



Maintenance Circle

NEWSLETTER FOR MANUFACTURING COMMUNITY

Word for the day: **Machines & Personality**

This week, we thought let us pause discussing about pure technical contents and focus on something little different. No, we are not becoming artistic or poetic here; our affinity with machines still remains intact. We are just looking at them from a different perspective, for a change.

Machines and Personality? Have we gone out of our mind to relate two non-related domains? Actually, they are quite related if closely observed. Despite machines being a lifeless assembly of various components made from different materials *AND* produced exactly to same specifications and standards, each machine "acquires" its own personality over a period of time. This fact is quite evident in our day to day usage of automobiles, computers, and so on. Without our knowing, we all get kind of "attached" to these "lifeless" machines and develop a feeling for them. At the slightest change of appearance or sound, we can sense that something is wrong and immediately take action to get it rectified. And, we will be able to recognize our machine almost instantly, wherever it is.

The machines involved in direct production or the supporting equipments – like generators, compressors, water pumps – also develop their own personality in due course of time. These personality "characteristics" will be affected by surrounding environment, inputs and their working cycles; kind of similar to human beings, whose character will be influenced by surrounding environment.

What are we trying to accomplish here? By understanding these personality traits, we should be able to troubleshoot and solve the problem little more effectively. This is somewhat similar to medical field in which doctors study and analyze each patient's *history* before prescribing certain medication or duration of the medication. For instance, a child suffering from fever will be prescribed less dosage of Paracetamol compared to an adult who might require more dosage. A person suffering from exhaustion will be treated differently if that person lives in hot and humid place. Each person has unique life style habits, physical structure and, therefore needs different regimen of same medication. Similar is the case with machines, although the ailments can be similar.

For example, an overload relay might trip in one motor due to mechanical binding and on another due to a fault in motor itself. A bearing might fail in same form either due to overloading or due to lack of lubrication. The list could be almost endless.

On analyzing these and such similar failures, the process of failure itself can be divided into three specific sections (failure here means either total stoppage of equipment or operating with reduced efficiency).



CAUSE – A sudden or gradual degradation of something that transforms into an effect. Examples: Excessive cholesterol deposition is the CAUSE of heart attack; Inferior termination of joints is the CASUE of cable burning; Exceeding load limit (axial or radial) is the CAUSE of bearing failure

SYMPTOM – An intermediate stage, in most of the cases, in which the cause gives some indication before it reaches its final stage. Examples: Excessive sweating and difficulty in breathing are the SYMPTOMS of one probable CAUSE, obesity; abnormal heat is one of the SYMPTOMS of loose termination; noise and heat are SYMPTOMS of faulty bearing

EFFECT – The final stage of a cause, resulting in some sort an end.



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Examples: Heart attack is the EFFECT of certain previous CAUSES including high cholesterol; burning of cable resulting either in short circuit or tripping is the EFFECT of loose termination; mechanical damage including machine stoppage can be the final EFFECT of bearing failure.

There is something interesting about this CAUSE-SYMPTOM-EFFECT flow. There is no unique relation between one cause, one symptom and one effect. It can have quite a few variations, some of which are listed below:

- One cause can produce more than one effect
 - In a motor starting system, loose termination (cause) can cause short-circuit(symptom) damaging contactors (effect) or motor windings(effect)
- More than one cause can produce one effect
 - Wrong alignment (cause) and overloading (cause) can result in bearing failure (effect)
- One cause can generate more than one symptom
 - Overloading of motor (cause) can generate abnormal heat (symptom) and unusual noise (symptom)
- One symptom can indicate more than one cause
 - High temperature of a rotating shaft (symptom) can indicate some mechanical restriction (cause) and shaft misalignment (cause)
- More than one symptom can indicate one specific cause
 - Sudden increased current consumption (symptom) and high temperature (symptom) can indicate motor overloading (cause)
- One cause can lead to another cause and so on before producing effect
 - Broken or worn-out balls (cause) in bearing can increase shaft tightness (another cause) resulting in some mechanical jam (effect)
- An effect can become a cause for further effect
 - Failed brake (effect due to some other cause) can prevent a motor from stopping resulting in either damage (effect) or over-travel (effect) of a conveyor line

From our previous experiences, in diagnosing health or machine problems, we usually focus more on finding solution for symptoms than causes. Consider for example, the burning of fuse link. A fuse link is the simplest form of protecting any electrical equipment against overload and short circuit. It never burns without a reason. When fuse burns, our normal tendency is to immediately replace with wire, usually of higher diameter such that it never burns. The cause for burning of this fuse is ignored, which ultimately results in either end electrical equipment damage or personnel injury.



