Applying STAMP on Safety Standards of domestic robots

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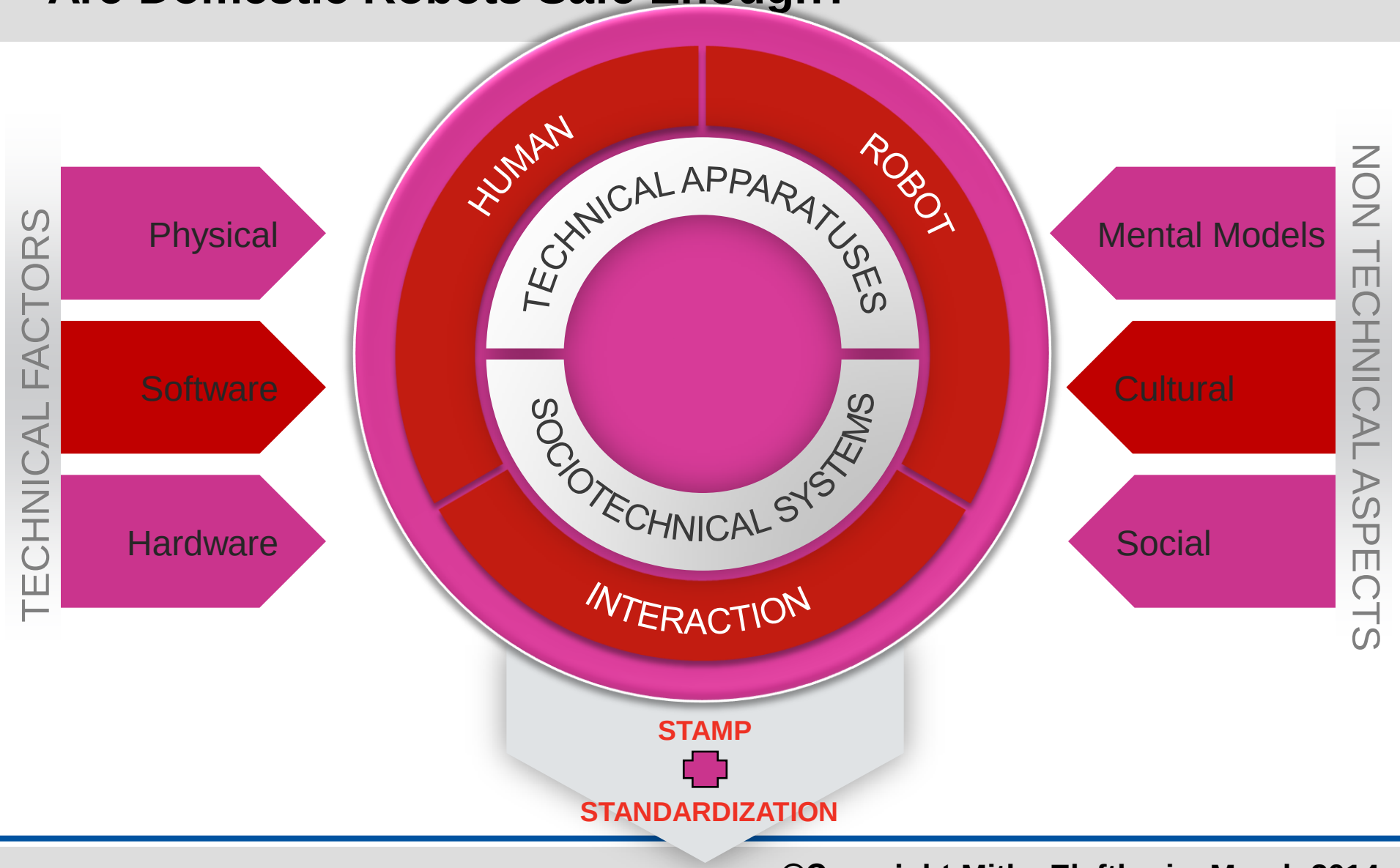
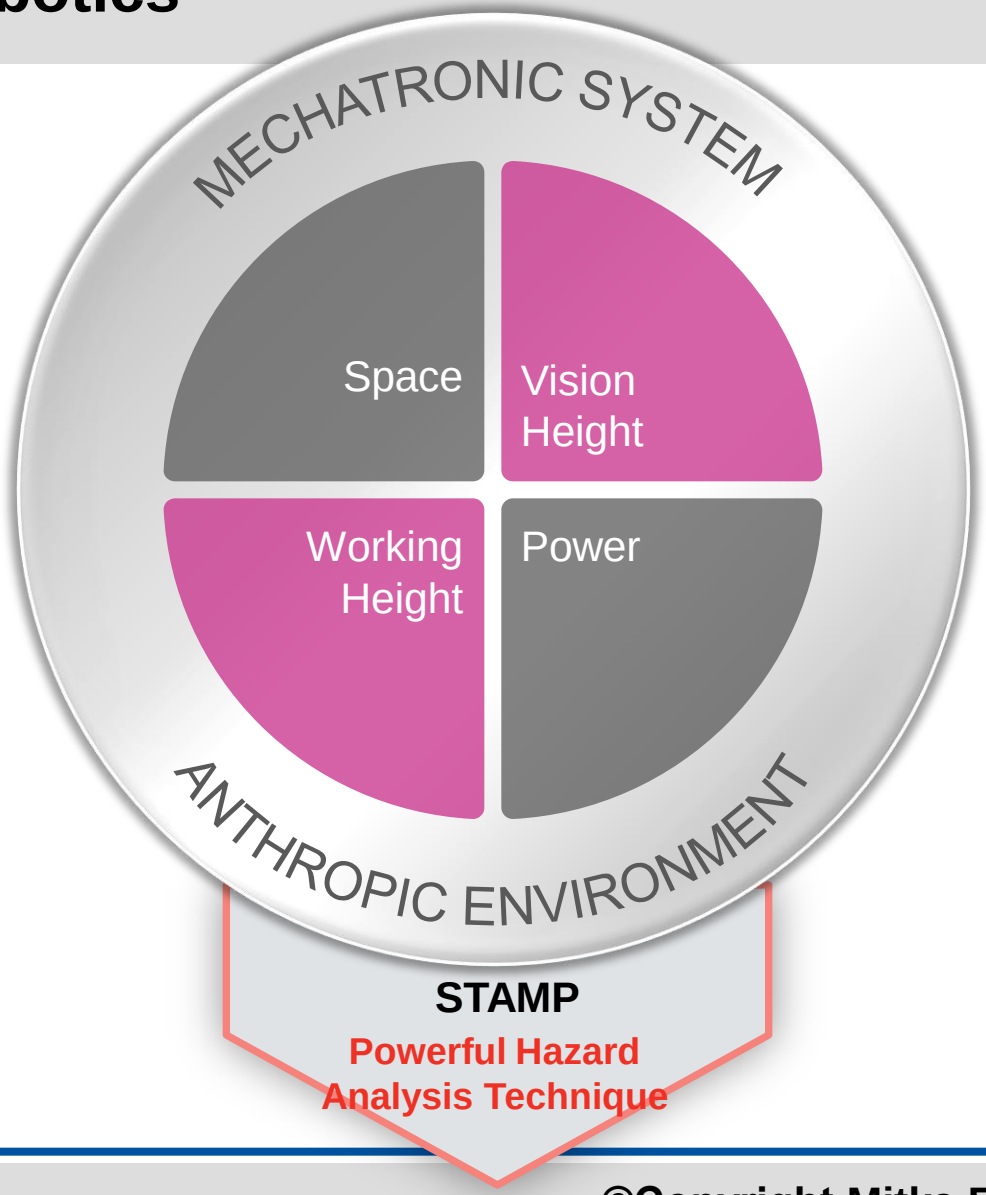
MIT STAMP Workshop

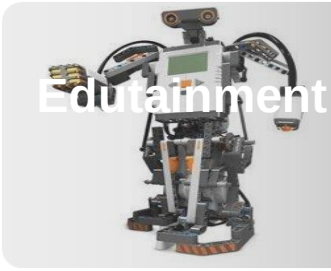
Are Domestic Robots Safe Enough?



