk you run, and if you do that you will have enough to pay for something better. ***John Ruskin (1819 - 1900)***

STAHL HEADERS/CAMS NEWSLETTER QUESTIONNAIRE

Your Name: _____

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_____

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Flow Bench: _____
Brand Model

Dyno: _____
Brand Model

Computer: _____

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Cams Used Most:
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Check you mailing label!
????? means we have not heard from you, please send back questionnaire.
means you will be dropped after this issue unless you reply.

AVERAGING DYNO DATA

I worked hard for 20 years and a few people started to believe I knew something. Then I worked for 10 more years and found out there are more questions than answers. Then it was suggested I should share some of the things we had learned with the help of others via a newsletter. Now I've become even more confused. Perhaps someone reading this will be kind enough to help me understand how some people think. For example in issue #7 I talked about how water must exit the brake right away. Yet I continue to run into people who have data repeatability problems and **they continue to test with the problems and make no attempt to correct the situation.**

On a rare occasion I have a conversation about the issue of repeatability. On even fewer occasions someone will mail me pictures of their dyno cell and I see that problems are caused by long outlet hoses on the brake or I see an extremely poor engine air supply system. In several previous issues I have covered the dyno exhaust system yet I continue to find people using dyno exhaust systems that are so bad that I cannot print the words to describe such actions.

Several years ago my youngest son who was in the Air-force came home one weekend and asked me what was new. I told him I had just figured out what **ignorance** was. He responded by saying that it was not complicated, ignorance was simply not knowing. I thanked him and asked him why it took me until I was 57 years old to figure it out.

Now I'm trying to figure out what you call it when you find people who appear to be limited in their learning capacity because they just don't seem to understand that averaging data between rpm boundaries is not a valid method to determine repeatability of one dyno test to another. Too many people think you can average ie. the torque or power figures for a test and compare the averages, or average ie. 3 tests together and use those numbers. Averaging is only valid if you have data that does not vary more than 5 to .6%. Averaging is used to get data that has .5 to .6% variation down 1 number. It is **not intended** to "adjust for ie. 1.5 to 2% variation in data". The days of 2% or more power gains are long gone in competitive engines. On a day when you can make a 1% power gain is sufficient reason to celebrate. Thus, unless you can recognize the l/2% (.5%) power changes how do you hope to develop an advantage.

So I delude myself into thinking that everyone who reads our newsletters will take each piece of information and apply it to themselves by asking "do I have that problem?" For those who wish to debate the validity of averaging numbers, I offer the following. If you had an engine with main bearing clearances of .OOl, .0015, .0025, .0035 and .004, is it right to total the numbers and divide by 5 and say that you have .0025 bearing clearance. I think not. To use averaging to check for data repeatability is exactly the same thing as the above bearing clearance example.

BAROMETERS

Due to the increasing awareness of people misusing mercury barometers and general confusion surrounding barometric pressure I offer the following information. In engine dynomometry there are two separate issues relative to the use of a mercury barometer. Most of us in the racing world like big numbers so we have chosen to use the SAE power correction standard that calls for correcting power so the numbers come out just as if the engine was run at a dry throttle atmospheric pressure reading of 29.92 inches of mercury and an engine inlet air temperature of 60 degrees F.

To obtain the correction factor in a world of no computers we need three things:
(1) a barometer reading,
(2) a vapor pressure value,
(3) an engine air inlet temperature.
The procedure is to read our barometer then read our wet and dry bulbs. Since a proper air supply system would conceptually have the wet-dry bulbs located in the engine air supply duct, we can use the dry bulb reading for inlet air temp. Next we go to the psychmetric chart to determine vapor pressure by finding the intersection of wet bulb and dry bulb readings. Then we subtract the vapor pressure from the barometer reading to achieve a dry throttle pressure **sometimes incorrectly referred to as corrected barometer.** The last step is to go to the power correction chart and align the dry throttle pressure with carb air temp to obtain a power correction factor value such as 1.043. This number is referred to as a power correction factor which is then used to multiply observed torque and observed horsepower to achieve corrected torque and corrected horsepower.

How do we go about obtaining accurate valid numbers for barometric pressure and vapor pressure? For those few people who want to do things **correctly** (according to the reference

papers and people who are more knowledgeable than I) the following is offered. Our **first** objective is to obtain a true barometric pressure for the site of the test or race. I have made an ongoing study for over twenty (20) years by recording readings of 3 different wall mounted "Navy type" barometers vs a Taylor engineers barometer (sells for $1000.00 presently) vs a Princo mercury barometer. At various times there has been a second Princo, several altimeters and other types of barometers. Recently a surveyor's altitude measuring barometer was added to the collection and is showing promising results but is difficult to read closer than .25" Hg.

I have run into several very successful people who have a round dial type barometer who each seem to think "I have a accurate barometer". To anyone who believes a round dial type barometer is going to be accurate when they take it out of the box or over ie. a 1" change of mercury in barometric pressure I can only say, "Why do you think there is a small screw accessible from the back?". The answer is, so it can be calibrated. How do you calibrate a barometer with an adjusting screw? **By using an absolute mercury barometer as a reference.** Do they stay in calibration? Sometimes, for a while, for varying lengths of time. **If you care enough to do the job correctly then use only an absolute mercury barometer** as a baseline, reference point etc.

