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Assessing Physical Deterioration for Cost Approach Analysis

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Abstract: *"Physical deterioration is generally a result of exposure to natural elements or the process area environment, internal defects from vibration and operating stress, and similar factors."*[1] *As one of the important obsolescence factors considered by the cost approach, physical deterioration influences the conclusion of value. This article discusses the methods I use to figure out the physical deterioration level of equipment during an inspection.*

Inspecting Equipment for Physical Deterioration

When I get a project to value a machine/production line, I visit the customer and check the machine. During the check I try to understand the machine's operation, its condition, and whether it suffers significant wear or could work effectively for many years. I compare the machine's physical condition with that of similar machines of the same age as part of calculating deterioration.

Many times, old complex equipment suffers from higher service costs, but if this equipment is well-maintained during its service life and is expected to operate longer with lower costs, it may be preferred over new equipment and its value may be higher than expected for a machine of its age. During the inspection I can learn about the machine/production line condition and get a feel for what rate of physical deterioration should be assigned, if any.

During the inspection, I focus on checking the four main systems for each machine or production line: pneumatic, electric, hydraulic, and mechanical.

Checking the Pneumatic System

Air leaks and existence of water in the compressed air line are the primary problems in pneumatic systems.

Air Leaks

Air leaks can come from machine parts, valves, air pipes, or other areas, and can many times be easy to find, especially noisy high-pressure air leaks. Leaks are most often from broken pneumatic pipes, caused by physical damage and/or dry and old plastic pipes.

Look at the pneumatic pipe itself and examine its condition. Does it look old and dry? Does it have small cracks in it? I always touch a few pipes with my hand to feel if they are still flexible or completely dry, hard, and easy to crack. This is especially important for pipes that deliver cutting or cooling oil with air pressure/air mist.

Dry and old pipes present a complex situation. They can indicate the condition of all the machine's pneumatic pipes, some of them inside the machine and hard to inspect.

Water in the Compressed Air Line

Always check for any water in a pneumatic system. The purpose of the pneumatic system is to provide dry compressed air for the proper operation of the associated machine, which is designed to operate with clean, dry air at the required pressure.

Moisture in a pneumatic system is problematic.

Many machines have a pneumatic air handling system in the entrance air pressure line to the machine. The system modifies the entering air by adding a measured amount of special oil and collecting any water that came in with the air supply. The added pneumatic oil helps the machine valves to operate smoothly. Unremoved water will cause rust in the valves and damage machine function and elements.

Where to Check

The handling system on the entrance air pressure line that catches the water includes a small cup. If the air dryer is not working well, water will fill the cup and get inside the machine's pneumatic circuit. To examine this cup, ask the operator to close the air supply to the machine, remove pressure from the inlet hose, and open the cup from below. If the system is working properly, no water will be in the cup.

You can also ask the operator to open the lowest connection point in the factory air pressure line near the machine to see if water comes out at that point.

Figure 1. *Pneumatic air handling system*
Source: *Liquidynamics*

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Checking the Electrical System

Use caution when working in the electrical cabinet–remember that you are not an electrician!

Ask the client to send an electrician with you. Ask the electrician to shut down completely the power to the machine and open the electric cabinet of the machine so you can do a visual inspection.

Just by looking, one can learn a lot about the condition of the equipment's electrical system, the service it has, the service people who work on it, and so on.

How does the electric cabinet look? Are the wires inside the original cable drag chain with its cover, or in a big mess all around? Does the electric cabinet close tightly or is it left open for dirt go inside? Is it relatively clean or is it full of dirt, old defective spare parts, tooling, or other haphazard items?

If you are more experienced, you can notice whether the components in the cabinet are from the same supplier. Component from different suppliers can imply that a defective part was replaced by a new one from a different supplier, sometimes to save costs. Relays from different suppliers may have different sensitivities which can cause malfunctioning of the machine.

Figure 2A: *Nice electrical cabinet*

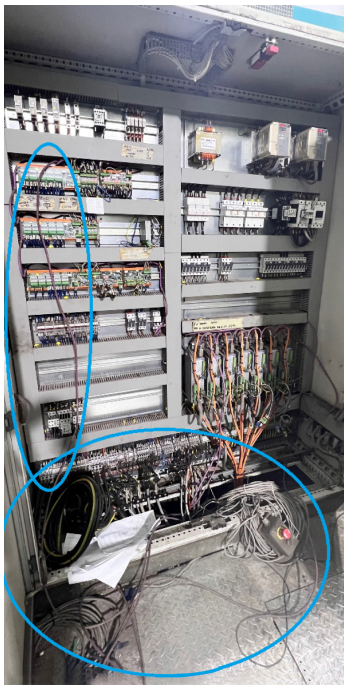

Figure 2B: *What happened here?*

Another problem with unmatched components is correspondence with the original electric drawing, provided by the machine supplier for certain electric elements. Different components may have different numbers for connecting points, which could make the machine more difficult to service.

Be sure to have a look at the electric cable drag chains in the machine. Are they fixed to their place? Not broken? Do they adequately protect the cables inside them? Can you examine the condition of the cables inside the chain?

