OPTICAL TOOLING AND INDUSTRIAL SURVEYING

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THE WEBSTER Dictionary defines Optical as pertaining to optics, dealing with or skilled in optics, and Alignment is the art in surveying of adjusting of mechanical parts to be aligned to fixed datum lines, or points, or to each other.

Tooling is the use of equipment and tools by the surveyor in his work.

The applications of surveying in every kind of heavy industry filled a long felt need where high precision and very low tolerances are the primary concern, providing answers to four fundamental questions: Is it straight? ... Is it flat? ... Is it plumb? ... Is it square?

In the past, in the mechanical field of alignment, the toolmakers old standbys - taut wires and hanging plumb bobs, trammels and steel scales, insulated micrometer rods, gauges, surface plates and blocks were used. But these were found to be not sufficient enough. The field of Optical Tooling and Industrial Surveying developed rapidly after World War II. Today, exact alignment, precise linear and angular measurements and perfect level and plumbness for vertical control can be obtained with properly adjusted Optical Tooling equipment and tools.

Today, the highly technological field of Optical Tooling demands knowledge in the field of electronics, computers, mechanical hydraulics, thermal and optical physics. Moreover, the knowledge needs to be constantly updated in this rapidly improving field. The branch of Optical Tooling and Industrial Surveying extends beyond the horizon of the conventional surveyor.

Because of the high accuracies required and the short distances usually involved, several fundamental departures from ordinary surveying practice are necessary. The methods involved are Collimation, Auto-Collimation and Auto-Reflection.

The lines of sights of any telescopic instrument used must be especially straight, the direction of lines of sights must remain the same within very close limits when the focus is changed especially on short sights. Unless the focussing draw is perfectly aligned, this condition will not be met.

Micrometers are mandatory to measure distances to one thousandth of an inch. In fact, efforts are being currently made to split an inch into 10,000 because industry says that this refinement is necessary if technology is to move ahead.

Measurements between gauge points are made with inside micrometers on long standard rods or invar bars, calibrated to 1 to 10,000 of an inch. An optical micrometer attached to the telescope is used in conjunction with either a special scale or a very precise tape or other instrument, when measurements are made from a line of sight.

In Optical Tooling, the aspects of tolerances associated with measurements become imperative. More important than in ordinary surveying because of the higher accuracies that need to be obtained. In general the accuracy that can be obtained is 1 part in 200,000. Maximum error with available Optical Tooling equipment should be held to that accuracy. This amounts to 0.002 inch at about 35 feet of a single measurement.

The reasons for such high accuracy and tolerance are due to the fact that modern industry operates on the basis of interchangeable manufacturing. The parts must be manufactured to such a degree of accuracy as is necessary to permit the proper functioning and assembly of the parts without additional machining required even though the individual parts may have been made in different places and at different times. It is to be considered that machines have inherent inaccuracies built into them. These being made by a human is also subject to slight inaccuracy. All optical tooling instruments have manufacturing tolerances which affect their accuracy. These tolerances are very insignificant and can be easily eliminated or minimized by methods and systems of measurements.

Accidental errors represent limit of the intruments, instrumental imperfection and inaccurate human judgement. Their size and signs obey the law of chance. Gauss has shown that this type of error varies with the square root of the number of measurements. K. Heisenberg in "Principle of Indeterminacy or Uncertainty Principle" showed that an irremovable minimum uncertainty exists in all physical observations in spite of perfection of an instrument or accuracy of the observer.

Precision in alignment is defined as the degree of perfection in the instruments and methods of measurements, and it is as important to realize that absolute precision can never be attained. Since no measurement is perfect, the results obtained must be qualified by some measure of accuracy, by comparison of at least two or more independent measurements. Accuracy is the degree of perfection obtained and is the chief art of the Optical Tooling and Industrial Surveying.

Any alignment work is a combination of linear, angular and vertical measurements and should be possible to form some sort of estimate of the errors arising from each type of measurements in order to get probable effect on the final results. It should be possible for a surveyor or engineer to guarantee that alignment survey is free from mistakes. The total accuracy of work depends on the accuracy of instrument adjustments, testing instruments in the course of work using methods of reversal principles to neutralize instrument errors and judge when accuracy of measurements require reversal principles even with adjusted instruments.

Generally, short sights of different lengths are being used, in order to focus require large movement of focusing lenses. Any misalignment in draw is magnified, and to eliminate such errors reversal principles will eliminate systematic errors caused by misalignments of instruments, equipment and procedures. Other errors affecting the accuracy of work in Optical alignment, and to be aware of, are vibrations and noise, deflections, temperature variations, refractions, obstructions and dust. Vibrations affecting optical instruments primary air vibrations communicated directly from the machinery to the air surrounding and secondary air vibrations created indirectly by the foundations.

