- Theory 8: Operation and Maintenance of
- Automated Inspection Systems

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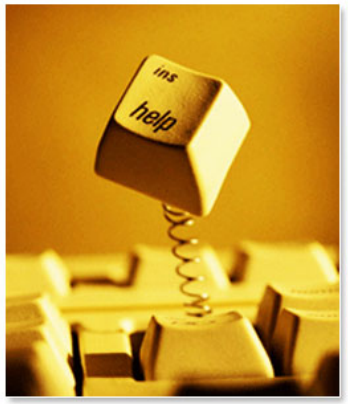
Theory 8: Maintenance on AVI: Prerequisites

1. During building of the URS a risk assessment should have taken place, so FMEA critical functions should have been addressed

2. This must be the bases for maintenance
   - Maintenance is not only checking for wear and greasing
   - The goal is to preserve the mechanical/electrical state of the machine as was during the initial validation.

3. In fact you preserve the baseline, otherwise you cannot guarantee equality in visual inspection after

- Machine errors
- Breakdown of mechanical parts
- Breakdown of electrical parts
- Worn-out of light sources
- Camera malfunction



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Theory 8: Maintenance on AVI: Needed tooling

You need tools for a regular check and decision making

1. Tooling to adjust electrical and mechanical zero point
2. Calibration tools
   - Focus of depth and aperture of cameras
   - Light intensity light sources. LEDs will loose brightness in time and you need to define when to exchange
3. Alignment tools
   - To check for unbalanced grippers or vial holders
   - To align star wheels and other transport parts

The mechanical impact on vision is huge

- Not well aligned creates crashes, product spills
- Unbalanced grippers or holders generate false ejects

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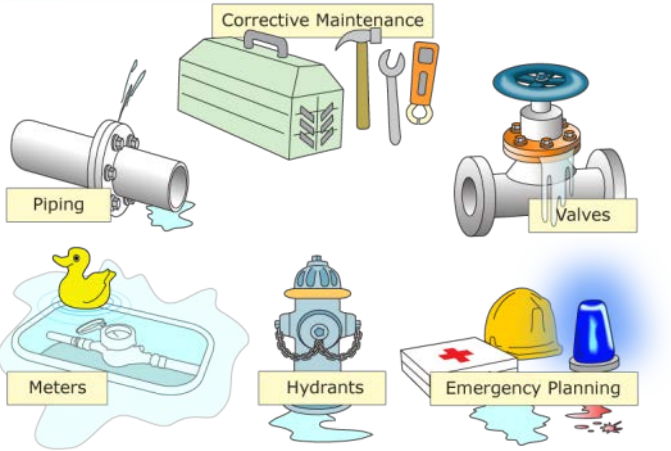
Theory 8: Maintenance on AVI: Corrective versus Preventive/Predictive



- Corrective maintenance
  - You act when something brakes down
  - Not completely unavoidable
  - Disadvantage: uncontrollable downtime

PM Preventive maintenance

- You act before something brakes down
- You periodically exchange parts
- You analyze and learn. It's a cycle

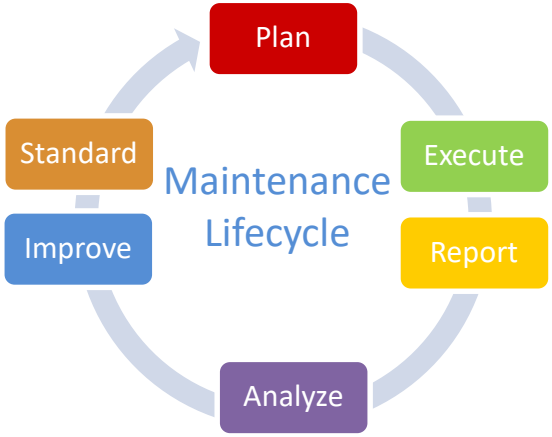
- An annual schedule of daily, weekly, monthly, quarterly and yearly task to perform
- First Line Maintenance should be part of this
- Disadvantage: you may exchange wear parts to soon and thus extra costs

PDM Predictive maintenance

- You act when the information gathered signals it's time
- You collect this information during production with minimal production loss

