**Capitalization – The first word of a sentence is capitalized as usual. Each bullet point answer begins with capitalization and ends with a period.**

1.1

1. Name the number of the standard for classification of manufacturing processes and the main groups. From what aspect are the manufacturing processes classified in this standard?

*The relevant standard is DIN 8580. The main groups of primary shaping, forming, separating, joining, coating, and changing of material properties are classified in terms of cohesion: creation, preservation, reduction, and increase.*

1. How are production and setup times divided for work order times according to REFA? How are basic times and allowance times further subdivided in execution time?

*Production and setup times are divided into basic times, allowance times, and recovery times.*

* *Basic times: activity times (influenceable and non-influenceable) and waiting times.*
* *Allowance times: factual allowance times, personal allowance times.*

1. What is the Rule of 10 in quality management?

*The cost of defects increases by a power of ten with each stage of discovery: development (1), process planning (10), production (100), customer (1000).*

1. What principles in processes are important in lean management?

* *Waste elimination.*
* *Process synchronization, process standardization, avoiding errors, improving systems, worker training.*
* *Improvement in small steps.*

1.2

1. What materials were processed in the Bronze Age and what products were made?

*Bronze, copper, and tin were processed as materials in the Bronze Age. For example, jewelry, tools, and weapons were made from them.*

1. What does division of labor mean and what are the advantages?

*Division of labor means division of quantities and division of tasks. In the case of division of quantities, each worker produces a specific quantity and carries out all related work processes. (Disadvantage: specialists are needed.) In the case of division of tasks, each worker only carries out a partial step for the complete work and only a few skills, which are learned, are needed (Advantage: higher degree of practice and shorter times).*

1. What are the most important changes in the four industrial revolutions that have taken place up to now?

* *Industry 1.0: beginning of the machine age with the invention of the steam engine, hydropower, the loom, and the spinning frame.*
* *Industry 2.0: introduction of assembly line work (division of labor by task).*
* *Industry 3.0: computing machines and personal computers, control systems for machines.*
* *Industry 4.0: digitalization and networking of production plants, introduction of cyber-physical systems, Internet of Things.*

1.3

1. What does the Pareto rule mean?

*According to the Pareto rule, also referred to as the 80/20 rule of cause and effect, some products create approx. 80 % of the effort (cause), but contribute only approx. 20 % to the result (effect). Pareto proves that the essential part of the success (approx. 80 %) is achieved only with approx. 20 % of the products.*

1. What does the long tail mean?

*Some products are bestsellers and sell very well with high unit numbers and revenue, while others only achieve small unit numbers and thus have high costs and low revenue (they are in the long tail). Through marketing on the Internet, the aim is to increase the marketing base and thus reach larger markets, so that niche products can also find buyers more easily.*

2.1

1. What are the manufacturing processes in the main group of primary shaping?

* *From a liquid or pasty state (casting of metallic and polymeric workpieces).*
* *From a solid, granular, or powdery state of metals (powder metallurgy: extrusion and sintering).*
* *Additive manufacturing processes (layer-upon-layer building of components with almost any geometry and with metallic as well as polymer materials).*

1. Describe the procedure during casting technology in broad terms.

*In casting, a component is created from the melt, e.g., molten metal is poured into a mold and solidification produces a solid body with a defined shape. Workpieces are generally cast whenever their production by other manufacturing processes is not economical or impossible (e.g., large components such as turbine housings, engine casings, etc.). Casting processes are particularly advantageous for the mass production of components.*

1. Which casting methods are distinguished between?

*Investment casting, full mold casting, sand casting, mask molding process, chill casting, die casting, centrifugal casting, continuous casting.*

2.2

1. What is the classification of forming processes according to DIN 8580?

* *Pressure forming.*
* *Tensile-compressive forming.*
* *Tensile forming.*
* *Bending.*
* *Shear spinning.*

1. What forming manufacturing processes are predominantly used in automobile and aircraft manufacturing?

* *Rolling (cold forming for stringers, frames, paneling, etc.).*
* *Deep-drawing and stretch forming (cold forming for body construction components, paneling, flaps, etc.).*
* *Extrusion (cold forming for highly stressed components, such as engines, landing gear, etc.).*
* *Forging (hot forming for die forging of undercarriage components, drive components, crankshafts, camshafts, rims, etc.).*

1. What is the difference between cold and hot forming?

*Hot forming takes place at higher temperatures (above the recrystallization temperature). The materials are generally much easier to form and recrystallization occurs simultaneously (with an associated reduction in hardening).*