Figure 3A: *Metal chips inside cable tray*

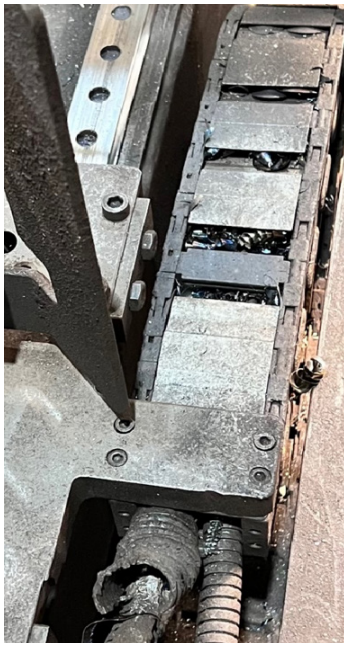

Figure 3B: *Damaged conduit with metal chips inside*

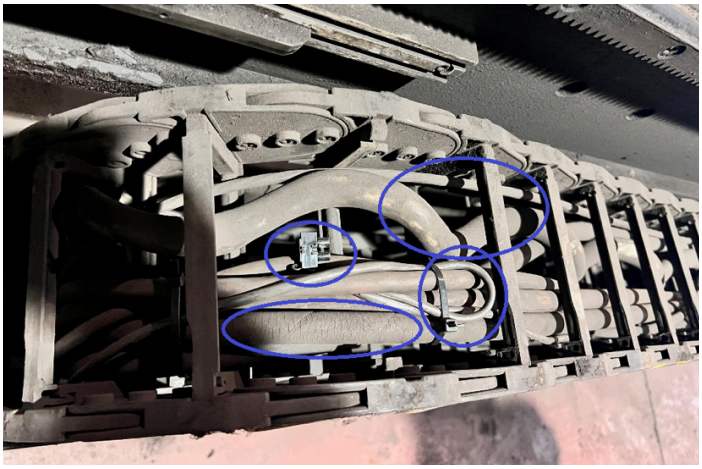

Figure 3C: *Very dry hydraulic hose, twisted electric cable, repaired electric cable*

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Checking the Hydraulic System

Check the level of hydraulic oil in the main tank. Lots of missing oil indicates something happened; ask the machine operator, the maintenance supervisor, or the client what happened.

Look for major oil leaks in different parts of machine. Leaks outside the machine surface are easy to see. Try to look more inside the machine area if possible.

Every hydraulic pipe is marked with its manufacture date. Different countries worldwide have regulations for checking and/or replacing these pipes, generally every 6 years. I've never had a client who changed all the hydraulic piping in the machine every 6 years, but the recommended change-date can provide useful information. You should always examine the condition of the pipes. Are they dry? Do any of the pipes have cracks? Is the protection rubber solid?

Figure 4A: *Date printed on cable*

Figure 4B: *Damage in hydraulic hose*

Ask when they last changed the hydraulic oil and filter. Is this mentioned in the machine service file? Normally the filter is changed when the oil is changed. If there is an oil level gauge with clear glass window, notice the color of the oil. A too-dark color can imply that the oil needs to be changed or that the machine is not being properly serviced.

Checking the Mechanical System

This topic is very wide and depends on the machine type as each mechanical system will be different. In general, though, you'll want to spend time on at least 3 main categories: axes, rotating parts, and general upkeep.

Axes

Begin checking the mechanical system of the equipment or machine by determining how many and which axes each machine has. Look at how each axis is driven and how its position is read by the controller.

Look at the guides for each axis. Are the guides in good condition? Do they self-lubricate? Are the protection covers for the guides intact? Notice the condition and connections of the motors. Are there visible issues such as hanging wires or loosely affixed motors?

Are the position switches broken or loose? Are the controls original? If they have been replaced, do replacements look appropriate for the machine? Are the position encoders working properly with intact protection covers?

Rotating Parts: Electric Motors and/or Belts

The noise of a high-speed moving/rotating part can sometimes disguise the noises that tell of problems in the machine's movement.

Ask the operator to move any fast, noisy part at a slow and medium speed, such as 15–20% and 50–60% of the normal working speed. At those speeds, can you hear any different noise that adds to the normal noise? Try to figure out if it is coming from the motor, or external bearings, the guide/leading screw, the belt, or another item.

Can you see the condition of any belts? Do they look dry? Are they tensioned? Do any belts have cracks?

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Figure 5A: *Where did these washers come from?*

Figure 5B: *Machine with cleaning issue*

General Upkeep

Does the machine have its original safety covers and protection devices like cover doors or safety curtains? Machines without these will suffer and the value will be reduced.

What is the level of cleanliness of the machine? Does it currently look clean? Does it look as it has been cleaned recently? Or is it sticky with years of old emulsion oil?

Look a bit more inside the machine. Do you can see any "spare parts" that are not connected? Sometimes a service guy opens a machine to fix something and leaves loose parts like screws, nuts, washers, and so on in the machine. Try to figure out where these parts are from and if they are essential to the machine work.

Conclusion

The inspection is an appraiser's opportunity to learn about the condition of a machine or production line to determine an appropriate factor for applying physical deterioration. Checking the 4 main systems for each machine or production line—pneumatic, electric, hydraulic, and mechanical—allows an appraiser to determine visual physical deterioration, or effective age: "that is, the age indicated by the actual condition of a property."[2] Comparing the machine's physical condition to that of similar machines the same age is part of calculating deterioration, a critical step in any cost approach appraisal.

About the Author

Ran Greenburg, ASA, MBA, B.Sc, manages, with his brother, the family's international company, Greenberg Machine Tools Ltd. (GMT), headquartered in Tel Aviv, Israel. In 2015, Ran established an appraisal department within GMT to provide valuation of industrial equipment. Ran is a mechanical engineer with a master's degree in business administration. He is a member of the ASA International Virtual Chapter (IVC).
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[1] Machinery & Technical Specialties Committee of the American Society of Appraisers, *Valuing Machinery and Equipment: The Fundamentals of Appraising Machinery and Technical Assets,* 4th ed., American Society of Appraisers (Herndon, Virginia: 2020), p.49.

[2] Ibid., p. 546.

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