Domestic Robotics



Classification of Domestic Robots ISO 8373 - Taxonomy



Robots and Robot systems

Industrial Robots

Fixed base /Mobile

Service Robots

Domestic Robots
Security
Collaborative
Edutainment

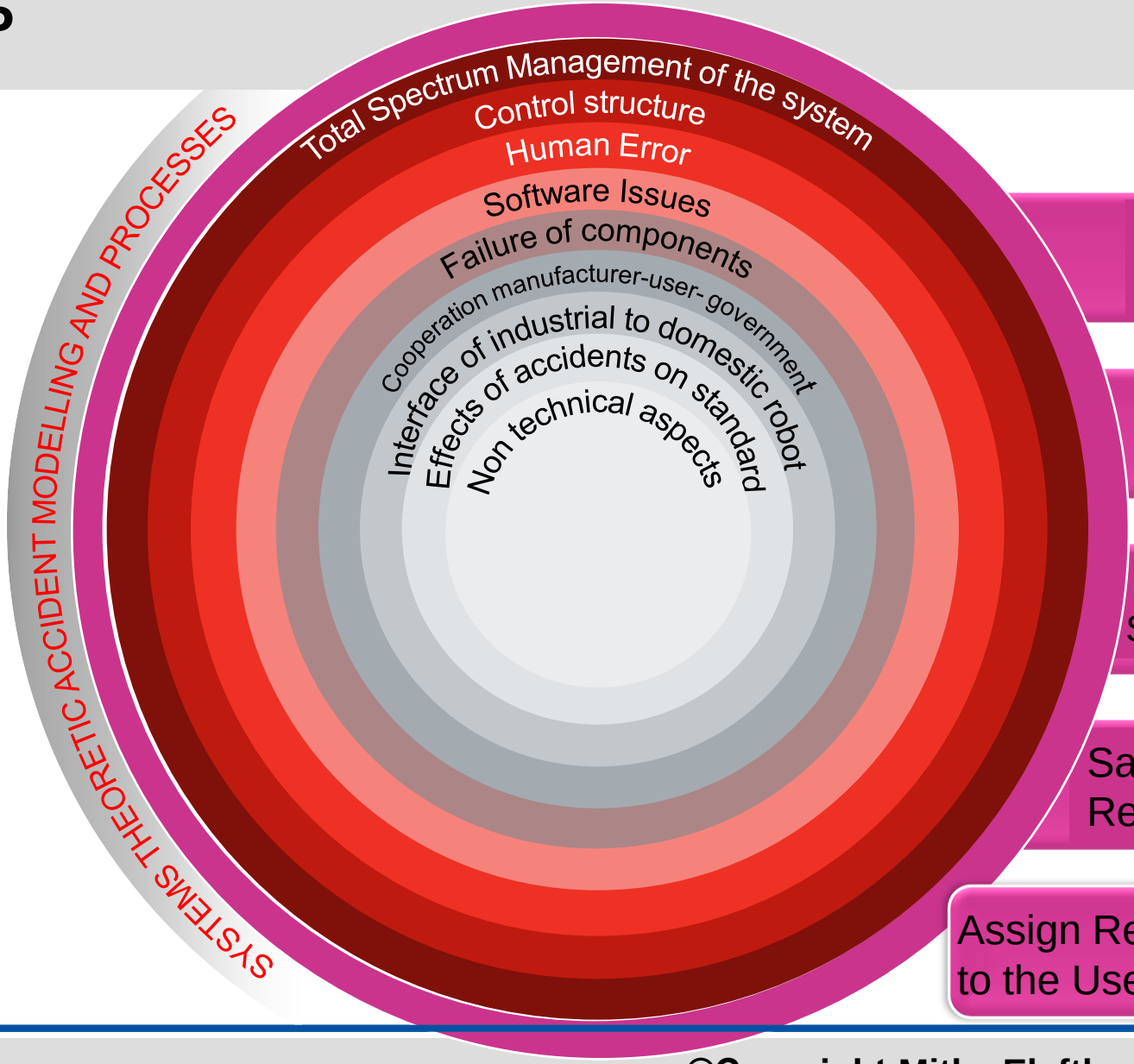
Personal
Professional

Other applications: e.g. Military

Personal

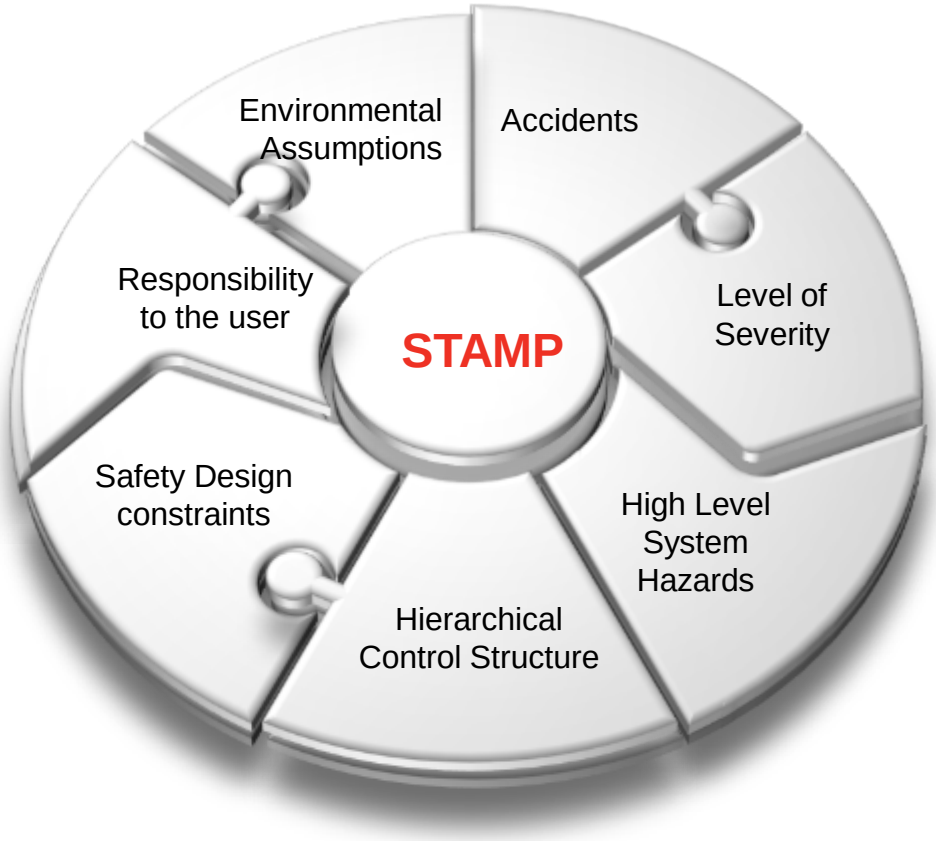
Pet-type robots
Partner type
Communication
Care robots

STAMP



Traditional Safety & Reliability Engineering Analysis

STAMP



Identify the accidents

A1. Injury or damage by jagged edges or corners.

A2. An actuator is stroked by arbitrary object.

A3. A component may explode.

A4. A resident pinched between arm-wall-object.

A5. Body's part caught in an uncovered actuator.

A6. Robot run on a person or another home asset.

A7. Electrical shock.

A8. Contact with worn insulation.

A9. Uncontrolled chemical/ fire factors.

A10. Robot halts.

A11. Coexistence problems.

A12. Irritant / sensitizing effects.

A13. Interference causes injury or equipment damage.

