

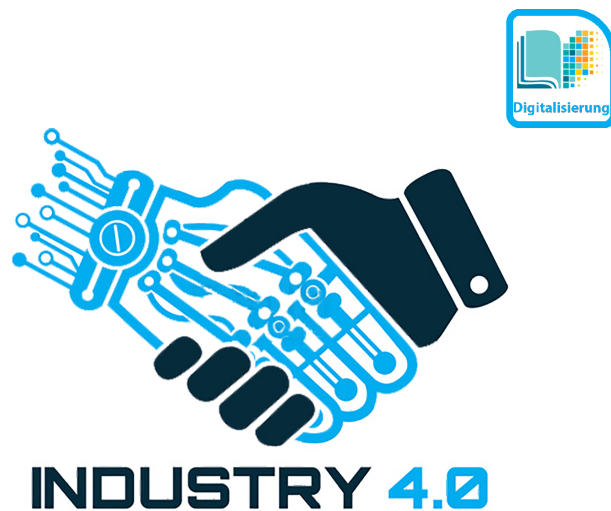
- Comprehension Questions with Solutions -

Industry 4.0 - Digital Transformation TWIE24

Industrial Engineering and Management Program

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CHAPTER 1

Digital Transformation

1.1 Comprehension Questions

1. How do Big Data and Smart Data differ?

Big Data refers to large amounts of data that exist in
unstructured form. Smart Data is already processed
data that is immediately usable.

2. Name the three stages in which digital transformation takes effect from a company's point of view:

Stage 1: Digitalization of the value chain

Stage 2: Digitalization of products

Stage 3: Introduction of new business models based on
value-added data services

3. What was the starting point for digital transformation?

Companies focus on the customer and customer value.
Customer-centric solutions are sought.

4. Name three examples of enabler technologies:

a) Internet of Things

b) Internet of Value

c) Computing Power

5. In which five steps can digital transformation be successfully implemented in companies?

Step 1: Digital Reality

Step 2: Digital Ambition

Step 3: Digital Potentials

Step 4: Digital Fit

Step 5: Digital Implementation

6. What is meant by predictive analytics?

Predictive analytics is the analysis of data that
makes it possible to predict future events or results.

7. Name the four levers through which digital transformation operates:

a) Digital Data

b) Automation

c) Networking

d) Digital Customer Access

CHAPTER 2

Disruptive Technologies

2.1 Comprehension Questions

1. Describe in your own words the theory of disruptive technologies.

... are innovations that replace the successful track record of an
already existing technology, an existing product, or an existing
service, or completely displace it from the market,
rendering the investments of the previously dominant
market participants obsolete.

2. According to which two types are disruptive technologies categorized?

- Low-End Disruption
- New-Market Disruption

3. Name three examples of disruptive technologies.

- Digital camera
- VoIP (Voice over IP)
- CD and DVD

4. How can already established market participants protect themselves against disruptive innovations ?

- Focus on product innovation (not on profit)
- Acquisitions of companies at an early stage
- Spin-offs

5. What alternative model regarding innovation management do you know?

S-curve model

CHAPTER 3

Artificial Intelligence

3.1 Comprehension Questions

1. What are the most important subfields of artificial intelligence?

Machine Learning

Deep Learning

Neural Networks

Data Mining

2. What does the "Turing Test" state?

In this test, a machine is credited with artificial intelligence

as soon as it is capable of communicating in such a way that a

human cannot distinguish whether they are communicating with

another human or with a machine.

3. According to Mainzer, when is a system considered intelligent?

A system is considered intelligent if it can solve problems

independently and efficiently.

4. How does a weak AI differ from a strong AI?

A weak AI acts intelligently within a narrowly defined

and specific context. A strong AI possesses at least

human-like intelligence in all areas.

5. What three learning approaches exist within Machine Learning?

Supervised Learning, Unsupervised Learning, Reinforcement Learning

6. When is Deep Learning preferred over Machine Learning?

Deep Learning is used primarily for large, multidimensional
volumes of data.

7. What does the field of Neural Networks take as its model?

The model for neural networks comes from nature.
There, neural networks, through complex interconnections,
provide adaptivity as well as a wide range of motor and
intellectual abilities.