Hopefully someone will soon be selling an electronic barometer that will maintain a calibration for ie. at least 2 months and then easily allow the user to calibrate it against a mercury barometer.

Our **first issue** to address using an absolute mercury barometer involves **compensating** the numerical value we read for the **temperature** of the mercury and the **location** of our mercury barometer. We measure the temperature of the mercury to determine how the expansion/ contraction of the mercury is effecting the readings. Next we need to adjust for the effect of gravity due to the differences in gravitational pull from one part of the USA to another upon both the reservoir of mercury and the column of mercury. The manual that comes with the Princo explains how to do this using the supplied charts. Each time the barometer is read you need to subtract the specified amount for temperature correction from the observed barometric pressure value and further subtract or add for gravitational pull depending upon where you are located.

If you do not have a mercury barometer, the first issue is of no concern to you. If you are using an electronic or a dial type barometer then it is supposed to self compensate for temperature and you have to calibrate it to take care of the gravity pull. Depac owners only have to be concerned with the first issue unless they want to calculate the correction factor and lock it into the Depac system. Superflow owners need to be concerned with both the first and second issues.

Our **second issue** relates to measuring the water content in the air by using a wet-dry bulb and/or humidity measuring system so we can obtain a **dry throttle pressure.** Apparently the method described above to obtain vapor pressure as a function only of wet-dry bulb is practical for a manual method. However it does not produce a totally accurate vapor pressure. It seems that barometric pressure needs to be considered as part of the equation and thus I suggest the use of a weather correction computer program. Although there are many digital temperature measuring devices for both air temp and humidity I suggest using only mercury thermometers for better accuracy. Keep in mind our objective is to measure the temperature and water vapor content of the air the engine is ingesting. A thermometer in the air stream will measure what we call "dry bulb". By covering the reservoir of a second thermometer with a clean cotton sock that has been adequately dampened with distilled water we can obtain a wet bulb reading if we pass enough air the sock/bulb. A fan blowing air across the bulbs will cool the wet bulb based on the air's ability to evaporate.

It is my opinion that **manual humidity gauges are as big a joke** for our purposes **as air density gauges.** I recently saw an electronic humidity gauge advertised for $495 that claimed +- 2% accuracy. If we have accurate barometer and wet/dry bulb readings our computer program should produce very accurate results for vapor pressure which will produce an accurate dry throttle pressure and thus an accurate power correction factor. If we are using the weather data to either correct drag strip times for engine power effect or to predict engine power effect upon ET or MPH then the more accuracy we have the more accurate picture we will have.

Most well tuned engines make the most power when the dry throttle pressure is the highest. Several times at Daytona I have seen a negative correction factor (ie. barometer of 30.2 and an air temp of 62 degrees) which frequently results in burned pistons.

If you are one of those people presently using

either Stuska or GoPower correction formulas or charts, barometric pressures as published by a radio station, television, or obtained by calling an airport, **your data is not valid or relative from one day to the next. The** barometer reading announced over the radio is corrected to sea level as is the reading given out by most airports. If you can afford to have a dyno or a race car then you can afford to have a absolute mercury barometer.

To achieve the most valid temperature numbers we should use mercury thermometers. The altimeters we have studied to date indicates they do not produce accurate or valid enough results to use for power correction or drag strip correction. Since numerous Depac owners choose to calculate the correction factor and lock it into the system I suggest you purchase a computer program that will calculate the values for you. In order to provide a reference point I offer the following values as output from the program we currently are using and is for sale.

Barm 29.92 Dry 60 Wet 38.77
AirDen 100.00 Humid 0.00% RelAlt 65
ET 7.15 Corr ET 7.15
MPH 192.57 Corr MPH 192.57

Barm 29.45 Dry 70 Wet 62
Air-Den 95.02 Humid 63.77% RelAlt 1687
ET 7.15 Corr ET 7.039
MPH 192.57 Corr MPH 195.618

Barm 29.75 Dry 85 Wet 73
AirDen 92.70 Humid 55.97% RelAlt 2484
ET 7.15 Corr ET 7.061
MPH 192.57 Corr MPH 194.986

We offer a computer program that performs the above weather data, includes both ET and MPH correction as per the printed example and will calculate a projected ET and MPH based on a previous run with its weather data.

This article on barometers has been one of the most challenging and difficult I have encountered. If you have trouble understanding the information please let me know. I will attempt to rewrite the difficult parts again. Until someone shows me a better way I suggest using only mercury thermometers for wet-dry bulb. Taylor sells a mason hygrometer for around $45. Princo 215-355-1500.

MIDAS TOUCH & OXYGEN SENSORS

For years I have tried to understand how some people can always be the best as in "If I machined your cyl head it was done right". These are the same types who never admit to making a mistake or doing something wrong. Anytime I hear someone tell me they can get 1 or 2 hp repeatability from the SF901 at 300 rpm acceleration mode it makes me feel like vomiting. Hell I know they can't even get 1% repeatability or at least no one has ever sent me data that supports the claim. Everything they own is the "best" and their ways of doing things is the only right way. I've finally found a label that I like. I call it the "Midas Touch".