ASSIGN A LEVEL OF SEVERITY

Assign a level of severity

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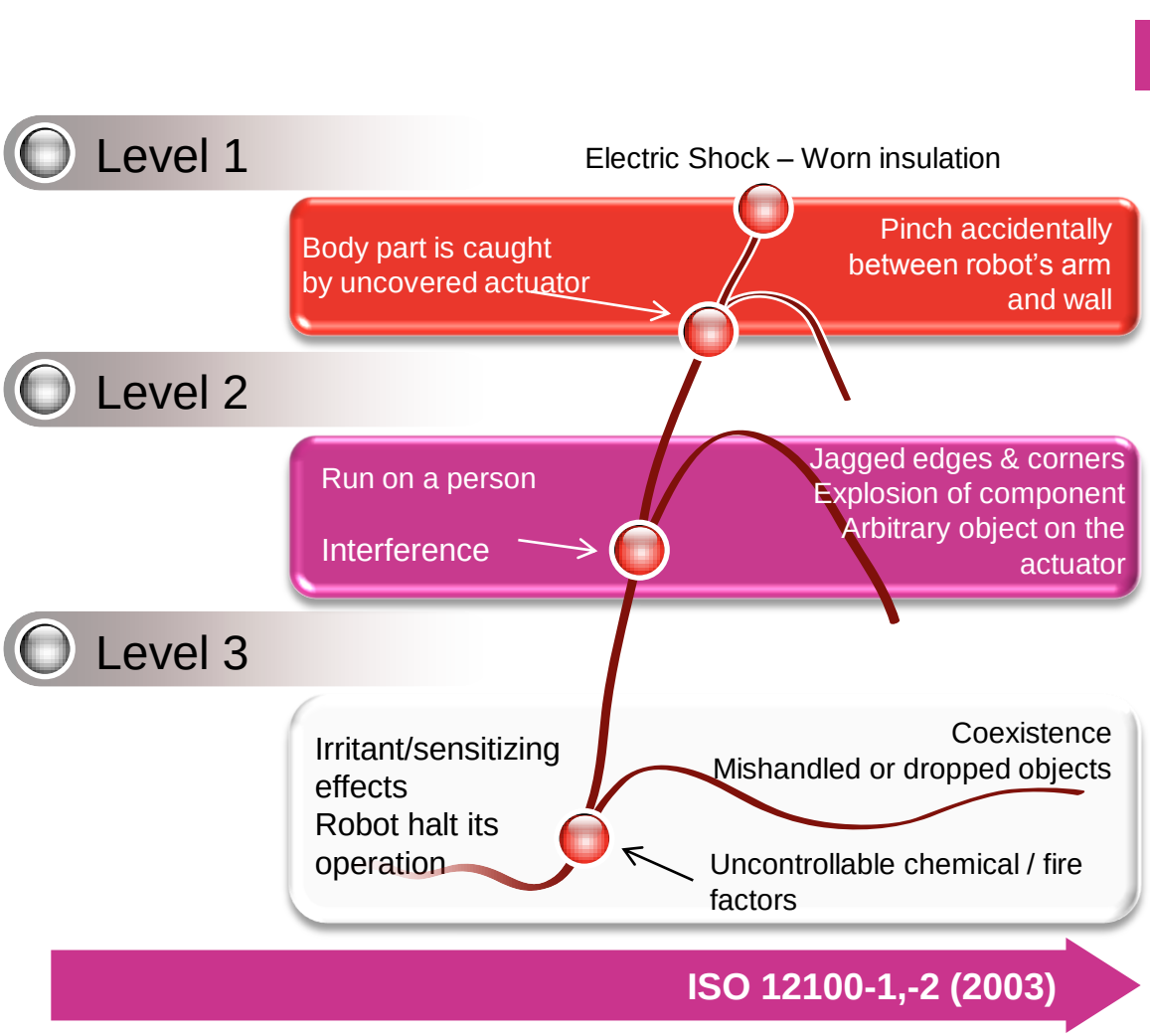
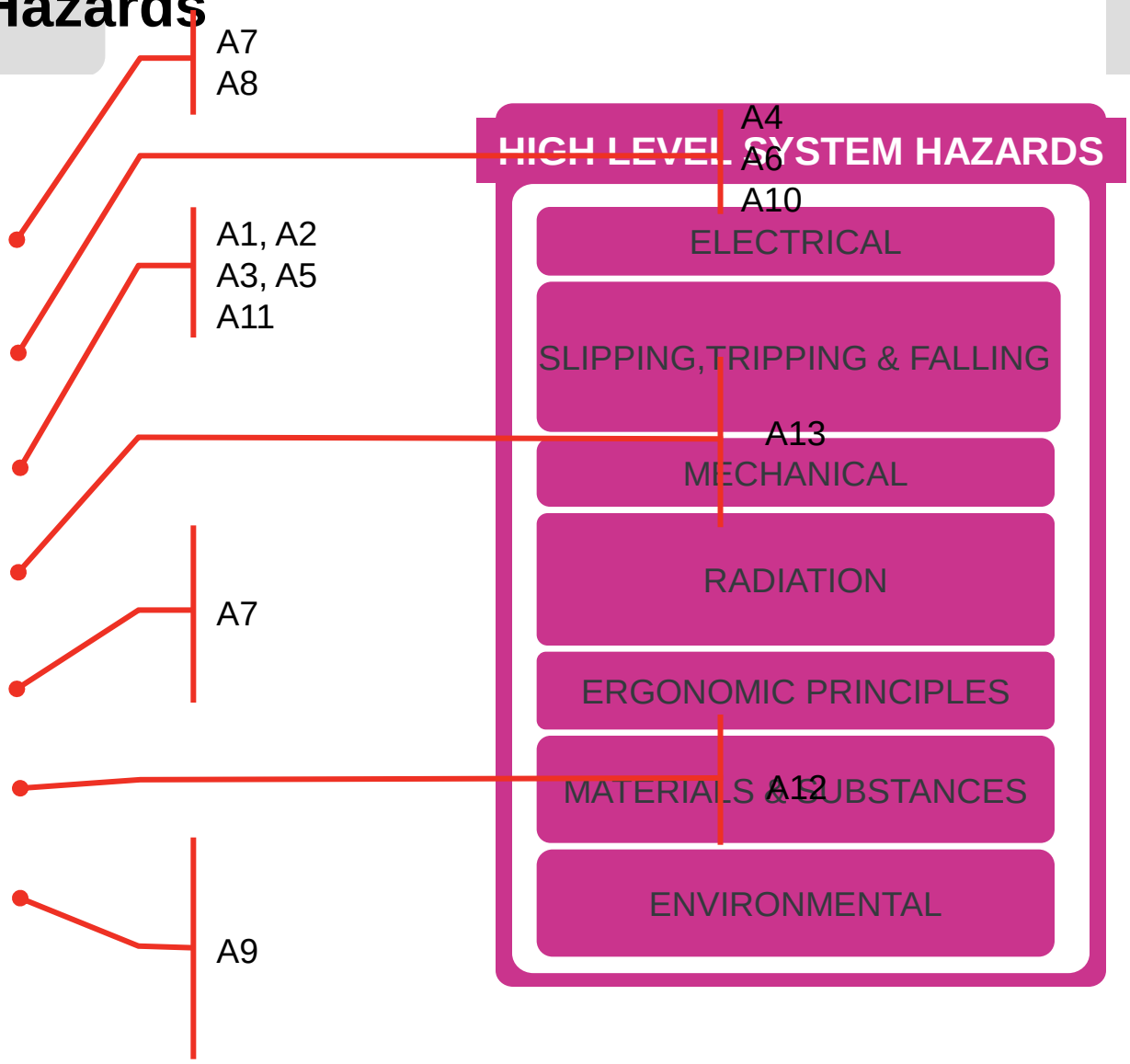


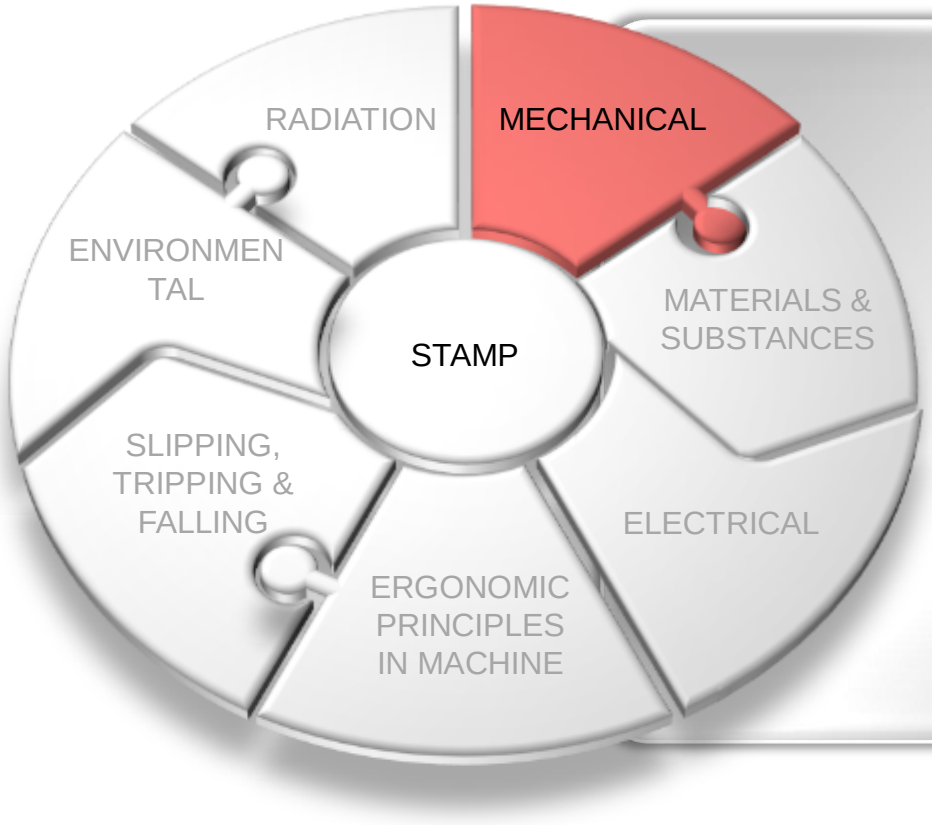
HIGH LEVEL SYSTEM HAZARDS

- ELECTRICAL
- SLIPPING,TRIPPING & FALLING
- MECHANICAL
- RADIATION
- ERGONOMIC PRINCIPLES
- MATERIALS & SUBSTANCES
- ENVIRONMENTAL

High Level System Hazards



Safety Design Constraints



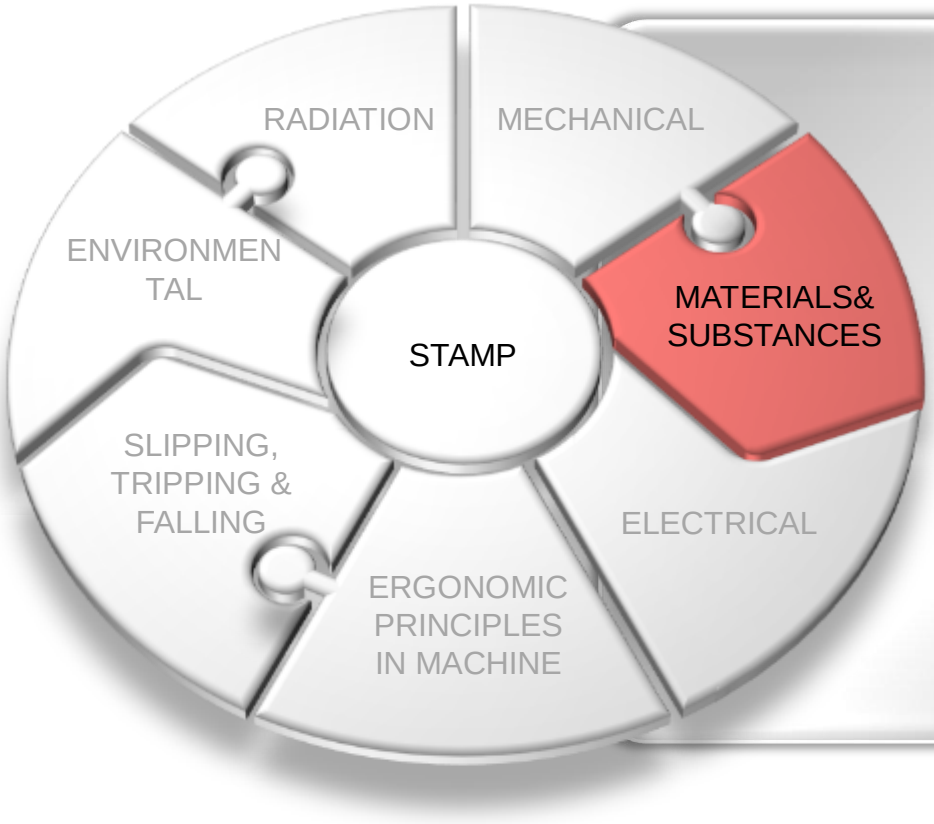
Cushioning shall minimize cutting, stabbing, shearing.