*Cold forming (at room temperature) requires much higher stresses than hot forming, but has the advantage of a considerable hardening of the materials.*

1. Where is the deep-drawing manufacturing process used?

*Deep-drawing is a manufacturing process used for the tensile-compressive forming of sheet metal blanks (circular blanks, plates, blanks) into a hollow body (e.g., a top-open cup). The drawing tool consists of a punch, die, and blank holder. The blank holder* *ensures that the sheet being drawn in does not form wrinkles.* *Deep-drawing is extensively used for body construction in automobile manufacturing.*

2.3

1. What are the most important manufacturing processes in the main group of separation?

*The manufacturing processes in the main group of separation are cutting (punching), machining, and removal (spark erosion, electrochemical processing, etc.).*

1. What are the main problems in machining?

*The problem in machining technology is heavy tool wear due to high temperatures, great pressure on the tool at the contact point during the cutting process, and relative movement between tool and chip.*

1. What does the term *tool life* mean in machining?

*The wear of a tool determines the tool life, i.e., the time a tool may remain in service. If there is a substantial amount of wear, there will be a major change in the process and deviations in surface quality and dimensional accuracy.*

1. What types of wear are distinguished in machining?

*Mechanical abrasion, oxidation, diffusion, the formation of built-up edge.*

2.4

1. How much does assembly contribute to the value creation processes in automobile and aircraft manufacturing?

*Around 50% in automobile manufacturing and around 70% in aircraft manufacturing.*

1. Which two groups are distinguished between in welding technology processes and what are the characteristics associated with them?

* *Fusion welding: problems include solidification shrinkage and solid state shrinkage, crystal formation, gas absorption, segregation, residual stresses.*
* *Pressure welding: Temperatures always remain below the melting temperature, so there is no solidification problem, only solid state shrinkage.*

1. What are the characteristics of adhesive bonding? What are the main advantages and disadvantages?

*Atomic bonding forces are formed during adhesive bonding: Cohesion (atomic forces between identical atoms) and adhesion (atomic forces between different atoms).*

*The main advantages are that different materials can be combined and low temperatures are sufficient for forming an adhesive joint.*

*The main disadvantages are the low temperature resistance of the bond (max. approx. 100 –150° C) and the aging of the adhesive.*

2.5

1. What future requirements are important to assembly in automobile and aircraft manufacturing?

* *High flexibility for current and future variants.*
* *Good accessibility for assembly processes.*
* *High maintainability*
* *Suitable for large production rates.*
* *Short lead times.*
* *High degree of automation.*
* *High flexibility.*
* *High cost efficiency.*
* *Increased quality level.*

1. What coating processes are predominantly used in automobile and aircraft manufacturing?

* *Pre-treatment with phosphate salt solutions (spraying and dipping), build-up of a crystalline metal-phosphate layer (only in automobile manufacturing for steel bodies, not in aircraft manufacturing).*
* *Anti-corrosion primer to prevent corrosion.*
* *Filler to smooth out unevenness (alkyd resins).*
* *Paint layer for coloration (water-soluble), possibly with effects such as metallic, pearl effect, etc.*
* *Clear coat (acrylic resins) to protect against mechanical, chemical, and environmental stresses.*

2.6

1. What process is used to increase component properties and what improvements can be achieved?

*Shot peening (shot blasting) is used to achieve the following goals:*

* *Increase in fatigue strength (up to 100%).*
* *Improvement of corrosion resistance (up to 100%).*
* *Improvement of wear resistance (up to 50%).*

3.1

1. What is the significance of one-time costs in manufacturing processes?

*The one-time costs, such as for setup procedures, jigs, workpiece holders and tools, are generally relatively high in conventional manufacturing processes, such as those for individual or small batch production. In additive manufacturing processes, one-time costs are low since the data preparation for the geometry is generated from CAD data via software programs and the setup procedures usually do not apply at all.*

1. Name the difference between additive and subtractive manufacturing processes.

*In additive manufacturing processes, the component is built successively and layer-upon-layer to produce the final contour by creating cohesion.*

*In subtractive manufacturing processes, the final contour is created by subtracting material by means of reducing cohesion, e.g., by chip removal in the machining manufacturing processes (turning, drilling, milling, etc.), in order to produce the final contour.*