Examples

- Statistically Inline monitoring of the eject rate per gripper
- Statistically Inline monitoring of the LED brightness



Best Practice

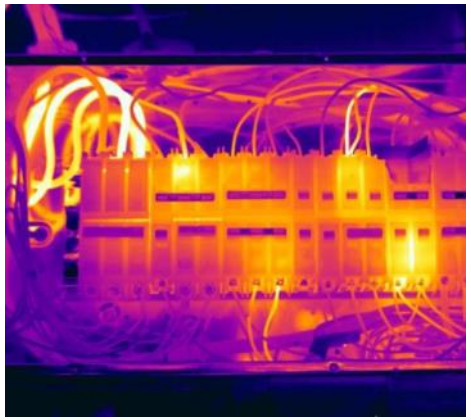
- A combination of PM and PDM
- PM has some PDM elements
- They form the maintenance lifecycle

Area of maintenance

- A multi disciplinal multi departmental combined effort
  - Mechanic
  - Electric
  - Computer(management)
  - Vision

Electrical

- Often seen as reliable and neglected
- The quality and reliability of electronics, sensors, PLCs etc. are very high nowadays



- Wiring is the Achilles
- Infrared measurements in the cabinet gives information
- But only for high current, a few percentage of the whole

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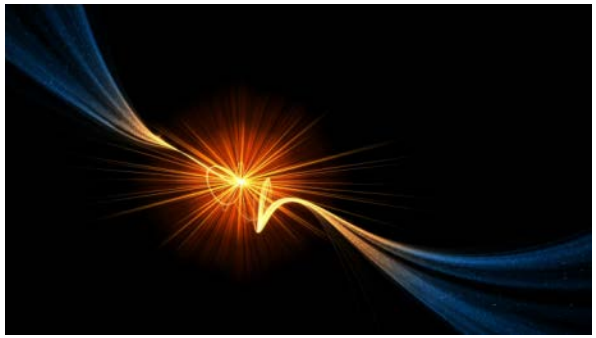
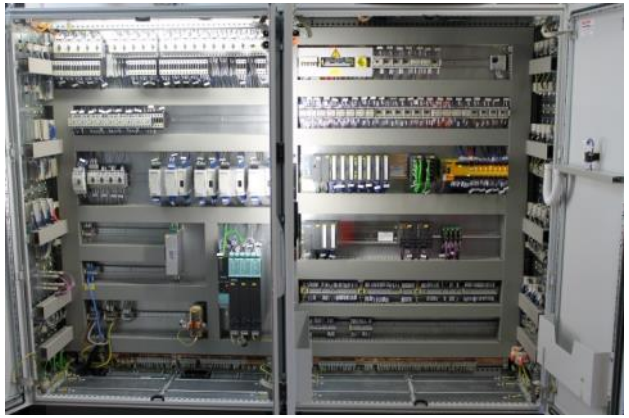
Theory 8: Maintenance on AVI: Electrical



Low current wiring

- Faulty contacts generate sparks
- Very difficult to find
- Brings your AVI in unpredictable state
  - PLC programs rely on sensor and state information



- Not everything in the design is failsafe
  - A sensor should generate an error if malfunctioning
  - or If the cable is broken
- The preventive measure can only be checking the clamps in cabinets and connection boxes annually

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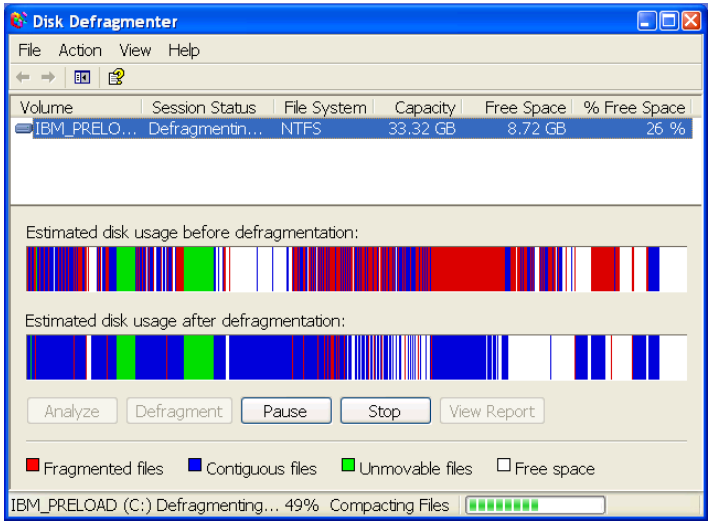
Theory 8: Maintenance on AVI: Computer Management