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Therefore, it is essential to analyze the symptoms more thoroughly to identify and eliminate the actual causes. When analyzing and troubleshooting machine problems, it is quite interesting to note that majority of symptoms almost fall into four types. Let us try to understand them, in little detail.

No matter what the end application is, each machine has some components that are "moving" – rotating, oscillating or sliding. There is always a relative motion that either generates or consumes energy. You may be wondering what will be moving inside completely electronic component based equipment. Good thought. The electrons "flow" rapidly from a source to sink. Capacitors get charged and discharged resulting in exchange of energy between various components. Whether visible or not, there IS something that is always moving. This motion, independent of complexity and type of equipment, will have four distinct qualities: **SOUND** (or **NOISE**); **HEAT** (or **TEMPERATURE**); **MOVEMENT**; **ODOR** (or **SMELL**). Over a period of time, each machine "acquires" its own uniqueness in these parameters and hence creates its own "personality." By being able to detect deviation in any of these from an earlier pattern, we can anticipate any CAUSE and rectify it before a major breakdown occurs.

How can we understand this personality?

Although high-tech sensors, built-in diagnostic systems are available to prevent certain EFFECTS, they cannot equal the judgment of four sensory organs of our body, in detecting the "personality parameters:" Eyes (for seeing MOVEMENT), Ears (for hearing SOUND), Nose (for smelling the ODOR) and Hand (actually skin for touching or sensing HEAT). These organs, if used effectively, can sense the slightest difference between "before" and "after" condition and probably avoid failures. But, unfortunately, none of the parameters "sensed" by these sensory wonders can be measured and recorded somewhere for others to refer to. All we need is a concentrated mind to "record" the personality traits of machines and store it in our memory, for future inference. The experience of "recording" these parameters and making a judgment at later stage is very personal. Of course, certain measuring and recording meters can be used for assistance.

Consider some examples of an automobile to substantiate this point:

- By "touching" the surface of gear box housing, we can almost sense some abnormality inside – absence of sufficient gear oil, tightness in gears or some mechanical jam
- By "seeing" the carbon deposit on spark plug, we can predict that engine oil is mixing with fuel in the combustion chamber or there is excessive carbon deposit due to inferior quality fuel
- By "smelling" the exhaust smoke, we can predict that the mixture is getting either too rich or lean or some problem in the engine assembly
- By "hearing" to how engine runs in idle condition, we can anticipate some problem in the injector timing

For any of these, we may not need any measuring instruments, *at least to begin with*. It is the subconscious comparison to previously "stored" "feelings" that tells us that something is not normal and needs immediate attention.

A machine, whether new or not, when installed, commissioned and put into operation successfully, its personality parameters must be recorded using our sensory organs and / or measuring instruments. In order to accomplish this task, if permissible, all other neighboring machines must be turned off and a quiet surrounding should be created. Ideal time for performing this exercise is early morning or late night



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when temperature is relatively cooler to be calm and can focus better (of course, mind will also be calm in these time zones)

Once the "normal" situation parameters are recorded, at a later stage we can immediately sense the difference in machine personality and take preventive measures. Some of the following examples support this methodology.

- How a DG set responds to fluctuating loads – does it accelerate immediately or gradually? This can be recorded by listening to the engine speed and looking at the exhaust smoke
- How hot will be the surface of a Variable Frequency Drive cabinet– although there are sensors to detect over temperature, a "warm" feeling inside the drive cabinet or by touching the heat sink, any deviation from normal situation can be predicted
- The starting characteristic of a motor – run on Direct-On-Line or Star-Delta or any other method – can be recorded by listening to motor sound and connected mechanical components
- The backlash between gears – By closely listening to gear movement, when it engages first before taking up the load

Sometimes, either due to difficulty in sensing the personality or our inability to focus consistently, it becomes quite impossible to "record" these parameters. But, like in our human relationships, it takes patience and repeated interaction with machines to understand them better. Once our relationship with machines is established, it becomes that much easier to record their unique personality traits.