1. What are the known uses of additive processes?

* *Rapid prototyping.*
* *Rapid tooling.*
* *Rapid manufacturing.*

1. What legal problems particularly arise from additive processes?

* *Intellectual property and industrial property rights.*
* *Producer liability.*
* *Safety requirements according to CE directives.*

3.2

1. Explain the procedure during stereolithography using key words.

* *Create a mathematic layer model from CAD data.*
* *Layer-upon-layer local crosslinking of liquid Duroplasts (epoxy resin with mixed-in hardener) by laser beam.*
* *Formation of a component through its layered structure.*

1. How is a solid produced from the liquid thermoset in stereolithography?

*A liquid photosensitive or a heat-sensitive polymer (generally a Duroplast, e.g., epoxy resin), into which a crosslinking agent (hardener) is mixed, is supplied with the energy required for the chemical reaction of the polymer by a laser with X/Y control. This starts a crosslinking process that converts the polymer into a solid state.*

1. How is crosslinking realized at the surface level in stereolithography?

*Crosslinking is achieved by using a laser to generate thin surface layers as solids one at a time. After a solid layer has been created, the component is lowered and the next layer follows.*

3.3

1. Explain the procedure during selective laser sintering using key words.

* *Create a mathematic layer model from CAD data.*
* *Layer-upon-layer melting of the plastic layer of a metallic powder (coated with a polymer). or layer-upon-layer melting of a plastic powder or a powdery sand (coated with a polymer for casting molds and sand cores) by the energy effect of a laser beam or an electron beam.*
* *Formation of a component by building a layered structure.*
* *Sintering of a component (for metallic powders, not for molding sand) in a sintering furnace to expel the plastic.*

1. Explain the procedure during SLM (selective laser melting) and SEBM (selective electron beam melting) using key words.

*Create a mathematic layer model from CAD data.*

*Layer-upon-layer melting of a metallic powder or a plastic powder by laser beam or electron beam.*

*Formation of a component by building a layered structure.*

1. What densities and strengths are achieved in the SLM and SEBM processes?

*The achievable strength and density of the material is in the range of approx. 97-99%, comparable to the properties of conventionally produced workpieces.*

3.4

1. Explain the procedure during FDM (fused deposition modeling) using key words.

* *Create a mathematic layer model from CAD data.*
* *Layered construction of a component made of meltable plastic (thermoplastic).*
* *The plastic is melted in a nozzle (pasty state) and then positioned with the nozzle in the X/Y direction.*
* *Layer build-up from the melted plastic in a pasty state.*
* *Formation of a component by building a layered structure.*

1. What processes occur in the FDM head?

*The material is drawn in by an extruder in the FDM head and heated electrically, the plastics are melted from a solid state and processed into a pasty mass in the FDM head. The pressure situation in the FDM head leads to the material being injected onto the build platform and layers are created one after another and the component is built. The material then cools and hardens at the desired position.*

1. What are the advantages of the FDM process and what types of components can be created?

* *Components with high accuracy.*
* *Components for demanding tests and harsh environments.*
* *Fasteners.*
* *Tools.*
* *Prototypes for the automotive and aerospace industries.*
* *Prostheses for medical technology.*

3.5

1. Explain the procedure during multi-jet modeling (MJM) and poly-jet modeling (PJM) using key words.

* *Create a mathematic layer model from CAD data.*
* *Liquid plastic or wax is sprayed in fine drops using a print head (similar to inkjet printers).*
* *The plastic or wax cools and becomes solid, forming a layer.*
* *Formation of a component by building a layered structure.*

1. What is the curing process for MJM and PJM?

*Liquid plastic (thermoplastic) or wax is applied as a layer to the build platform or to a previous layer using a print head, similar to inkjet printers, whereupon the plastic or wax cools and solidifies. Plastics that are sensitive to UV light and are cured with UV light can also be used. This creates the component by building a layered structure.*

1. Why are supporting structures necessary?

*Suitable supporting structures must be used for material overhangs. The material for the component material and the material for the supporting structure are processed simultaneously using multiple nozzles. The component materials are typically thermoplastics used as photopolymers, which can be cured by UV lamps. Supporting structures are often made from waxes that can be easily melted off.*

1. How does the MJM process function?

*The MJM process consists of spraying an adhesive onto a layer of a powdery base using a jet process, the powder is bonded as a base and a solid structure is formed.*