Sharp edges, corners and picks shall be avoided. Soft material shall be used for covering.

Label signs on stored energy sources to avoid pressing an inappropriate switch.

Replace mechanisms if they work under heavy load.

Safety Design Constraints



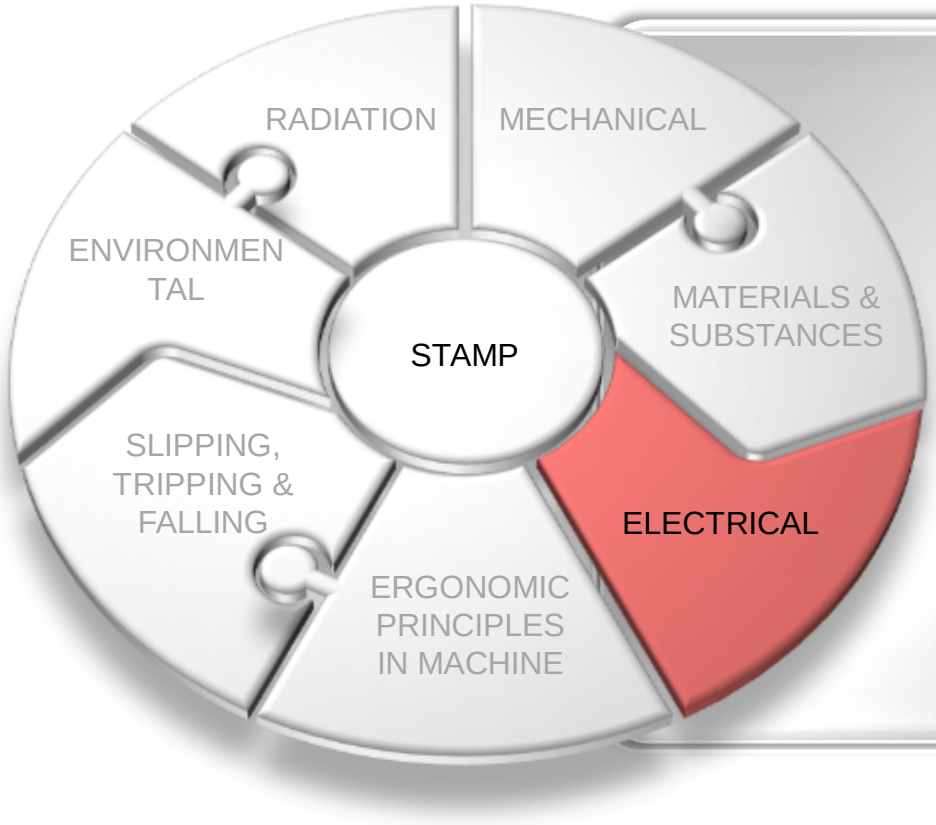
No additional clothing.

Nickel & Chromium substances --> Appropriate info.

Surfaces & Covers free from loose chipping or peeling paint.

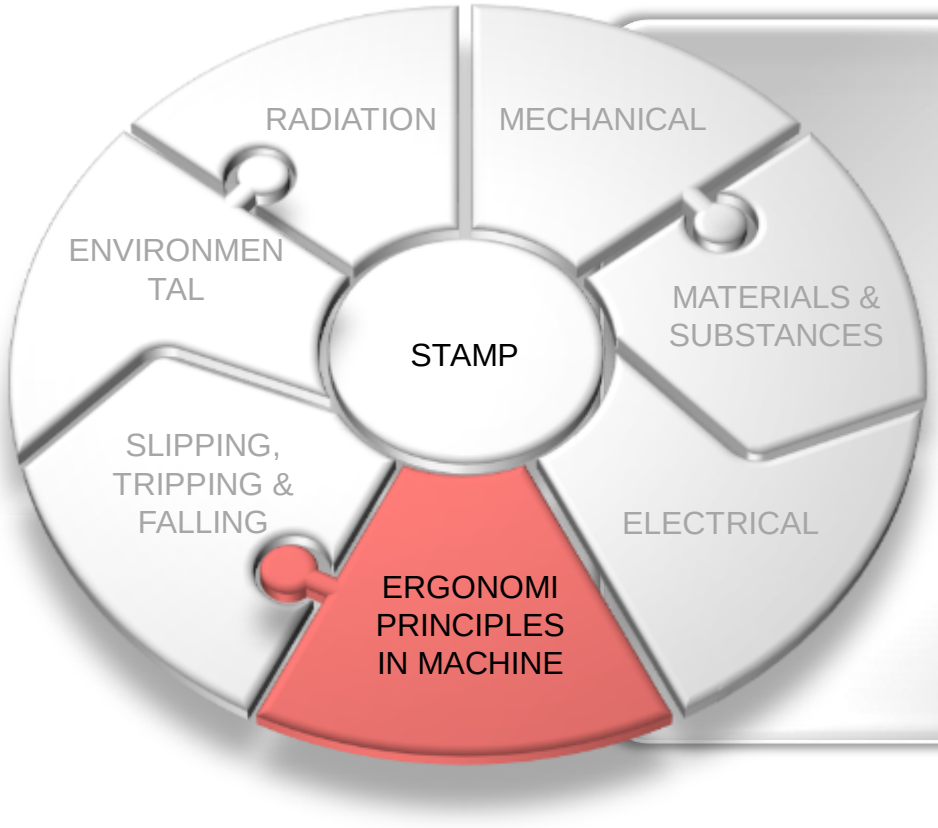
No flammable dust, toxic vapours, paint thinner, oil based paint, ammonia, drain cleaner, chlorine bleach.

Safety Design Constraints



Screws & Fixtures against signals / connectors.
Homogeneous network of multiple sensors adequate to its task.
Design connectors against separation of wires.
Prevent cords from coming in contact with burrs, cooling fans.
Internal connectors must be waterproof and give a reliable connection.

Safety Design Constraints



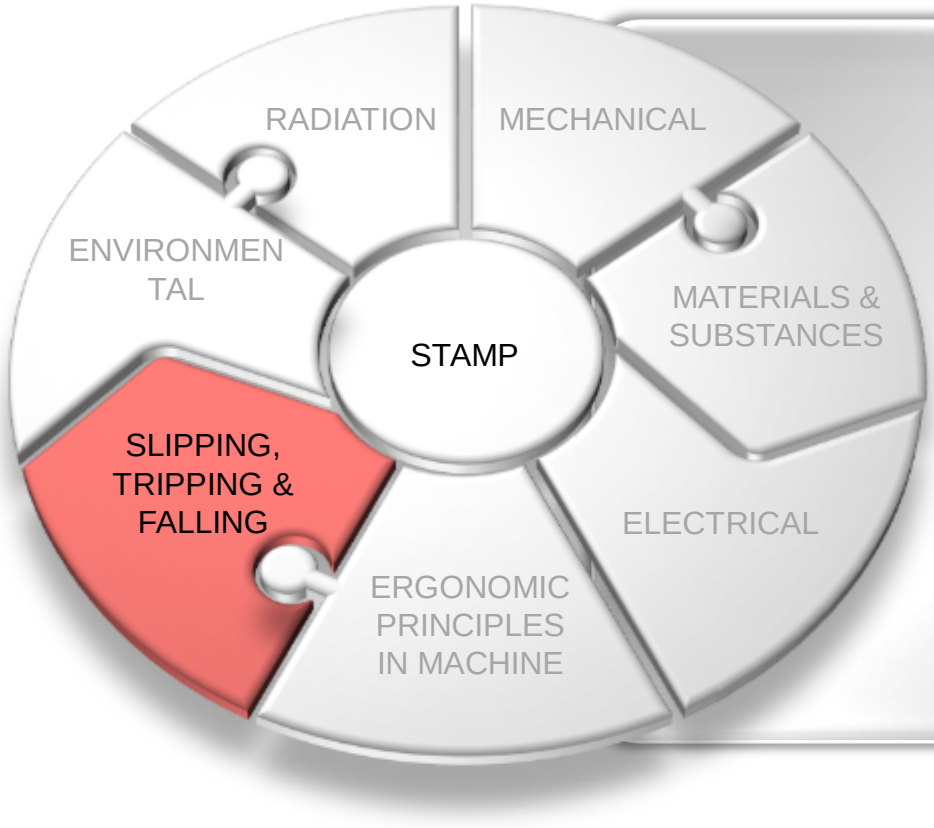
Inspect cables for frays.

Panel covers and cable cross-section.

The electrical equipment should follow the relevant requirements.