Modern AVI will use Intel processors to communicate with the users and organization

- Very often using the Windows operating system
- Temporary information is stored on the hard drive in huge amount
- Defect images for later usage etc. and often not removed



- What's important: frequent back-up
- What's not important: frequent clean-up
- Although the NTFS file system is more stable: Fragmentation will take place and could slow down the overall performance
- In short: don't neglect. It also needs a frequent overhaul

In short

OF LIMITS

Small unwanted changes will have huge effect

- Camera position, diaphragm, aperture
- Position LEDs, especially front light
- You can DIY, but you need special trained staff
- Depending on machine configuration cleaning is possible

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Theory 8: Maintenance on AVI: Vision

- Maintenance is not just another department it should be embedded
  - Create ownership

And not

- I here a strange sound in my machine

  Well, not my problem

The machine operator stands closes to AVI

- They are the ears and eyes of maintenance
- The first that should signal that something is not in order
- Unexpected machine errors and more frequent
- Involvement by feeling they are owner
- A simple way to achieve this is First Line Maintenance

- First Line Maintenance

Simple tasks that operators can be thought

- Cleaning and greasing if applicable
- Checking wear and tear parts that are visible
- Exchanging replacement parts like computer filters
- Testing the validated state with one or more test kits

Tasks that are split in

- daily
- weekly
- monthly

By means of

- illustrations
- checklists

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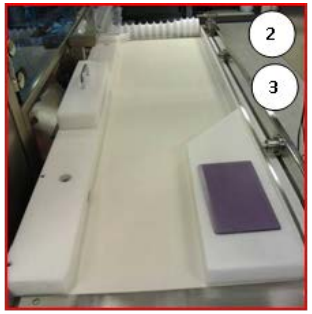
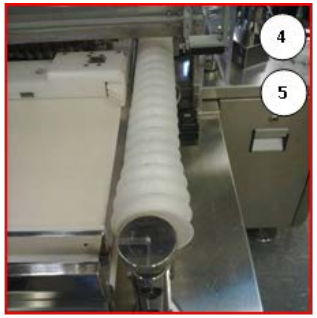
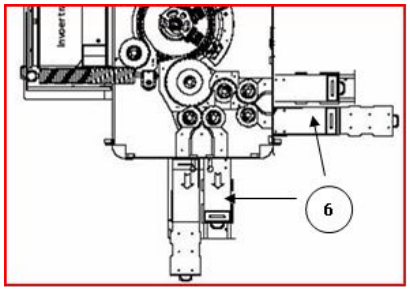
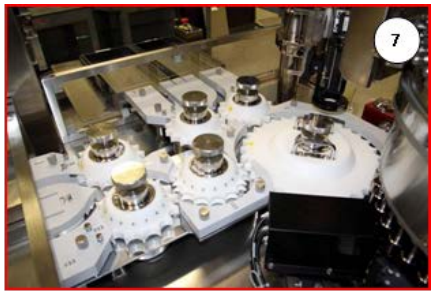
Theory 8: Maintenance on AVI: Vision









Item No.	Area	Method	*Criteria*	Frequency				
				Per shift	daily	weekly	monthly	Time [Min].
1.	General	a. Vacuuming machine , clean with ammonia solution followed by alcohol. Plexiglas only with soap solution!! b. Line tidy and clean c. Replace vacuum cleaner bags. ***Combine this with a format change***	*Free from product and dust and everything that does not functional belong*			+		60
2.	Intake belt	Clean with alcohol solution	*Free from product, dust and other dirt*			+		10
3.	Intake belt	Crease with silicon oil. Rub the belt with a light with silicon oil wetted cloth and rub dry afterwards.	*Dry and smooth. To do every two pallets*	+				5
4.	Intake worm	Clean with ammonia solution followed by alcohol.	*Free from product, dust and other dirt*		+	+		5
5.	Intake worm	Crease with silicon oil. Rub the worm with a light with silicon oil wetted cloth and rub dry afterwards	*Droog en glad. Om de twee pallets uitvoeren*	+				5
6.	Outlet trays	Clean with ammonia solution followed by alcohol.	*Free from product, dust and other dirt*		+			5
7.	Starwheels and guiding	Clean with ammonia solution followed by alcohol.	*Free from product, dust and other dirt. Formatparts may only returned in the cupboard clean!*		+	+		5 / 15