8. What three main types of modeling does Data Mining include?

Descriptive, predictive, and prescriptive modeling

CHAPTER 4

Autonomous Driving and Risk Ethics

4.1 Comprehension Questions

1. How is the term „autonomy“ to be understood in the field of autonomous driving?

The term “autonomy” describes self-determination
within the framework of a superordinate (moral) law.
In the field of autonomous driving, it is the human being
who sets out this moral law by
programming the vehicle’s behavior.

2. How can the decline in road fatalities be explained? Please name at least 3 examples.

Increase in safety-related requirements in road traffic.
Increase in digital driver assistance systems.
E.g. 100 km/h speed limit on rural roads.
E.g. mandatory seatbelt use.
E.g. emergency brake assist.

3. What does the concept named „Semulin“ deal with?

A self-supporting concept for autonomous driving.
Multimodal input and output modalities.
Processes facial expressions, gestures, and speech.
Links together the previous HMI.

4. What question arises from the risk-ethical consideration of the causes of error in road traffic with regard to the use of autonomous vehicles?

Currently, 93.5 percent of accidents result
from human error.
The question is therefore what kind of errors
will replace human errors.

5. How will the form of decision-making change in autonomous driving?

The intuitive-situational decision will change into
the deliberate, conscious decision.

This is defined by the planned programming.

6. What is meant by the term „crash optimization “?

Reaction of the autonomous vehicle
in the event of an unavoidable collision.

E.g. collision with the safest road user.

SUV vs. small car.

CHAPTER 5

Extended Reality (XR)

5.1 Comprehension Questions

1. What is meant by the term "immersion"?

The term "immersion" describes the effect of complete immersion of the user in virtual reality.
The user perceives the simulated reality as "real".

2. What do "AR" and "VR" mean, and how does the representation of objects differ between the two technologies?

AR is the abbreviation for Augmented Reality. With AR, virtual objects are projected into the real environment.
VR stands for Virtual Reality. With VR technology, the real environment is completely replaced by a computer-generated 360° environment.

3. How is the term reality defined, from which language is the term derived, and how does it differ from virtuality?

Reality means "that which actually is" or "the totality of what is real" and derives from the Latin "res" for "thing, matter." Reality encompasses everything that a human being can see with their own eyes and interact with, without being additionally influenced by any technology, whereas the virtual environment is computer-generated.

4. What area does XR technology come from, and what factors have enabled its wider use?

The origins of XR technology lie in the field of multimedia and gaming. Through continuous technological advances, VR technology has become increasingly affordable and thus a marketable product for the consumer market.

5. Name one commercial application of AR and one advantage that results from its use.

The head-up display of a car can project data such as speed and navigation instructions onto the windshield.

The driver does not need to look at their phone while driving and take their eyes off the road in order to keep track of the route. Safety is increased.

6. Name one field of application in industry for each of VR, MR and AR technology, and explain 3 advantages of one of the three fields of application.

AR: production controlling, MR: maintenance, VR: product development:

1. Costs can be saved, since no physical prototype needs to be produced.

2. The product can be analyzed and tested at an early stage. Errors are detected and fixed promptly.

3. The customer can participate intensively and from the very beginning in the creation of their product and influence its design.

7. Explain a concrete example from industry in which a company benefited from the implementation of XR technology.

Bell Helicopter designed a helicopter using VR technology and needed only about half a year for the conceptualization, instead of the usual five to seven years. The use of XR technology enabled the company to achieve both time and cost savings.

8. Name two opportunities that arise from the use of XR and one risk. Suggest a way in which the risk could be counteracted.

Opportunities: increase in efficiency and reduction of travel/travel costs. Risk: low acceptance. Employees may have problems with the new technology, may not want change, and may reject the new possibilities. Measure: involve employees early on, offer training, and show them the advantages that result for them from the implementation of the technology.

CHAPTER 6

Blockchain Technology

6.1 Comprehension Questions

1. What is meant by a distributed network?

A distributed network consists of nodes that communicate with one another and store the blockchain's data redundantly. Independent computers communicate with one another, and the failure of one computer does not affect the other computers.

2. In which areas is blockchain used?

Smart contracts (finance, politics, insurance)
M2M machine-to-machine communication
Smart grids - decentralized energy supply
Smart identity

3. How can transactions be authorized and identified?

Through asymmetric encryption and digital signatures. Transactions are signed using the private and public key.