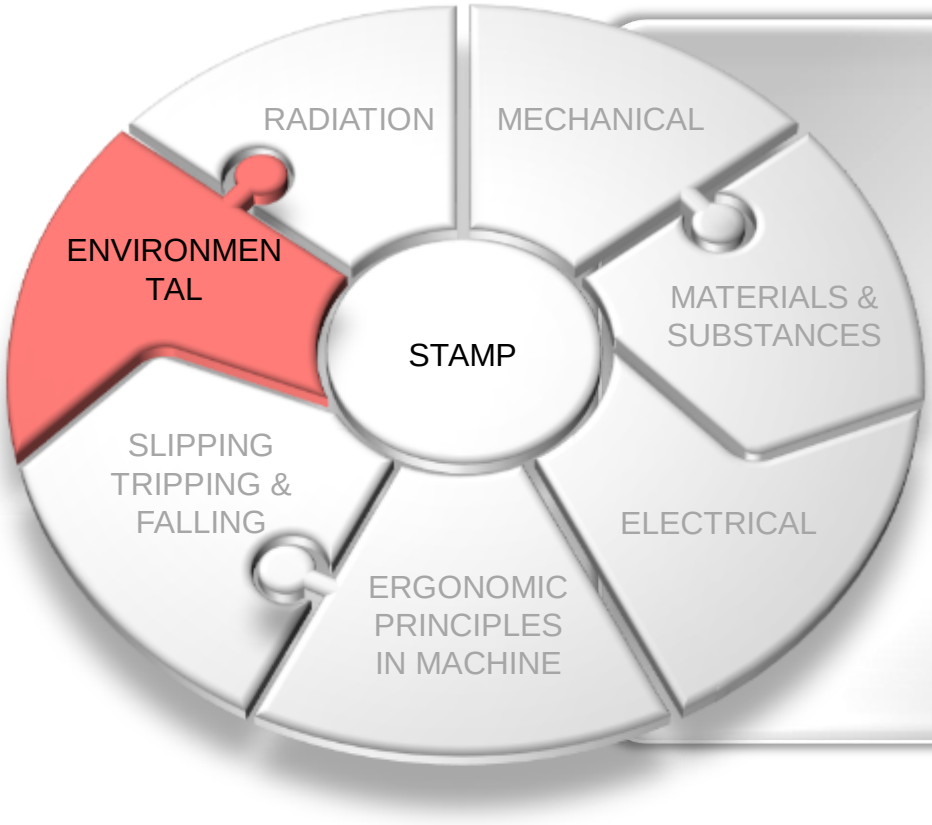
Install emergency buttons & tactile sensors which halt all mechanisms in case of danger.

Safety Design Constraints



3 types of emergency stops + remote + passive infrared sensors should be installed. Red functional tested and well maintained (regular test and calibration).
Check repeatability, settings and reliability.
Find bugs in program
Faulty mechanics or installation
Mechanical stops or shock absorbers.
The restart method must be tested that deals for all malfunctions. A more detailed method than a simple button.
Must not restart after 5 seconds.
Provide a known safe point for restart

Safety Design Constraints

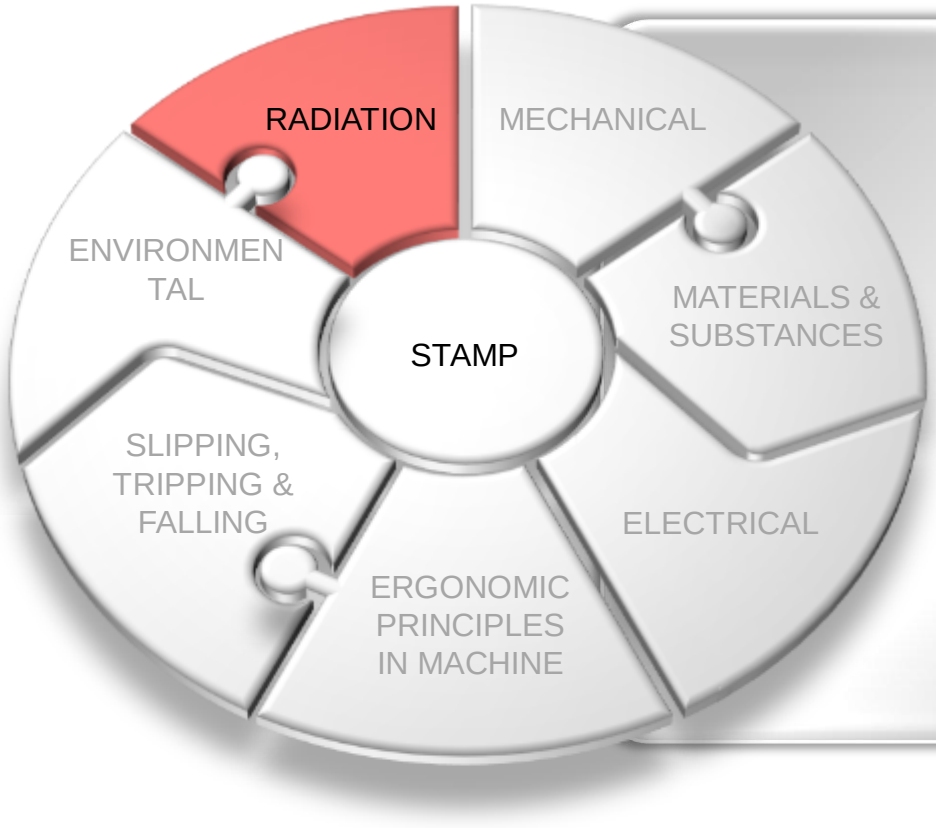


Robot movements shall be as smooth as reasonably practical, given the appropriate task goals of the robot.

Supplementary use of inherently anti-noise components e.g. foam, baffles, curtains, coatings to protect hearing.

Use of active sound absorbing mechanisms to avoid emitting noise.

Safety Design Constraints



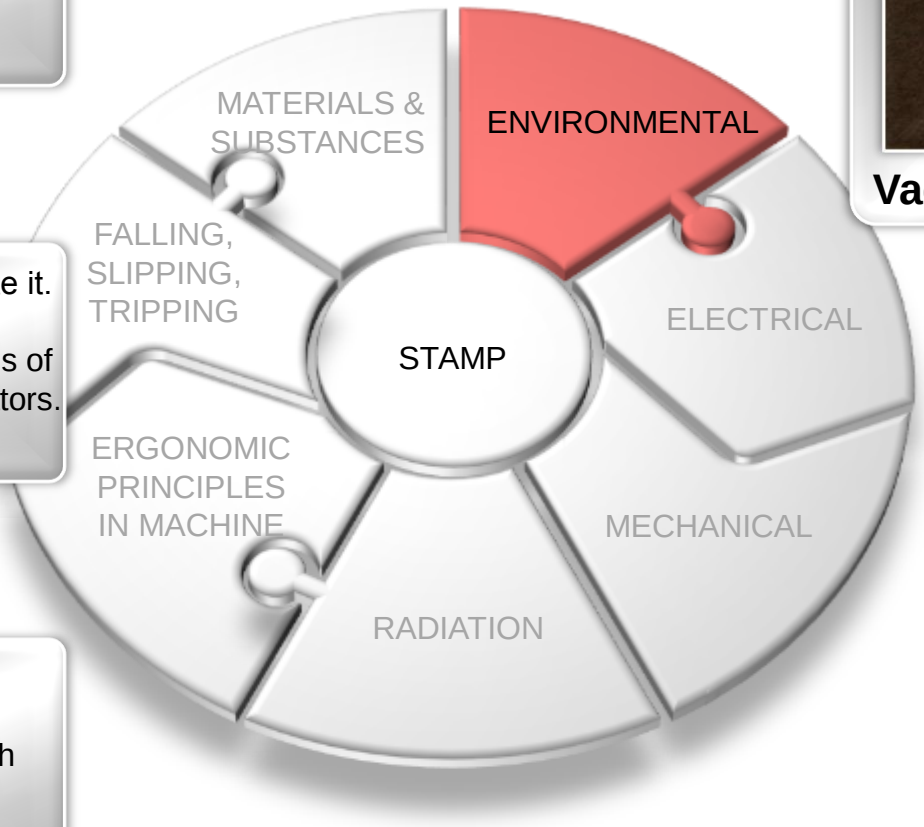
Disorientation must be avoided.
The frequency of signal must not interfere other robots or devices.
The robot must not response to other signals like light wavelengths, acoustic frequencies, background noise frequencies for audio signals. It must respond to remote controller.
Robot's tasking path shall not be affected by adjacent metal robot's equipment, hidden cables, another device using frequency within the same range.

Assign responsibility to the user for safety-critical actions

- Operate the robot scheduled times every day.
- Air-openings opened.
- Don't expose it to high temperatures.

- Don't allow humidity to mutilate it.
- Close the door of balcony.
- User must recognise variations of audible signals such as indicators.

- Operate it away from candles embers, distilled alcohol, gasoline, thinner, ashtrays with burning cigarettes.