3.6

1. Explain the procedure during 3D printing (3DP) using key words.

* *Create a mathematic layer model from CAD data.*
* *Powder-based process in which particles of plastic or sand are distributed over a layer.*
* *An adhesive or bonding agent is sprayed in fine drops with a print head (similar to inkjet printers).*
* *The particles bond together as the adhesive cures and forms a layer.*
* *Formation of a component by building a layered structure.*

1. What are the prerequisites for 3D printing and how does crosslinking occur?

*An essential prerequisite is that the materials exist in powder form and can be crosslinked with a bonding agent or adhesive. The piezo injection unit supplies the bonding agent or adhesive in dosed quantities.*

1. What materials are suitable for 3D printing?

*Materials in powder form, such as metals, ceramics, sand, and plastics, can be used as materials. The materials must be able to be wetted by the bonding agent or adhesive.*

3.7

1. Explain the procedure during LLM (layer laminated manufacturing) and LOM (layer object modeling) using keywords.

* *Create a mathematic layer model from CAD data.*
* *A laser is used to cut plastic or paper webs.*
* *The cut plastic or paper layers are provided with an adhesive and laminated to the base surface.*
* *A component is built by bonding the layers.*
* *Formation of a component by building a layered structure.*

1. What type of components can be produced particularly cost-effectively with LLM and LOM?

*Such laminate processes for building components by layers are particularly suitable for producing especially large, solid components (e.g., seats, body components, and other large structures in the automobile sector).*

1. How are the strengths of laminate components formed?

*The mechanical strengths vary in the* *direction of the foil or film and perpendicular to it, since the strength is determined by the respective foil or film material or adhesive bond. This results in a substantial anisotropy (directional dependence of the properties).* *The cost of reworking the geometry and surfaces is also very high.*

1. What are the different types of foil and film cutting and what is the risk of delamination?

*Cutting devices typically cut perpendicular to the foil or film, which is unfavorable for shallow bevels. It is more favorable to use milled foils or films, since the contours can be adjusted by positioning the cutter. There is a latent risk of delamination and paper components in particular must be additionally treated to protect them from delamination.*

3.8

1. What are the main advantages of selective mask sintering?

* *Integral exposure of the entire component surface via the mask pattern, thus increasing the speed of processing (not every point has to be traversed).*
* *Faster process compared to selective laser sintering (SLS).*

4.1

1. What is the goal of rapid prototyping?

*Rapid prototyping offers various possibilities, for example, creating a prototype of a component for which a CAD design is available in the shortest possible time, indicating the geometry of a future component, and producing visual samples, as well as support in the development of complex designs.*

1. What additive processes are used in rapid prototyping?

* *Stereolithography.*
* *Laser sintering.*
* *Fused deposition modeling.*
* *Multi-jet process.*
* *3D printing.*
* *Laminating process.*

1. What are the characteristics of rapid prototyping processes?

*A characteristic of rapid prototyping is that no tools need to be produced to create a component. All additive processes work without the use of molds, which saves time and costs.*

4.2

1. What processes are used for prototyping? What process achieves the greatest time savings and the highest increase in product quality?

* *Physical mock-up (real structure, model building, large time investment, small increase in product quality).*
* *Digital mock-up (virtual structure, 3D CAD representation, medium time investment, medium increase in product quality).*
* *Rapid prototyping (real structure, lowest time investment, greatest increase in product quality).*

1. What are the most important reasons for using rapid prototyping in the early development phase?

* *Design model: requires high level of geometric detail and surface quality, visual acceptance.*
* *Ergonomic model: indicates operating functions, simplicity of operation.*
* *Functional model: provides functionality for testing the application and processes.*
* *Geometric model: filling of installation space, testing of space conditions (particularly in demand in automobile manufacturing).*

1. What other support system is known in development?

*Simultaneous engineering (also referred to as concurrent engineering) is a well-known support system in development in which a large number of activities are carried out in tandem, including for the production of prototypes.*

4.3

1. What are the typical application industries for rapid prototyping?

* *Household and consumer appliances: checking appearance, function, handling.*
* *Automotive industry: checking maximum design freedom, component interactions, utilization of installation space.*
* *Aerospace industry: components with optimized designs and extreme loads.*
* *Aircraft industry: planning, structural design, and interior design in the model making.*
* *Healthcare: production of prostheses, implants.*
* *Machine manufacturing: alternative product developments, particularly for complex designs.*
* *Architecture: checking appearance, geometries, functionalities, and overall appearance of buildings.*

