International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 7 Issue 1, January-February 2023 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Human Errors and their Effects on Outputs of Reverse Engineering

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ABSTRACT

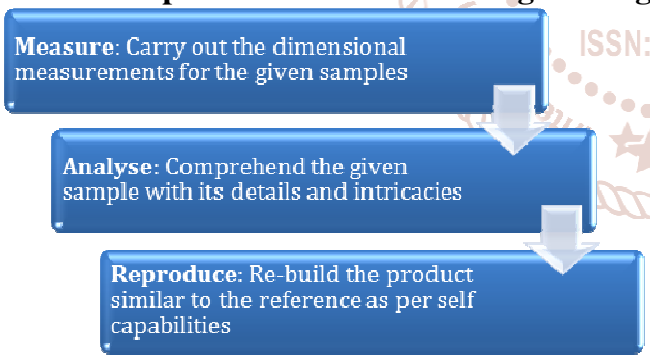
The science of measurements and metrology indeed calls for a premise wherein accuracy of measurement is a must, but in the process of practical measurements, it is natural that errors may creep in due to various factors attributed to either human intervention or machine constraints. This paper shall try to focus on the errors that can creep in due to human intervention in the process of Reverse Engineering, which is highly dependent on the accuracy of the measurements, which become a key factor for the success of the entire process. The general procedure of Reverse Engineering shall be first described along with the basic concepts of accuracy, precision, resolution and errors, which are like the four pillars of the process. The concept of error magnification shall then be briefly explained. The paper shall then elaborate on the concepts of measurements due to human errors and further explain the same in detail with respect to employment of analog, digital and computer integrated measuring instruments. The desired outputs of Reverse Engineering and the effect of human errors on the same shall then be elaborated and the paper shall conclude with the findings of the study.

KEYWORDS: *error, effect, reverse, measurement, accuracy*

How to cite this paper: Gourav Vivek Kulkarni "Human Errors and their Effects on Outputs of Reverse Engineering" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-7 | Issue-1, February 2023, pp.494-496, URL: www.ijtsrd.com/papers/ijtsrd52708.pdf

IJTSRD52708

A. General procedure of Reverse Engineering



Reverse Engineering in the recent times has become a discipline by itself. In the recent past, Engineers have elevated it from the notion of being a process of mere replication to a process of value added design. It has thus become a field wherein results are known but what is required on the part of the Engineer is the means by which the same can be achieved with the best possible accuracy.

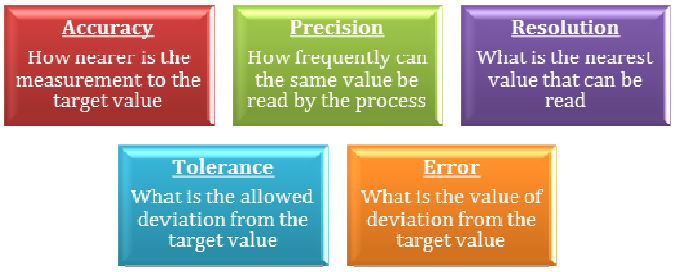
The first stage in the process of Reverse Engineering is measurements. The given samples are put through a rigorous measurement regime wherein every intricate detail of the same is captured and recorded. This is essential to build the basis for the design using the process of Reverse Engineering.

The second stage is that of analysis of the measured dimensions of the features so that the voice of the customer is aptly grasped and part is developed accordingly. It is necessary to have appropriate competence in the respective fields of end users so that the part under development can meet all the tangible requirements of the customer.

The third stage is that of reproducing or rebuilding the design with reference to the part received, but with certain amount of engineering efforts put in, in order to ensure a value added design. Thus Reverse Engineering not only requires an error free input, but also calls for a set scientific process that can ensure that the inputs are accurate.

B. Concepts of Accuracy, Precision, Resolution, Tolerance and Errors

While carrying out any measurements, according to probability studies it is practically impossible to hit the bull's eye every time. Thus it is natural that there are going to be certain deviations from the true values. There are certain terms used in metrology which help the engineer measure the extent of deviation and apply corrective measures as required. The following illustration briefly explains the same.



Accuracy can be understood as the ability to measure a given dimension such that the outcome of the measurement is as close as possible to the true value. Precision on the other hand is the ability of the instrument or process to be capable of measuring a particular value in the same manner irrespective whether it is accurate or not. It is a requirement that the measurement should be accurate as well as precise which means that the value measured should be as close as possible to the true value and should be precisely measured for any number of iterations.

Resolution can be understood as the interval of values that can be read in the neighbourhoood of a particular true value. Since there are infinitely many values available in the neighbourhood, the physical limitations restrict the instrument to measure only a few of them. Tolerance being a permissible range allows the practical manufacturing limitations to be aptly considered. Error is a quantitative measurement of the actual deviation of the measured value from the true value.