4. Which two concepts are most commonly used for reaching consensus?

Proof of Work
Proof of Stake

5. How is a new block created in the cryptocurrency Bitcoin?

Miners attempt to find the nonce (= random number) through random trial and error.

6. What does the term DAO mean?

Decentralized Autonomous Organization (DAO)

7. Name two opportunities and two risks of blockchain technology, respectively.

Opportunities: availability of data, integrity of data

Risks: scalability, legal framework conditions

CHAPTER 7

Cryptocurrencies

7.1 Comprehension Questions

1. Why are cryptocurrencies, by definition, not a currency?

The term currency describes the sovereign-regulated
monetary system of a state or currency area.
Cryptocurrencies originate from neither a state
authority, nor is their control exercised by one.

2. Explain the term „scalability“ in connection with cryptocurrencies in your own words.
Why is scalability important?

Scalability describes the ability of a cryptocurrency
to maintain functionality as usage increases.
A viable means of payment must be able to
handle a large number of transactions without
loss of performance

3. Explain the possibilities of M2M transactions using an example of your own choosing:

In the IoT, machines can not only communicate with one another,
but can also pay each other using blockchain technology
An example of this is a refrigerator that knows its own
contents and can reorder them in good time

4. Name four possible areas of application for self-sovereign identity management:

a) Access management for buildings
b) Educational certificates
c) E-voting
d) Finance

5. What time limit applies to the taxation of profits from trading in cryptocurrencies?

Holding period $\leq$ 1 year: offset against income tax

Holding period $>$ 1 year: capital gains are tax-free

6. Name one risk of cryptocurrencies and explain it.

Volatility: Many cryptocurrencies are subject to strong

value fluctuations $\rightarrow$ unsuitable as a means of payment

CHAPTER 8

The Working World of the Future - Work 4.0

8.1 Comprehension Questions

1. What challenges arise from demographic change?

Due to demographic change, a shortage of human capital is to be expected as a result of the aging of the share of the working population in society. Occupational fields that are not substitutable will in future have to compete for a smaller number of available employees.

2. Which fields of activity are least affected/threatened by automation and digitalization?

Occupations based on creativity and social interaction, or that require complex cognitive activities.

3. How can the concept of social partnership help enable a socially sustainable transition to Working World 4.0?

In the course of the transition to Working World 4.0, at least in certain areas, technologically induced unemployment is to be expected; not all those affected by this will experience smooth transitions into follow-up employment. In the spirit of the existing social partnership, employer and employee associations as well as the state can offer mutually acceptable solutions here, e.g., through compensation payments, severance payments, further training offers, or similar measures.

CHAPTER 9

Big Data

9.1 Comprehension Questions

1. How is Big Data defined?

Big Data refers to the use of large volumes of data from
diverse sources, at high processing speed,
to generate economic value

2. What is an algorithm?

An algorithm is a defined procedure for eliminating a
problem or accomplishing a particular task.

3. What advantages result from Big Data? Name two, with a brief explanation.

- Gaining customer understanding
- Optimization of business processes
- Assistance with decision-making
- Optimal use of resources

4. What is the greatest risk that Big Data brings with it? (Brief justification)

Privacy and data protection:
Through decryption and analysis of these traces, a person
can be linked to the data, causing them to lose any kind
of anonymity

5. What is Predictive Analytics?

By analyzing data directly from main memory instead
of from disk, insights can be derived immediately
and reacted to quickly.

6. Name three examples of where Big Data is used.

- Connected vehicles

- Smart grids

- Credit card fraud

CHAPTER 10

Medicine 4.0

10.1 Comprehension Questions

1. Explain why digitalization of the healthcare system will be indispensable in future.

Due to demographic change and rising life expectancy,
costs in the healthcare system will continue to rise in
future. Digitalization of the healthcare system can
reduce these costs again.

2. Name three challenges of digitalization in the healthcare system!

1. Digital care network
2. Interoperability & isolated systems
3. Numerous paper documents & system discontinuities
4. Telemedicine
5. Market consolidation & skilled-worker shortage
6. Patient focus & complexity

3. Define the term **interoperability**.

Interoperability refers to the ability of a system to
work together with other systems.