1. What industries most commonly use rapid prototyping applications?

*The focus lies in automobile and aircraft manufacturing, and architecture.*

5.1

1. What is the fundamental task of rapid tooling?

*The goal of rapid tooling is to produce tools for production or prototyping at low levels* *in terms of time and costs, thus ensuring the production of the necessary tools.*

1. What are the main advantages of rapid tooling compared to conventional processes?

*Rapid tooling uses additive processes to create tools for manufacturing processes, which can significantly reduce time and costs.*

1. Which elements can be produced for casting technology with rapid tooling?

*The 3D printing process can be used ,e.g., to create sand molds and sand cores that are used as lost molds or lost cores made of molding sand, as well as tool inserts made of metals for plastic injection molding applications.*

1. What are the main advantages of rapid tooling in the production of metallic injection molds?

*During the manufacture of a tool or tool insert, internal cooling channels close to the contour can be created. Generatively manufactured tools or tool inserts are characterized by improved cooling performance compared to tools made from solid material.*

5.2

1. What is the difference between indirect and direct processes in rapid tooling for mold making in casting technology?

*Indirect: First, a master pattern is produced using an additive process, such as 3D printing (3DP) or stereolithography (STL). A sand casting mold and sand cores are then produced from this master pattern in a subsequent non-additive process.*

*Direct: In an early phase of development, sand molds and cores are created directly, which are used for casting technology to produce initial casts and, in turn real cast parts.*

1. What factors determine the cost of manufacturing inserts for plastic injection molds?

* *Number of mold cores.*
* *Size of the components.*
* *Desired surface properties.*
* *Number of gates.*
* *Number and geometry of the cooling channels.*
* *Expected wear and tear.*

1. What are the advantages of using rapid tooling compared to traditional processes?

* *Rapid product provision.*
* *Short development times for tools.*
* *Typically uses original series plastic grades.*
* *Low-cost alternative to conventional toolmaking.*
* *Suitable for small and medium product series.*

1. What are the opportunities in rapid tooling to produce larger quantities by plastic injection molding?

*The use of aluminum injection molds is cost-effective in many rapid tooling processes. Depending on the quantities (up to 30,000 pieces) and the material used, aluminum molds produced with selective laser sintering (SLS) can be deployed. Aluminum injection molds also allow the use of fiberglass-reinforced plastics.*

6.1

1. Name the main advantages of rapid manufacturing for the development sector.

* *Reduced time-to-market.*
* *Reduced development time and development costs.*
* *Fast availability of components for functional tests.*
* *Elimination of tools and tool costs.*
* *Production of geometries that are not possible with conventional processes.*
* *Geometric changes in the early stage possible at any time by changing data.*
* *Development of customer-specific and application-specific products (e.g., patient-specific implants, etc.).*
* *Improved adaptation to applications (e.g., bionics, lightweight construction, etc.).*

1. What additional aspects of production make rapid manufacturing an interesting manufacturing process?

* *Fast replacement parts production.*
* *Fast delivery time for customer-specific products.*
* *No warehousing (production on demand).*
* *Production of components at the place of use (without transport).*
* *Simplified way to create integral components for lightweight construction.*
* *Production of components that cannot be manufactured using conventional technology (e.g., medical technology, biotechnology, etc.).*
* *New applications in areas such as art, design, and architecture.*

1. What are the disadvantages of rapid manufacturing?

*The disadvantages are processing speed and manufacturing times, which are greatly slowed down or increased compared to conventional processes.*

6.2

1. In what areas do the major advantages of rapid manufacturing lie?

*The advantages particularly lie in individual production (e.g., in the medical field for implants) as well as replacement parts supply and production.*

1. What role does the location of manufacture play in rapid manufacturing?

*Particularly for replacement parts, on-site printing can be realized nearly anywhere in the world and the parts can be used immediately after manufacture without additional transport.*

1. In what sectors are components produced with rapid manufacturing interesting and which series sizes appear to be economically feasible?

* *Machine manufacturing.*
* *Automotive industry.*
* *Aircraft manufacturing.*
* *Aerospace.*
* *Medical technology.*
* *Architecture.*
* *Toys, etc.*

*Series sizes in the area of individual and small batches production appear to be economically promising, although large series and mass production appear to be of little economic interest.*

1. What metallic alloys are used in rapid manufacturing in the field of medical technology and what process is used to produce implants?