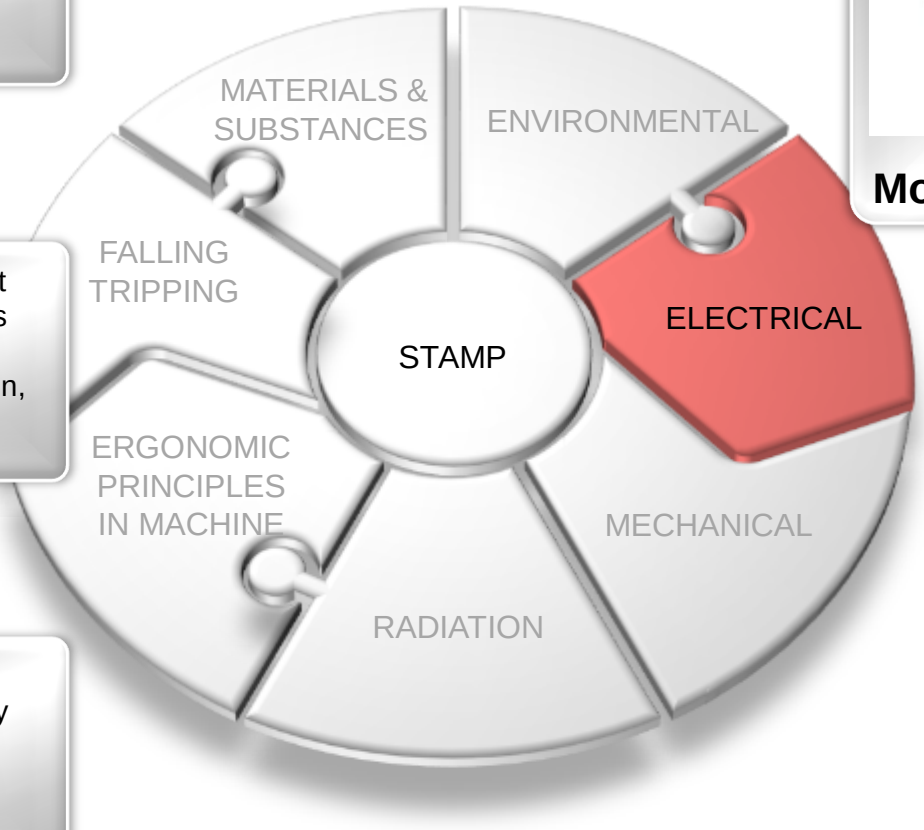
Vacuum cleaning

Assign responsibility to the user for safety-critical actions

- User should be advised how to perform regular test and maintenance of electrical equipment.

- User must not remove, bend, cut weld electrical or electronic parts inside the chassis.
- The power cords must be uneven, without irregular corners. Cut continuous loop.

- Keep cords in good condition, maintain regular. Make sure they are carrying the right current capacity at the label.
- Attach cords in the wall using tape.



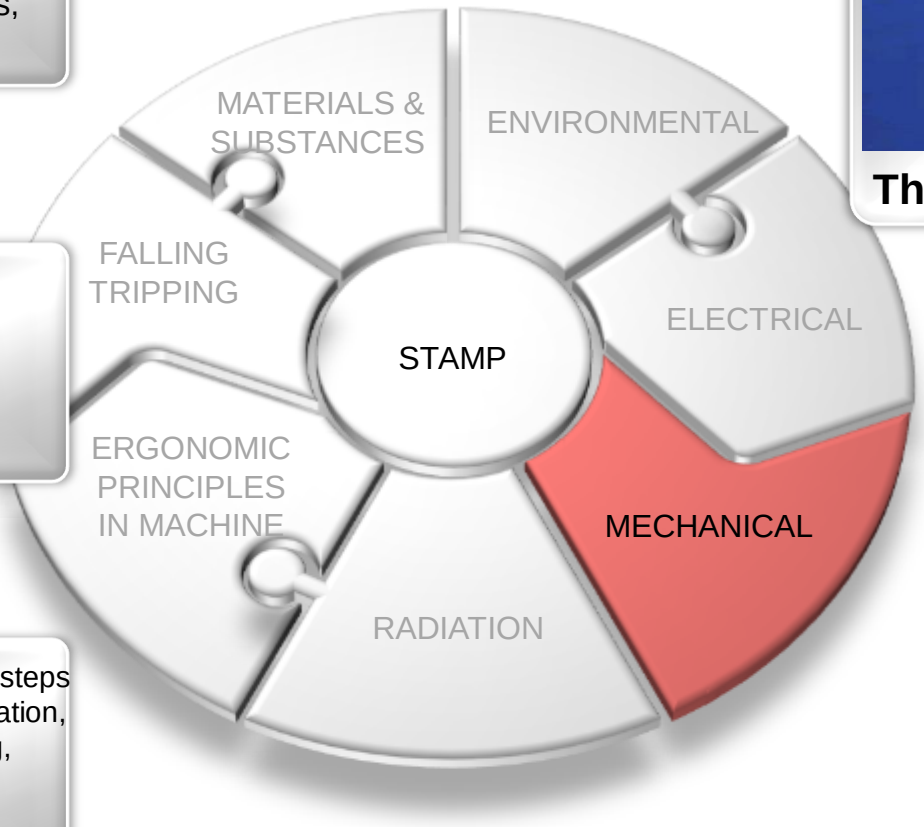
Mowing

Assign responsibility to the user for safety-critical actions

- User should pay extra attention to symbols indicating ON/OFF, wear protective clothes, caution/danger/attention notes, tips and hints.

- Warning symbols shows a possibly dangerous electrical condition.

- Manual should bear figures and steps in order to make clear the installation, guidance for packing, unpacking, preparation, software, beacons, console and charging station, installation of wires, remote control.



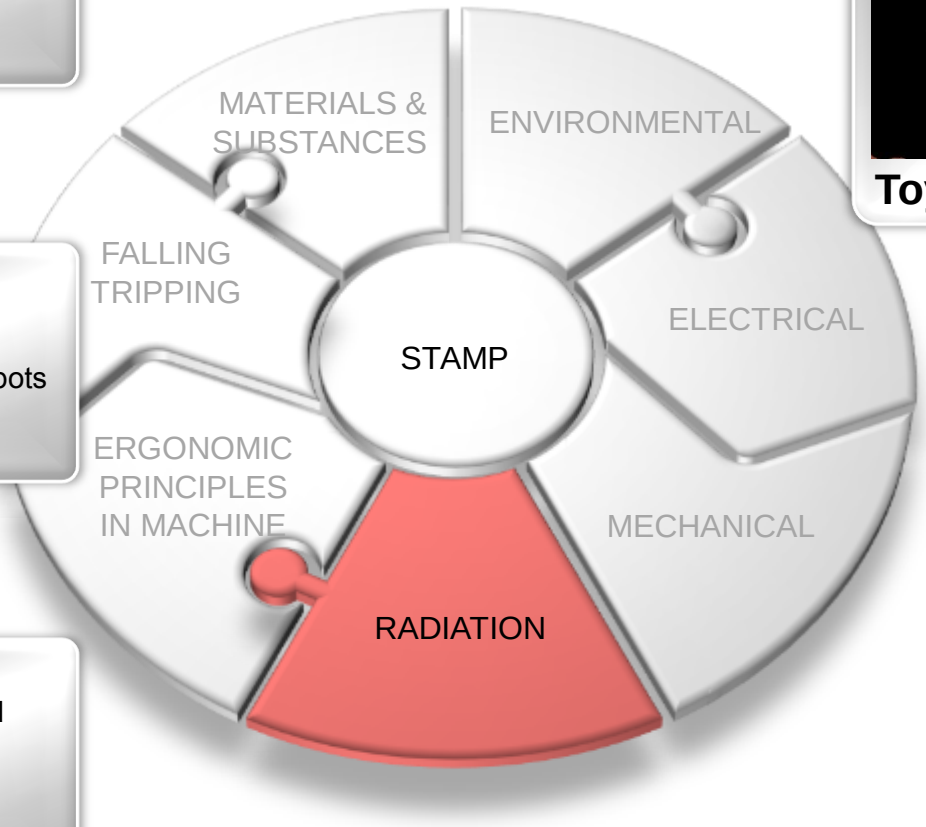
Therapeutic seal

Assign responsibility to the user for safety-critical actions

- Place the robot away from sources with bright sunlight, fluorescence and electronically dimmed lightning.

- User shall be informed for the spectrum and frequencies that causes interference.
- Don't use two or more same robots in case the they interfere one another (infrared sensors).

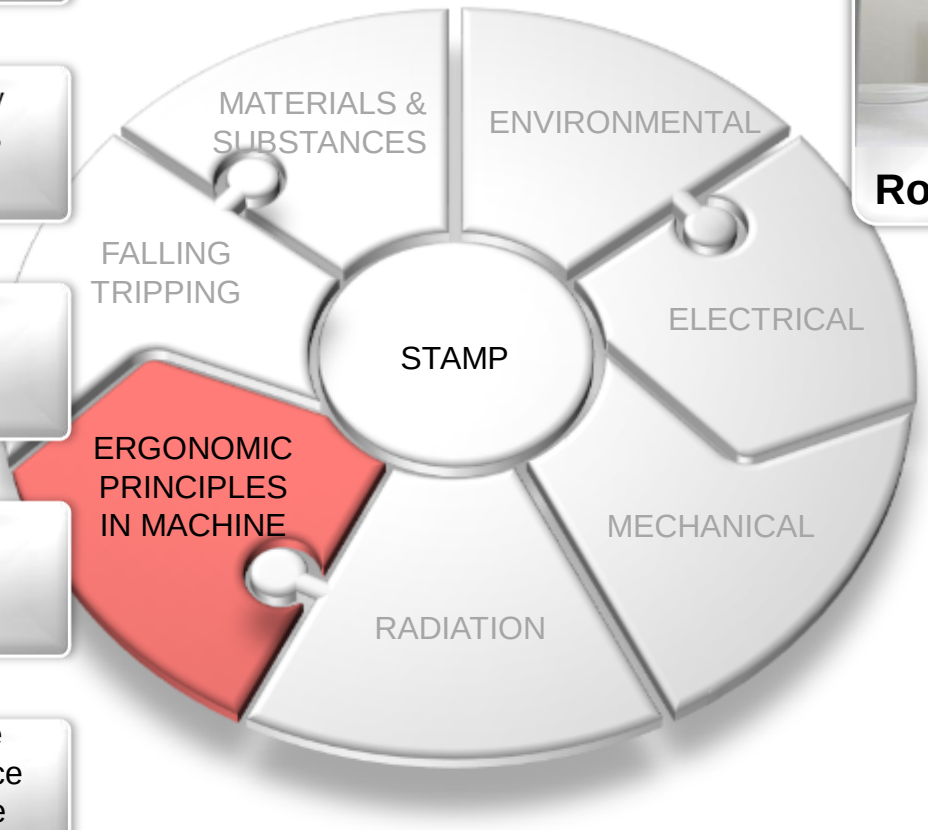
- Jamming devices like infrared LEDs that may saturate infrared sensors are not allowed in the same area.