When trying to solve a problem on the machine, it is equally important to have a calm and focused mind along with a strong positive attitude. We all are quite aware of how perfect Japanese are when it comes to establishing work instructions and procedures at the shop floor level. What we may not be aware is that they are strong followers of Zen Buddhism¹ in shop floor as well. Whenever they are faced with a problem, instead of just getting about solving it, they follow certain simple steps: Take few deep breaths; relax their mind to understand as much background of the problem as possible; spend few minutes in analyzing problem area and ALSO the non-problem area surrounding it.

Once few minutes are spent on "tuning" their mind to handle the problem, all relevant questions are put forth, either within mind or written clearly on a paper although latter method is better. This practice is known as 5W-1H matrix, usually followed in TPM practice; this practice finds its usefulness in solving non-machine or non-technical problems as well. The underlying principle is to ask "WHY" five times, which is sufficient enough to arrive at "how" to solve the problem (quite similar to what were



¹ Buddhism is being referred here not as a religious practice but as a method which Japanese follow to calm their mind and senses that will help prevent making wrong judgment. Of course, this is not taught as a special course anywhere but is a part of their life style, usually beginning from school days.



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taught in our school days: "It is impossible to fold paper of any size, more than seven times")

Consider a problem of an operator producing scrap parts on a machining center. In this scenario, the problem is "SCRAP PARTS," which directly is causing raw material wastage, machine hour loss and operational expenses.

Note that in following "5W-1H" methodology, directing the problem to "WHO" is always avoided. Instead the focus is on solving "WHAT" of problem and not "WHO" of problem, at least in the beginning stage.

Let us consider another example, which is not directly technical or commercial. Here a shop floor person slipped while walking. And, the objective is to find the final CAUSE of this slippage (EFFECT). From the questionnaire, the conclusion made was "No Preventive Maintenance" which needs to be solved.

Note also that the problem to be solved is an EFFECT that will have certain SYMPTOMS which needs to be eliminated by asking why's and arrive at the root CAUSE. It is quite possible to identify more than one CAUSE with this deduction method.



Interestingly, there is a mention of the 5W1H outside the technical domain also. It is aptly quoted by Rudyard Kipling, one of the leading and famous English story tellers, in his short poem:

*I keep six honest serving men
They taught me all I knew;
Their names are **What** and **Why** and **When**
And **How** and **Where** and **Who***

This can be used to understand many objectives and ways to fulfill them

5W1H	Meaning	Considerations
Why	Why do we need to do it? (Objective)	Can it be avoided? Can some of it be left out?
When	When it needs to be completed? (Time frame, Deadline)	Can time frame be changed? When is the implementation deadline?
Who	Who should do it? (Person, Team)	Can the person be changed? Can someone else also do it?
Where	Where should it be done? (Location, Position)	Can it be done in some other place? Why is it done here only?
What	What do we need to do? (Target)	Can any other target be achieved? What is the target's objective?
How	How should it be accomplished? (Resources, Investment, Infrastructure)	Is there a economical way? Is there a faster better method?

And, we can add as many questions as we want to the list before finally arriving at a clear cut objective and methodologies to be adopted.

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One of the most important objectives of understanding machine personality, either using our "smart sensory" organs or some simple methodologies, is to avoid *short-cut* and *short-term* solution to any problem. More the time spent on analyzing and understanding the SYMPTOMS, better will be the identification of CAUSES and permanent will be the elimination of CAUSES.

No matter how simple the problem is, instead of just jumping into conclusion and fixing it, some thinking and analyzing will help. Remember: No two machines will have same personality and hence same symptom on machines might have different cause. So, do not always carry the experience of one machine to another.

Robert Lee Frost, another great English poet of 20th Century has written a short poem titled, "The Road Not Taken" which carries its relevance even today and probably forever. Here we reproduce it know that whether we are handling a machine or physical or mental problem, the attitude and understanding "personality" makes the difference between an average solution and an excellent solution! Similar cause or symptom need not necessarily lead to same solution.

*Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;*

*Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,*

*And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.
I shall be telling this with a sigh*

*Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.*

Understand your machines like people.....they can say a lot more than what they seem to appear.....