④ What about Hobbyist Interferometry?

Building something that demonstrates the principles of interferometry may not be all *that* difficult (see the comments below). However, constructing a useful interferometer based measurement system is likely to be another matter.

So you would like to add a precision measurement system to that CNC machining center you picked up at a garage sale or rewrite the servo tracks on all your dead hard drives. :) If you have looked at Agilent's products - megabucks (well 10s of K dollars at least), it isn't surprising that doing this may be a bit of a challenge. As noted in the section: Basics of Interferometry and Interferometers, a high quality (and expensive) frequency stabilized single mode HeNe laser is often used. For home use without one of these, a short HeNe laser with a short random polarized tube (e.g., 5 or 6 inches) will probably be better than a high power long one because it's possible only 2 longitudinal modes will be active and they will be orthogonally polarized with stable orientation fixed by the slight birefringence in the mirror coatings. As the tube heats up, the polarization will go back and forth between the two orientations but should remain constant for a fair amount of time after the tube warms up and stabilizes. Also see the section: Inexpensive Home-Built Frequency or Intensity Stabilized HeNe Laser.

The problem with cheap laser diodes is that most have a coherence length that is in the few mm range - not the several cm or meters needed for many applications (but see the section: Can I Use the Pickup from a CD Player or CDROM Drive for Interferometry?). There may be exceptions (see the section: Interferometers Using Inexpensive Laser Diodes) and apparently the newer shorter wavelength (e.g., 640 to 650 nm) laser pointers are much better than the older ones but I don't know that you can count on finding inexpensive long coherence length laser diodes. Even if you find that a common laser diode has adequate beam quality when you test it, the required stability with changes in temperature and use isn't likely to be there.

The detectors, front-end electronics, and processing, needed for an interferometer based measurement system are non-trivial but aren't likely to be the major stumbling block both technically and with respect to cost. But the laser, optics, and mounts could easily drive your cost way up. And, while it may be possible to use that $10 HeNe laser tube, by the time you get done stabilizing it, the effort and expense may be considerable.

Note that bits and pieces of commercial interferometric measurings systems like those from HP do show up on eBay and other auction sites from time to time as well as from laser surplus dealers. The average selling prices are far below original list but complete guaranteed functional systems or rare.

(From: Randy Johnson (randyj@nwlink.com).)

I'm an amateur telescope maker and optician and interferometry is a technique and method that can be used to quantify error in the quality of a wavefront. The methods used vary but essentially the task becomes one of reflecting a monochromatic light source, (one that is supplied from narrow spectral band source i.e., laser light) off of, or transmitting the light through a reference element, having the reference wavefront meet the wavefront from the test element and then observing the interference pattern (fringes) that are formed. Nice straight, unwavering fringe patterns indicate a matched surface quality, curved patterns indicate a variation from the reference element. By plotting the variation and feeding the plot into wavefront analysis software (i.e., E -Z Fringe by Peter Ceravolo and Doug George), one can assign a wavefront rating to the optic under test.

The simplest interference test would involve two similar optical surfaces in contact with each other, shining a monocromatic light source off the two and observing the faint fringe pattern that forms. This is known as a Newton contact interferometer and the fringe pattern that forms is known as Newton's rings or Newton's fringes, named for its discoverer, you guessed it, Sir Issac Newton. If you would like to demonstrate the principle for yourself, try a couple of pieces of ordinary plate glass in contact with each other, placed under a fluorescent light. Though not perfectly monochromatic, if you observe carefully you should be able to observe a fringe pattern.

Non-contact interferometry is much tougher as it involves the need to get a concentrated amount of monochromatic light through or reflected off of the reference, positioning it so it can be reflected off of the test piece, and then positioning the eye or imaging device so that the fringe pattern can be observed, all this while remaining perfectly still, for the slightest vibration will render the fringe pattern useless.

(From: Bill Sloman (sloman@sci.kun.nl).)

An interferometer is a high precision and expensive beast ($50,000?). You use a carefully stabilized mono-mode laser to launch a beam of light into a cavity defined by a fixed beamsplitter and a moving mirror. As the length of the cavity changes, the round-trip length changes from an integral number of wavelengths of light - giving you constructive interference and plenty of light - to a half integral number of wavelengths - giving you destructive interference and no light.

This fluctuation in your light output is the measured signal. Practical systems produce two frequency-modulated outputs in quadrature, and let you resolve the length of a cavity to about 10 nm while the length is changing at a couple of meters per second. The precision is high enough that you have to correct for the changes in speed of light in air caused by the changes temperature and pressure in an air-conditioned laboratory.

Hewlett-Packard invented the modern interferometer. When I was last involved with interferometers, Zygo was busy trying to grab a chunk of the market from them with what looked liked a technically superior product. Both manufacturers offered good applications literature.

(From: Mark Kinsler (kinsler@froggy.frognet.net).)

You can get interferometer kits from several scientific supply houses. They are not theoretically difficult to build since they consist mostly of about five mirrors and a lens or two. But it's not so easy to get them to work right since they measure distances in terms of wavelengths of light, and that's *real* sensitive. You can't just build one on a table and have it work right. One possible source is: Central Scientific Company.

(From: Bill Wainwright (billmw@isomedia.com).)

Yes, you can build one on a table top. I have done it. I was told it could not be done but tried it anyway. The info I read said you should have an isolation table to get rid of vibrations I did not, and even used modeling clay to hold the mirrors. The main problem I had was that the image was very dark and I think I will use a beamsplitter in place of one of the mirrors next time. The setup I had was so sensitive that lightly placing your finger on the table top would make the fringes just fly. To be accurate you need to take into account barometric presure and humidity.

(From: Sam.)

And check out my range of interferometer kits on eBay under user ID: siliconsam. Sorry for the plug. ;-)