Toy for children

Assign responsibility to the user for safety-critical actions

- User should retain the safety and operating instructions of the manual for future reference.
- User must not try to repair any tools or components while it is executing.
- User must be informed about maintenance requirements.
- If it starts vibrating he should call the authorised personnel.
- The user should recognise the number and name of the device for identification that should be easily readable and displayed.



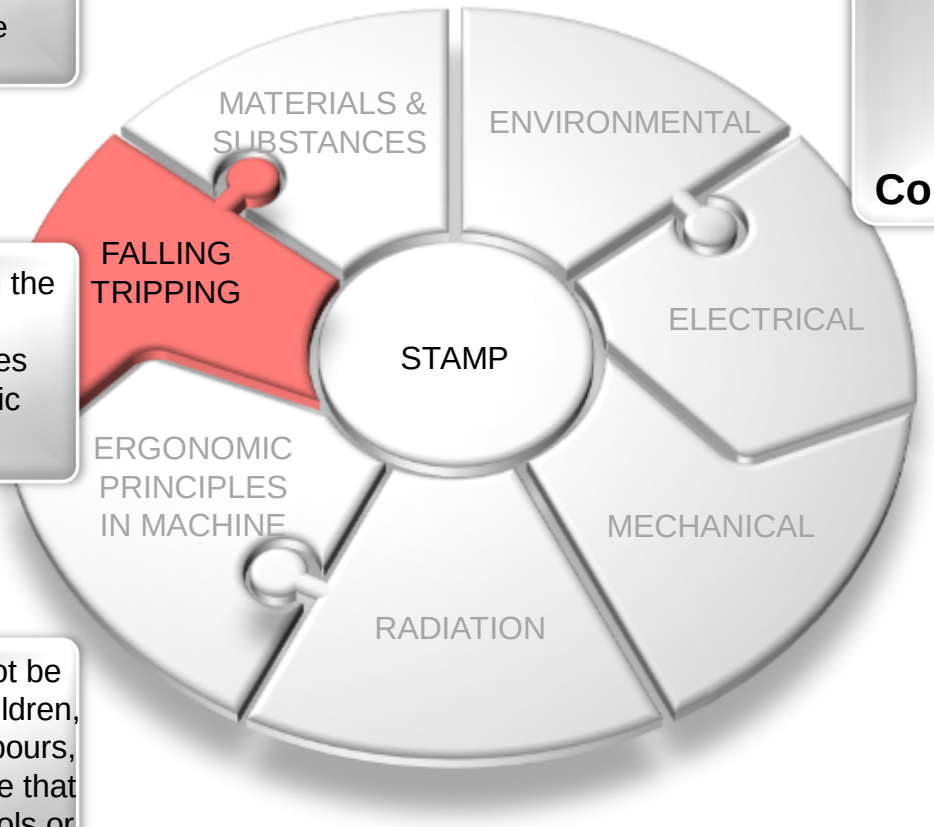
Robot with tools

Assign responsibility to the user for safety-critical actions

- User must inform unaware residents about hazards caused by improper handling of device, of supplementary tools, or thrown objects such as cuts, burns, eye injuries or soft tissue damage.

- A robot must not be turned in the direction of the people, pets, homes, streets, or automobiles where parameters of domestic tasks are changing.

- The operational area must not be overcrowded with infants, children, passengers, disabled, neighbours, guests, elderly or pets in case that the robot contains harmful tools or accessories.



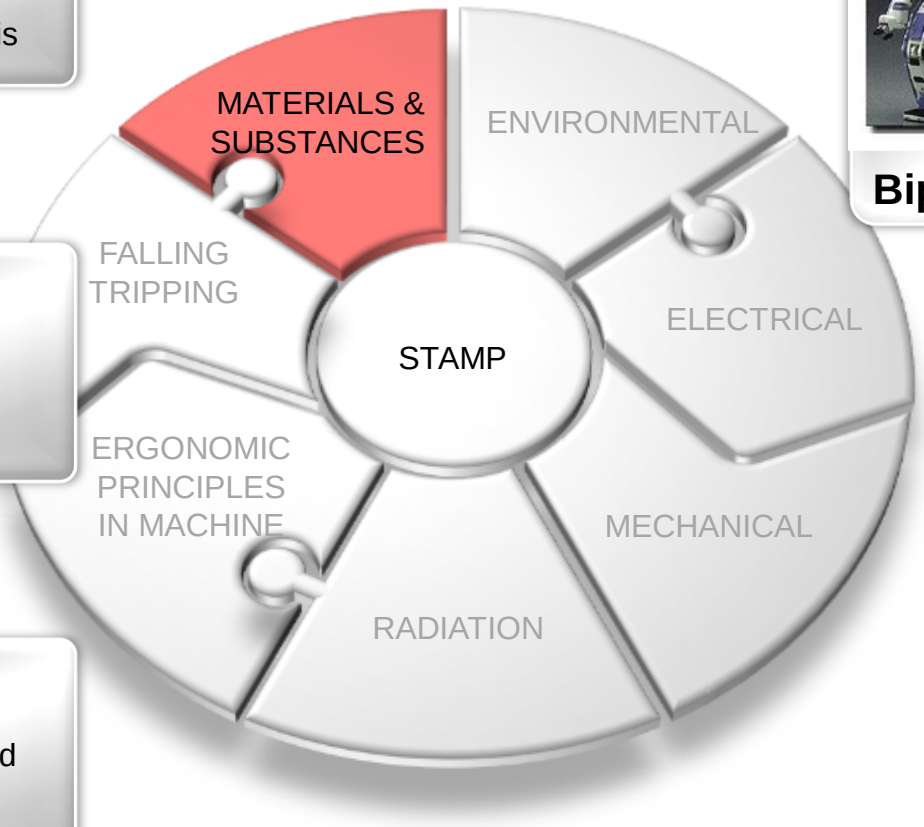
Companion

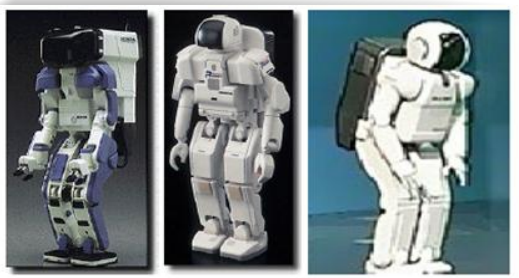
Assign responsibility to the user for safety-critical actions

- User must not spoil, mutilate, burn up or incinerate the battery as it will explode.
- Charge in dry well-ventilated area where the temperature is moderate.

- Specific responsibilities for maintenance should be assigned to the user.

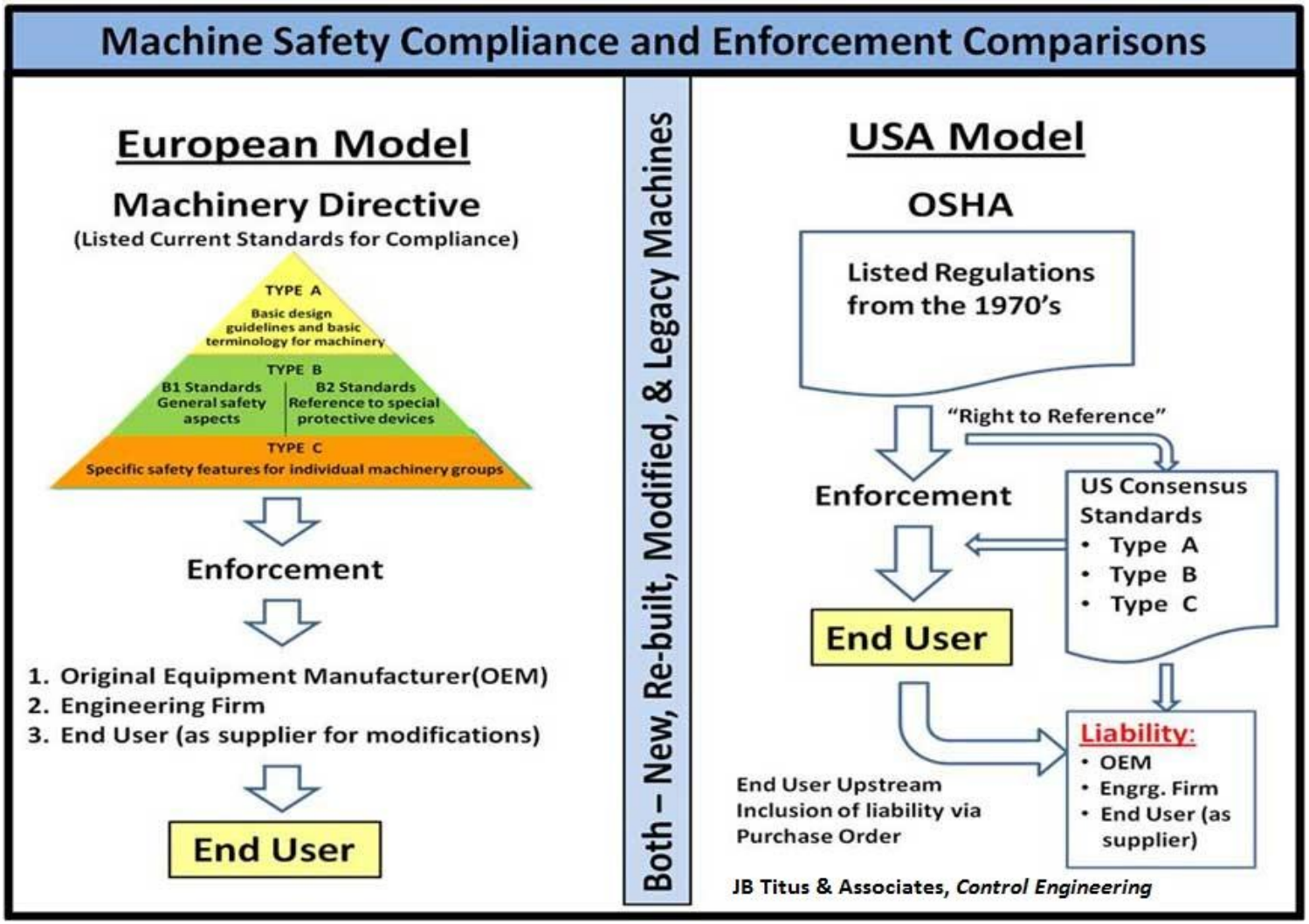
- User must inspect cables for frays.
- User must not use a damaged cord.