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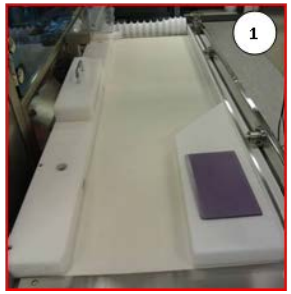
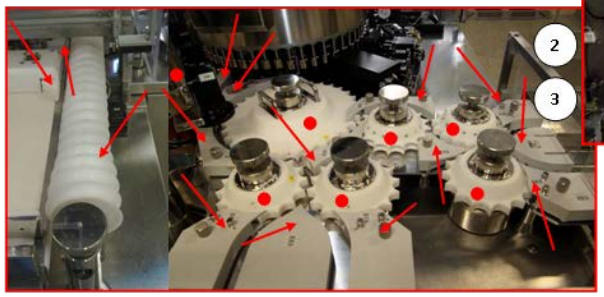
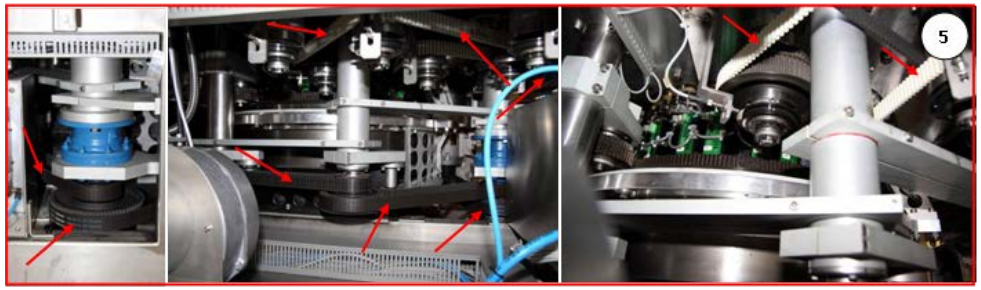
Theory 8: Maintenance on AVI: Vision







Item No.	Area	Method	*Criteria*	Frequency				
				Per shift	daily	weekly	monthly	Time [Min].
1.	Intake Belt	Check on damages	No tears or fraying			+		5
2.	Starwheel and Worm	Visual inspection on damages and dirt on/in the vacuum channels	*No failing pieces of plastic and these channels are open*			+		10
3.	Guidances	Visual inspection on damages	*Undamaged and no missing plastic pieces*			+		2
4.	Lenses, mirrors, prismes	Visual inspection of the surface	No dirt, dust and scratches			+		5
5.	Drive	Visual inspection on drive belts, in doubt warn TS	*Drive belts have the right tension and no tears*			+		5
6.	Cabinet	Visual inspection on filter. 4 pieces. If necessary clean	*Free of dirt and dust*			+		5

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Somes References

- **Compendia**
  - ✓ USP<790> visual inspection, Jan 2014
  - ✓ USP<1790>, visual inspection companion chapter (guidance), Aug 2017
  - ✓ EP, JP Visual inspection
- **Articles:**
  - ✓ PDA Journal all Knapp Articles from [1980-1992]
  - ✓ J. Shabushnig, PDA 2014, PDA survey visual inspection;
- **Books:**
  - ✓ Computer Vision: Algorithms and applications Richard Szeliski 2011
  - ✓ Computer Vision: Detection,Recognition and reconstruction, Roberto Cipolla 2010
  - ✓ Particle for Parenteral, J. Shabushnig, R. Cherris, PDA 2016,
- **Lectures/Webressources:**
  - ✓ Standford Univ. CA: Bernd Girod, Digital Image Processing
  - ✓ Python OpenCV documenation

- Acknowledgements
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