Thus it is required that the accuracy, precision and resolution shall be as high as possible while error shall be as low as possible and ideally zero. Tolerance is left to the discretion of the Designer.

C. Error Magnification

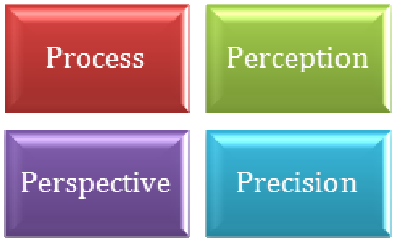
Errors are a notorious element in the field of engineering.

Although they are inevitable, there are a few that are good like in case of thermal expansion while a few that are catastrophic like in turbomachines. It is therefore required that errors, their occurrence and propagation is kept at bay.

Error magnification is a process wherein a small error in some part of the equipment can lead to a catastrophic dame at the other end. A deviation of even one degree of angle results into a deviation of around 17.45 m per kilometre. Therefore it is particularly required that errors in measurements are kept minimum right from the beginning. It is indeed known in the field of Engineering that if the process is rightly followed, the output ought to be as desired.

D. Errors on account on human intervention

Human errors are mainly due to variations in comprehension or perception. Every human being looks at the outcome of the measurements from their own perspective, which is a result of the past trainings and experiences. Some of the factors related to this are as follows.



As stated in the previous section, it is necessary that the right process is undertaken in order to carry out any kind of measurements. In case this is not done, there are other variables that may get into the process and can affect the outputs. Perception is highly dependent on the way in which the person is trained to do a particular task. It is essential that the right tool is chosen to perform the right task with the right process such that there is a possibility of being capable of achieving results that are in consonance with the desired results. Perspective is an important factor that leads to most of the errors. This may include errors due to parallax, wrong readings noted on account on visibility and so on. The measurements should be carried out in adequate lighting environment under controlled conditions such that there are no errors on account of external factors that could have been controlled, which if done, could have eliminated the unnecessary errors. Precision is another factor that is as important as the process. There are times when even though the process is followed to the last letter, there are certain errors that still make their way to the outputs. This can happen on account of lack of precision in the process being followed, which can be attributed to physical factors like working schedule, ergonomics, comfort and so on.

E. Measurements and Human errors

Human errors are thus inevitable in the process of measurements. Even if the process is automated, human supervision is absolutely essential. Thus one cannot deny the intervention of humans. In this section, three types of measuring instruments shall be considered and the ways in which measurements are carried out on the same shall be explained with intent to highlight the effect of human errors on the outputs as all this being done as a part of the process of Reverse Engineering.

E.A. Measurements using Analog Measuring Instruments

Analog measuring instruments are those which use a scale and pointer display in order to speak out the measurements being done by them. In case of analog

instruments, there are two aspects viz. parallax and calibration. While some measuring instruments may have graduations engraved on a scale but instruments like dial verniers need to be handled with proper care to ensure that there are no errors due to observer's parallax. The instrument shall also be calibrated periodically as per the Quality Control requirements and the frequency of use.

E.B. Measurements using Digital Measuring Instruments

Digital measuring instruments are those which use transducers and similar devices to convert variation in physical quantities to calibrated electrical or electronic signals which are read and displayed accordingly. These instruments do not generally have any chance of parallax errors as the outputs are in the form of a digital display. However, there can be confusions if there is mis-function of the display itself. This calls for proper checks and measures to be in place before the process starts.

E.C. Measurements using Computer Integrated Measuring Instruments

Computer integrated measuring instruments use computers to carry out accurate measurements with the aid of computers to capture various types of input data in various forms like light, radiations, sound, and change in physical quantities like resistance and so on. By far these instruments are the most accurate and reliable, provided they are used by a competent person with proper knowledge, experience and training. The errors in this are with respect to the inputs wherein the user needs to be careful while capturing the data from the received samples which are under reverse engineering process.

F. Desired outputs of Reverse Engineering and effect of Human errors

The desired outputs of Reverse Engineering mainly comprise of the extent of accuracy of the re-built model with reference to that of the received samples. As seen from the analysis put forward in this paper, human errors are mainly in connection with the recording errors as all other processes are done by the machine without much or with the minimum amount of human invention, which is so less that the overall results are not affected. However, when it comes to setting up the equipment and recording of the measurements, there are errors with respect to references, perspective and process. These need to be addressed with utmost care as the output of the process of reverse engineering is solely dependent on the measure of bandwidth of these errors.

Conclusion

Thus it can be concluded that although inevitable human errors need to be addressed by applying the necessary checks and measures like procedures, check points, training and commissioning of equipment and personnel, which can render a chance to produce outputs that are accurate to the best possible extent.

Acknowledgement

The author thanks Management of Athena India Hitech Components Private Limited, Bengaluru, for their constant support and encouragement to come up with this work.

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