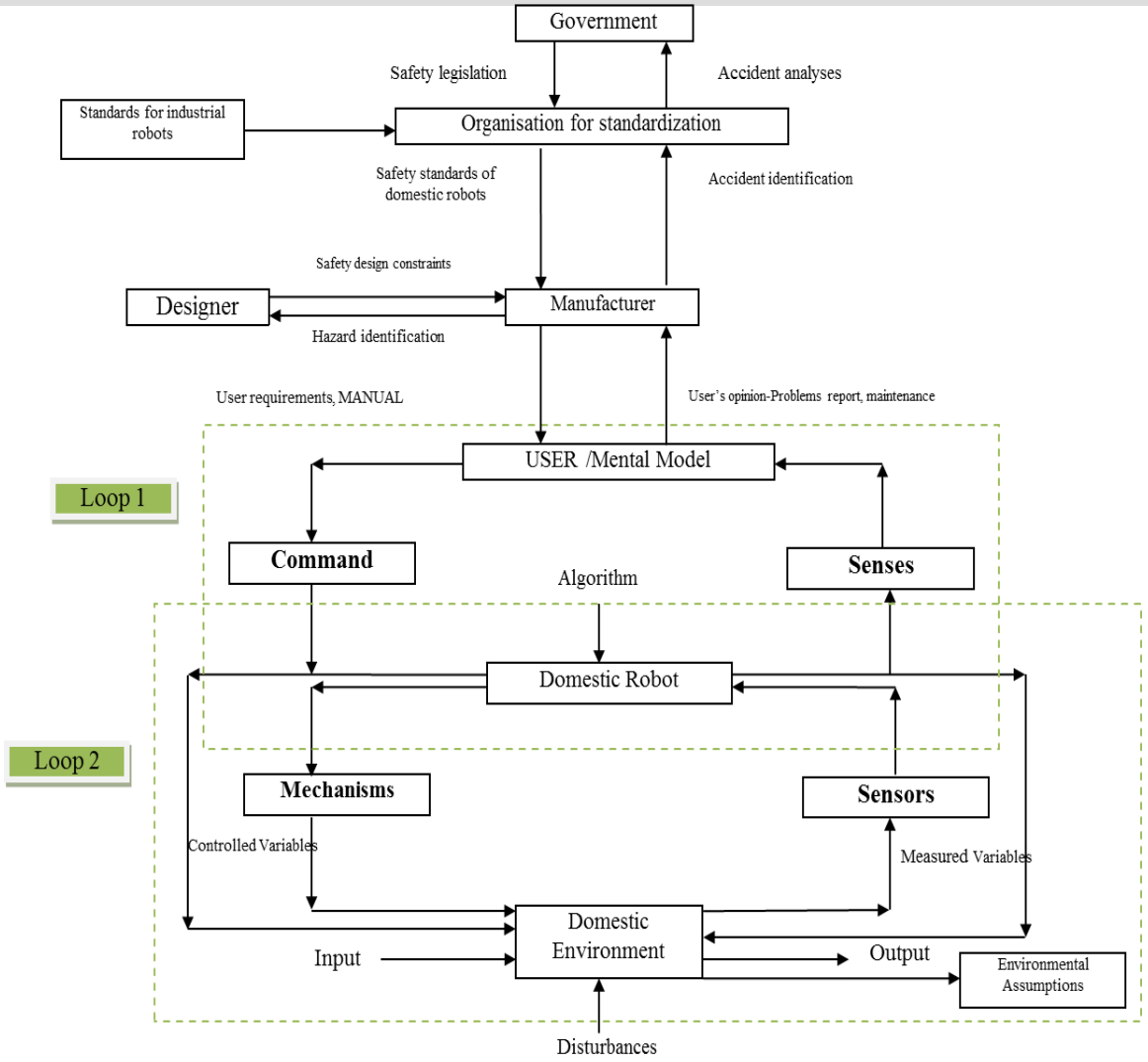


Biped

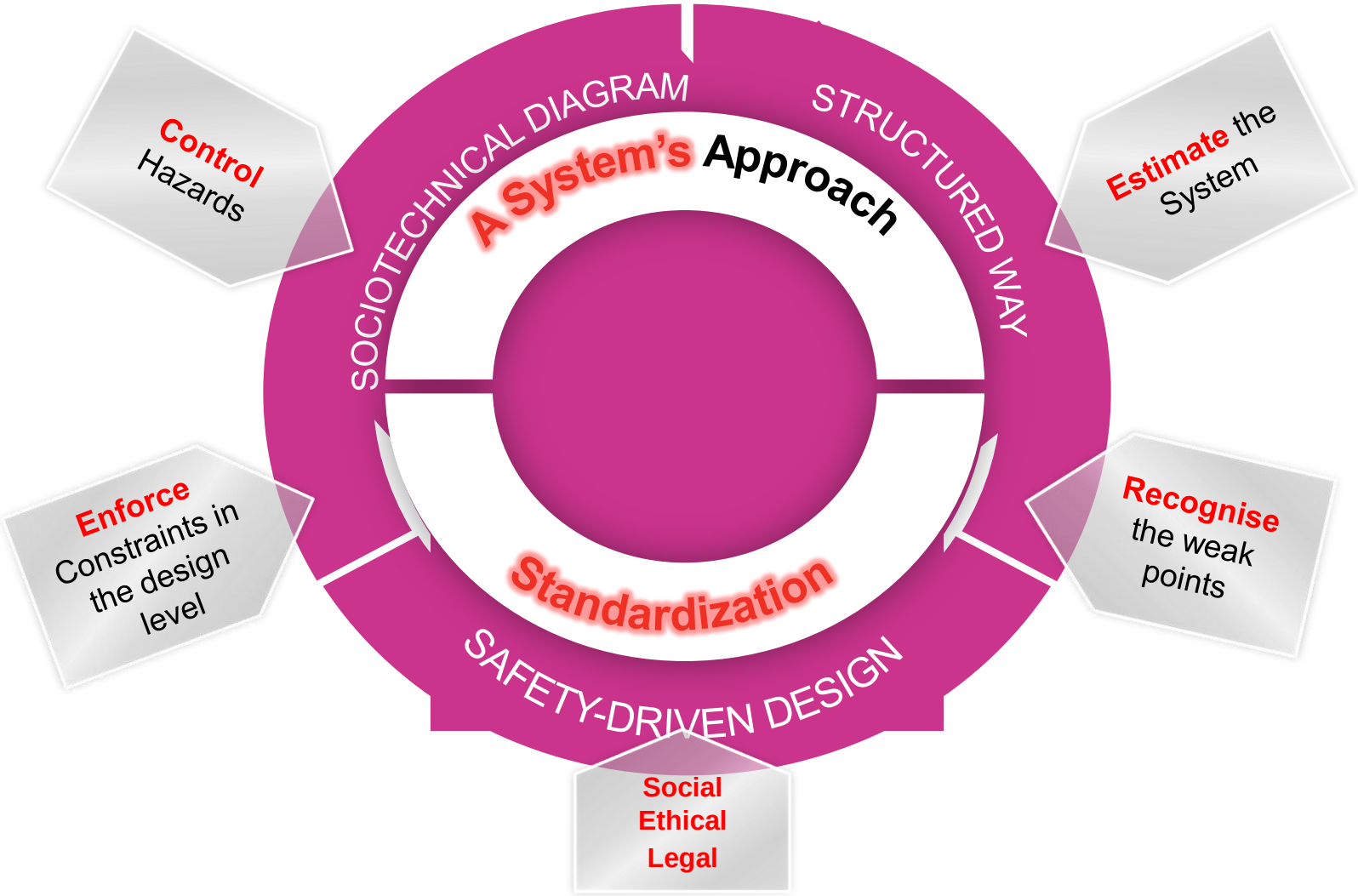
Standardization and Machine safety…



Standardization and STAMP model…



Benefits of STAMP on standardization



Thank you for your attention!

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