I've got to tell you about a drag racer, who's name must be kept confidential for obvious reasons who I call "King Midas". This guy does not understand the differences in barometric pressure as produced by a mercury barometer, dial barometer, values given out over the radio, observed barometer and a barometer corrected to sea level. He calibrated a round dial barometer to his local radio station and nothing I could say made a dent and, in fact, he wanted to argue with me. I observed his barometer at a major NHRA event and it was off at least .6 of an inch. This is the same barometer he uses in his dyno facility. I often wonder how much it changes calibration from the vibration of traveling in his truck. Think about how that affects any realistic numbers he wants to deal with relative to power, drag strip et and mph correction or what will happen if he ever tries to apply weather correction to a engine torque value for intelligent clutch management.

This is the same guy who told me that the single wire oxygen sensor he bought from xxx was accurate and dead on for mixture in his dyno facility. I don't want to take the space here to dwell on oxygen sensors. If you are interested ask for our paper on oxygen sensors. However everyone needs to know there is no application to use a OEM (original equipment manufacturer) oxygen sensor on a race engine. They are intended for use in a very narrow range each side of 14.7 air/fuel ratio. Anyone selling a single wire oxygen sensor to be used for air/fuel ratio measurement is ripping off customers and is typical of the junk sold in the racing world due to lack of proper engineering or knowledge.

The bottom line today is in my opinion if you want to have any kind of valid data on full throttle race engine air/fuel ratio then buy Horbia's air/fuel ratio device which incidentally has a 0-5v output for most data acquisition systems. So it is appropriate for me to quote the famous American race car designer Bob Riley who once said to me "I will give you my opinion but I will not debate the subject."

DOING THINGS RIGHT

Often my Dad used to say to me "Son, if it's worth doing, it's worth doing right." For a long time I've been trying to understand why people don't do things right. The reasons we've found so far are:

1) The customer won't pay me to do it any differently.
2) I think the way I am doing it is the right way.
3) I think the way I am doing it is "good enough." There is no reason to do it any different.
4) I am too lazy to put in the effort required to do it any better.
5) I can't afford to do it right. (either money or time)
6) I don't believe doing it right will make any difference.
7) I don't understand all the issues that are involved.
8) Right or wrong getting it done is most important.
9) I don't have time to do it any differently.

I need help to finish this list... so if you have any thoughts please write, fax (717-854-9486) or call.

MEASURING CAMS

Since I have spent considerable time experimenting with cam measuring equipment I offer the following comments. The best method I have found to determine the accuracy of my measurements is to measure the same lobe 5 to 9 times and look at the repeatability. When I get it right, the duration at specific lift values such as .006, .013, .020, .050, .lOO etc will repeat within .Ol to .03 degrees. In addition, the acceleration profiles lay on top of each other and I set my graph resolution so that acceleration uses most of the screen. There **has never been a time** when I could measure a lobe the first 3 attempts and get repeatability. Thus I am saying that if you think you can measure all the lobes on a camshaft with any accuracy by measuring each lobe once, you are either one of those people who have the "Midas touch" or engaging in a practice of self abuse. My advice for years has been to measure 1 intake lobe, 1 exhaust lobe, lobe separation and then use a micrometer to measure the rest of the lobes. All the intake lobes should not vary more than .005 in total height from the toe to the heel. (Max number you can obtain measuring a cam lobe.) The same goes for all the exhaust lobes. As long as racing cams are ground on Van Norman, Berco or Storm Vulcan cam grinders, the above is accurate and valid. If the cam was ground on a CNC cam grinder then there is reason to measure all the lobes and I wish you luck. It certainly will be time consuming to measure each lobe somewhere between 5 and 15 times if you have a good fixture. The practice of measuring all the lobes of a cam in the engine/block is an ultimate example of self abuse. Of course I have done a lot of self abuse in my life due to ignorance on my part. I certainly do not accept everything people tell me as factual. I can tell you, if someone makes me aware of new information it gets my attention. Next, I attempt to try to determine if what they are telling me is supportable by facts.

NEAT STUFF

Audie Technology is continuing to improve the Cam Pro System and by the time you read this will be offering a motor drive option that will promote repeatability. Audie's software is without question the most powerful software in the world of computerized cam measuring equipment. He also now offers a program called "Valve Pro" that permits modeling valve motion including graphic display for example of rocker arm motion. In fact you can "blow up" the roller tip of a rocker arm and watch it move across the end of the valve stem. The incredible programming effort combined with limited market to recover investment has resulted in pricing that will separate the serious people from those who are wanta bees. Since many people have converted their cam measuring equipment from that of another manufacturer I suggest to you that if accuracy is one of your goals, then you need to be using Audie's current fixture. Call them at 610-630-5895.

For those of you not on Audie Technology's newsletter mailing list I urge you to call 610-630-5894.

When man learns to understand and control his own behavior as well as he is learning to understand and control the behavior of crop plants and domestic animals, he may be justified in believing that he has become civilized.

E. C. Stakman