4. Name the 5 areas into which eHealth can be divided.

- a) eCare (healthcare provision)
- b) eAdministration (administrative processes)
- c) ePrevention (prevention)
- d) eResearch (research)
- e) eLearning (teaching)

5. How many euros could be saved annually in Germany through a digitalized healthcare system?

In Germany, around 42 billion EUR could be saved annually.

6. Describe the changes that have taken place from Clinic 1.0 to Clinic 4.0.

a) Clinic 1.0: New processes (anesthesia)

b) Clinic 2.0: New technologies (X-ray)

c) Clinic 3.0: Information-processing and information-storing machines

d) Clinic 4.0: Introduction of networked technologies as well as real-time communication

7. Explain how the role of the physician will change in Clinic 4.0.

The role of the physician will shift away from a general practitioner toward a specialist. They will become a team player who works closely with other physicians.

8. Name 4 systems present in nursing care in a digitalized hospital.

1. Mobile documentation systems

2. Location systems

3. Electronic order-entry systems

4. Hospitality entertainment

5. Mobile identity access

6. Nursing documentation via voice bot

7. IoT sensor technology for hygiene management

9. Describe the risks that arise with the digitalization of the healthcare system.

The greatest risk is computer viruses. These can manipulate data or render it inaccessible. Further risks exist in the area of data protection. The liability risk must be clearly clarified in advance in order to rule out ethical problems.

10. Name the three areas of telemedicine.

a) Teleconsultations

b) Telemonitoring

c) Teletherapy

11. How will the digitalization of the healthcare system develop in future?

In order for all the advantages of a digitalized healthcare

system to be leveraged, intelligent networking of this

system must take place. Medical insights can be

gained faster and more precisely through AI.

Robots will provide support in nursing care.

All actors in the healthcare system must work together.

CHAPTER 11

Digital Administration

11.1 Comprehension Questions

1. Describe in your own words what is understood by digital administration.

Digital administration, also called e-government,
is understood as digital processes in administrative institutions,
which are carried out with the help of information and communication technology
Examples of this would be:
applications of any kind, as well as digital voting

2. What advantages does e-government offer the population?

It offers citizens much more flexibility, since citizens can access
the services independently of time and place.

3. Name two laws that enable digitalization?

OZG – Online Access Act
E-Government Act

4. How can the transition to a fully digital administration in Germany succeed?

The recommendation pyramid must be implemented.

1. Develop a uniform strategy
2. Allow innovations in administration
3. Create interfaces so that all authorities can use
the same resources
4. A legal framework must be created

5. Which technologies do you know that are transferable to state administration?

Blockchain

Machine learning and artificial intelligence

Augmented & virtual reality

Internet of Things

6. Explain to what extent blockchain is of interest for administration.

There are two major thematic blocks in administration:

Certifications and register management.

Both can be perfectly replaced by blockchain technology,

since blockchain is predestined

to secure data in a tamper-proof way and forever.

CHAPTER 12

Digitalization of Culture

12.1 Comprehension Questions

1. What is "Kultur Digital"?

It is a program that seeks to support cultural institutions
in shaping digital opportunities and challenges
themselves.

2. What are digital serious games?

These are games that take place in a hardware- and software-based
virtual environment and aim to stimulate the learning of specific
and desired content.

3. How does the value of NFTs behave?

Once acquired, an NFT can no longer be sold for the same price.
It behaves like an investment, whose
value rises/falls depending on market conditions.

4. What can simply be said about the ownership of a digital work of art?

It belongs exclusively to the artist, provided they have "minted" it.

5. What is the question that arose at the end of the #vorstellungsänderung experiment?

Is the idea that theater takes place in separate rooms already
a thing of the past?

6. What types of funding does the "German Federal Cultural Foundation" (Kulturstiftung des Bundes) offer?

general project funding, program funding, cultural lighthouses

7. What is the Soundgraph 3.0?

It is a project of the Fonds Digital that visualizes a
digitally composed piece

CHAPTER 13

Cloud Computing

13.1 Comprehension Questions

1. Which 5 technological characteristics define Cloud Computing?

On-demand self-service

Broad network access

Resource pooling

Rapid elasticity

Measured service

2. What do the abbreviations SaaS / PaaS / IaaS mean?

Software as a Service (SaaS)

Platform as a Service (PaaS)

Infrastructure as a Service (IaaS)

3. How is Cloud Computing structured?

One way to structure the cloud is to divide it into three layers,
with each layer representing a degree of abstraction.