*Titanium alloys (e.g., TIAl6 V4) are used. The SLM process (selective laser melting) is used.*

7.1

1. Which fields of action are significant in the use of cyber-physical systems?

* *Standardization for network architecture and communication.*
* *Operation of complex IT systems for industry.*
* *Highly dynamic and comprehensive broadband infrastructure.*
* *Complete data security.*
* *Targeted development of standards and rules for work organization and work design in the digital industrial age.*
* *Education and training of personnel in the area of Industry 4.0 and CPS, cyber-physical systems.*
* *Legal framework.*

1. What goals are relevant to the realization of a digital strategy?

*A uniform understanding of the future integration of humans, machines, sensors, actuators, and processes is necessary to implement a digital strategy. A structural change must therefore be brought about.*

1. Which current standard (or rule) exists as a recommendation for action for the development and use of cyber-physical systems?

*The Digital Factory Guidelines according to VDI 4499, Sheets 1-4 describe the recommendations for action regarding CPS.*

1. What is the definition of a cyber-physical system?

*Cyber-physical systems (CPS) are characterized by a linking of real (physical) objects and processes with information processing (virtual) objects and processes via open, partially global information networks that are interconnected at all times.*

7.2

1. What are the essential elements that define cyber-physical systems?

*In the context of Industry 4.0, cyber-physical systems include the “Internet of Things” and “big data”.*

1. What company planning and control tasks are taken over by Industry 4.0 within the framework of the network?

* *Order management with customers.*
* *Supply chain management with current demand and delivery status.*
* *Production processes with material supply in the raw goods area and with storage and transport in the finished goods area.*

1. What potential for improving efficiency does Industry 4.0 offer in production?

*Industry 4.0 offers considerable potential for flexibility and automation.*

1. Which fields of action are interesting for the further development of CPS?

* *Standardization for network architecture and communication.*
* *Operation of complex IT systems for industry.*
* *Highly dynamic and comprehensive broadband infrastructure.*
* *Complete data security.*
* *Targeted development of standards and rules for work organization and design.*
* *Education and training of personnel in the area of Industry 4.0 and CPS.*
* *Existence of legal framework.*

7.3

1. What is an important prerequisite for data exchange in CPS?

*A prerequisite for the use of cyber-physical systems is communication* *regarding the processing of orders via the Internet between the groups involved, such as the OEM, the suppliers, and the customer.*

1. Which participating groups should be fully involved in the CPS planning process?

*All groups participating in production, such as suppliers, internal and external production units, internal and external warehousing, and shipping agents should be involved.*

1. Do manual intervention options exist for the persons involved?

*In the event of corrections,* *it must be possible to actively intervene in the production* *through manual interaction.*

7.4

1. What guidelines address the digital factory topic regarding the fundamentals?

*The VDI 4499 Guidelines, Sheet 1 describe the processes (models, methods, tools), the introduction and organizational measures, as well as the system architecture, and data management.*

1. What guidelines address the digital factory topic regarding operating a digital factory?

*The VDI 4499 Guidelines, Sheet 2, present the application of operating a digital factory in the lifecycle phases of the factory, examples of application areas (machine tools and production plants), and the data infrastructure for operating a digital factory.*

1. What guidelines address data management and system architectures?

*The VDI 4499 Guidelines, Sheet 3, provide orientation regarding:*

* *Procedure for realization and implementation.*
* *Preparation and concept management.*
* *Data model and data management.*
* *Implementation.*
* *Recommendations on system architecture and data management in the digital factory.*

1. What guidelines address integrating humans into the digital factory?

*The VDI 4499 Guidelines, Sheet 4, handle the topics*

* *Fundamentals with types of digital human models and legal frameworks*
* *Aspects of ergonomic analyses*
* *Application examples.*

7.5

1. What does the “dynamic reconfiguration” function involve?

*Within the shortest possible time, dynamic reconfiguration of the production plants must be used to respond to newly changed conditions for production in order to induce the boundary conditions (clamping devices, jigs, tools, etc.) for a variant change in production (this was previously referred to as retrofitting effort).*

1. What capability must be present when boundary conditions change?

*There must be a high degree of flexibility in control and mechanics. The manufacturing process must be designed so flexibly that its processes can be subsequently changed at any time.*

1. What is understood as self-organization in the context of Industry 4.0?

*Production should be largely self-organized. The production plants of the OEM and the supplier, the personnel involved, the customer, the production planning and production control systems, and so on, must communicate in great depth with one another. Using IT, the OEM, supplier, and customer communicate directly with each other under Industry 4.0 structures.*