Vibrations and noise create problems in the use of optical equipment, in their accuracies and should be realized that vibrations and noise can never be fully eliminated. Although it could be limited to smaller proportions, using preventive measures.

The adjustment of surveying equipment is generally a shop operation, however the user must be able to make all adjustments by himself, having knowledge of the mechanical and optical geometry of instruments and equipment.

As in every field, Optical Tooling and Industrial Surveying, sometimes called Mechanical Surveying, has its own terminology and the language in its use. Knowledge and familiarity of various machine components is essential in practical use and application in heavy industry. Understanding machine drawings is also very important.

Every Optical Tooling Alignment project has to be followed up by a Technical Report clearly and precisely illustrating the surveying procedures, methods, graphs, profiles, sketches, tables, etc. Clients base their decisions on those reports, to improve the efficiency of productions. For example, in Paper Machines the speed up of machines, the life expectancy of bearings, quality of production depends heavily on the results.

My experience in Optical Tooling and Industrial Surveying is mostly with Paper Machines, applications in the Aviation and the navigation fields, Helicopters, Submarines, movements of Bridges, Hydro Towers, Roller Coasters, Buildings, etc. My projects are widespread across Canada and the United States. We have clients in Africa, Asia, Europe and in Britain. This is a challenging field and we enjoy providing services to heavy industry.

I have been involved in part time teaching at Seneca College, subject "Computer Aided Industrial Surveying and Optical Tooling".

The future of Optical Tooling and Industrial Surveying is brighter and broader with more and more applications in industry. It would be beneficial to more surveyors to be involved in this vital field that creates more employment opportunities. ●

TIPS FOR WITNESSES

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1. TELL THE TRUTH. If you tell the truth and tell it accurately, nobody can cross you up.
2. DON'T GUESS. If you don't know, say you don't know.
3. DON'T MEMORIZE what you are going to say.
4. UNDERSTAND THE QUESTION before you attempt to give an answer. If you don't understand the question, ask the lawyer to repeat it.
5. TAKE YOUR TIME. Although you can't be rushed into answering, taking too much time on each question may lead the jury to think you are making up an answer.
6. STICK TO FACTS. No hearsay, nor your conclusions, nor opinions. You usually can't testify about what someone else told you.
7. DON'T BE TOO FINAL. Don't say "That's all of the conversation," or "That's all I remember happening." It may be that after more thought or another question you will remember and want to say something important.
8. GIVE A POSITIVE ANSWER IF YOU CAN. Avoid saying, "I think," "I believe," "in my opinion" and "I guess". If you are asked about details which you don't remember, just say that you don't remember them. But don't let the cross-examiner get you in a trap of answering question after question with "I don't know", or "I don't remember".
9. DON'T VOLUNTEER. Answer directly and simply only the question asked you, and then stop. Do not volunteer information not actually asked for.
10. CORRECT MISTAKES. If your answer was wrong, correct it immediately.
11. BEWARE OF QUESTIONS INVOLVING DISTANCES AND TIME. If you make an estimate make sure that everyone understands that you are estimating and make certain your estimates are reasonable.
12. SPEAK UP. Talk loud enough so that everybody can hear you. Speak clearly and distinctly. Keep your hands away from your mouth.
13. YOU'RE ON YOUR OWN. Don't look at the lawyer, or the judge, for help when you're on the stand.
14. DON'T ARGUE. Don't fence or argue with the lawyer on the other side. He has a right to question you, and if you give him smart talk or evasive answers you will make a bad impression.
15. DON'T LOSE YOUR TEMPER no matter how hard you are pressed.
16. BE COURTEOUS. This is one of the best ways to make a good impression on the court and the jury. Be sure to answer "Yes, ma'am" and "No, sir" and to address the judge as "Your Honour".
17. DON'T DENY DISCUSSING CASE. If asked if you have talked to the lawyer on your side, or to an investigator, admit it freely. Remember, you're sworn to tell the truth.
18. DON'T BE AFRAID to look the jury members in the eyes while telling the story. Jurors are naturally sympathetic to witnesses and want to hear what they have to say. Eye contact helps to establish credibility.
19. DRESS PROPERLY. A court of law demands respect.
20. WAIT UNTIL THE JUDGE HAS RULED on any question about which an objection has been made. You may never have to answer the question if the judge sustains your attorney's objection. ●