- Application

- Platform

- Infrastructure

The layers of the cloud can be used to classify the
various models of Cloud Computing.

4. What other technologies exist alongside Cloud Computing?

Grid Computing

Edge Computing

Fog Computing

5. What does the abbreviation ADV stand for?

Auftragsdatenverarbeitung (data processing agreement)

CHAPTER 14

Digital Resilience

14.1 Comprehension Questions

1. How should the term „Digital Resilience” be understood?

The term digital resilience refers to the crisis resistance of companies that are exposed to a multitude of external influences and are able to withstand them with the help of digital technologies. Resilience stands for the robustness of machines, systems, organizations, or companies and should be anchored in companies' strategy.

2. Justify the relevance of cyber security solutions.
Also name three goals with regard to the resilience strategy.

The main task of cyber security solutions is to minimize threats by protecting systems and data against unauthorized access, manipulation, and theft.

A resilience strategy aims at three things:

- withstanding an accidentally or deliberately induced IT disruption.
- keeping an interruption as short as possible and returning quickly to normal operations.
- emerging strengthened from the incident
- that is, learning continuously and systematically.

3. Name two advantages of the smart container project „DProdLog”.

- Inventory levels are recorded automatically.
- Fill levels are automatically reported to the service portal.
- An automated order is triggered.

4. Why should one not rely solely on cloud computing?

Address the advantages of edge computing in your answer.

- Edge computing has the advantage that data is processed in real time, resulting in lower latency.
- Should network problems occur, edge computing systems can continue to operate locally.
- The transmission of sensitive data to cloud systems is avoided, increasing data security.

5. What do disaster recovery systems aim to achieve?

- Reducing the effects of disasters, disruptions, and external effects on companies and organizations.
- Using backup systems to increase IT security.

6. Show the differences between edge and cloud computing.

- Decentralized architecture vs. cloud-based architecture.
- Data is processed in real time vs. data must first be sent to the cloud.
- Special hardware required vs. availability everywhere.

CHAPTER 15

Additive Manufacturing in Industry 4.0

15.1 Comprehension Questions

1. What is meant by additive manufacturing?

Additive manufacturing is a process for the layer-by-layer production of three-dimensional objects, in which material is only deposited where it is needed. It enables resource-efficient, flexible, and individualized production.

2. How does additive manufacturing differ from subtractive processes?

In subtractive processes, material is removed (e.g. milling or turning), whereas in additive manufacturing material is added layer by layer to create the part.

3. Which file forms the basis for additive manufacturing?

A digital STL file (Standard Tessellation Language).

4. Nennen Sie zwei Vorteile der additiven Fertigung im Vergleich zu traditionellen Fertigungsverfahren.

5. What is meant by Rapid Prototyping (RP)?

RP is the fast and cost-effective production of prototypes, in order to carry out design and functional testing in early development phases.

6. Beschreiben Sie kurz das Funktionsprinzip des Material Jetting.

7. Welche Rolle spielt das Pulverbett beim Binder Jetting und Powder Bed Fusion?

8. What challenges exist in industrial series production with additive manufacturing?

Long print times, high production costs for large quantities,
post-processing of surfaces, limited build volume, and
investment costs for machines.

9. How does additive manufacturing support Industry 4.0?

Through digital networking, automated process chains, digital
warehousing, on-demand production, and flexible manufacturing,
which shortens development times and reduces storage costs.

10. Nennen Sie die vier Hauptgruppen von Werkstoffen in der additiven Fertigung.

11. Vergleichen Sie Powder Bed Fusion (PBF) und Directed Energy Deposition (DED) hinsichtlich Präzision, Bauraum und Anwendungen.

12. Why are support structures necessary for some processes, and how can they be implemented?

Overhangs greater than 45° require support structures to stabilize the
part during printing. They can be made of the same material
(mechanically removable) or of a soluble material that is subsequently
dissolved.

13. Which factors influence the mechanical properties of additively manufactured parts?

Material choice, layer height, nozzle temperature, extrusion speed,
build chamber temperature, shrinkage or warping effects, and post-
processing.

14. Diskutieren Sie die ökologischen Vorteile additiver Fertigung und deren Grenzen.

15. Wie verändert die Additive Fertigung die Wertschöpfungskette im Vergleich zu klassischen Produktionsverfahren?