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Teemu Santonen & Jani Kiviranta

CREATECHVISION – Technology vision for the creative industries

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Leverage from the EU 2014–2020

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CREATECHVISION – Technology vision for the creative industries

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Executive summary

RESEARCH OBJECTIVES: THE European Social Fund (ESF) funded "CREATECHVISION – Technology vision for the creative Industries" – project's main aim is to define technology vision for creative industries. Technology vision will identify, describe and prioritize technologies which can be utilized in short-term (0 to 2 years) and mid-term (2 to 5 years) time scope. Technology vision will provide guidance on which technologies the creative sector should invest now and in the near future, while taking into account the specificities of the different creative industries.

DEFINITION OF CREATIVE INDUSTRIES: Creative industries are constantly changing and evolving. As a result, providing a solid definition is a challenging task, since many different classification models are available. This study adopts core competence based classification model consisting the following competences: (1) Management of creative work, (2) Visualization and graphical design, (3) Arts and crafts, (4) Writing and storytelling, (5) Performing arts, (6) Music and sound, (7) Solution and concept creation.

RESERCH DESIGN: A traditional consensus driven Delphi-study consisting three response-feedback rounds was conducted in year 2021. The carefully selected panel consisted of experts from different creative industries. These experts were profiled according to needs of their core competence area and their technological knowledge. The number of respondents in different rounds varied between 19 and 14 respondents. Technologies were evaluated from the following perspectives: in the 2 and 5 year time frame (1) importance / desirability of technologies and (2) diffusion of technologies according to diffusion of innovation theory framework as well as technologies impact on (3) business potential, and (4) the number of jobs.

RESULTS: As a result, 32 different technologies were identified and divided in following categories: (1) cloud services, (2) presentation technologies, (3) production technologies and (4) artificial intelligent solutions. In the overall review, technologies included in cloud services and presentation technologies categories received the highest prioritization. Somewhat surprisingly last place in the prioritizing was given to

artificial intelligence solutions. The top eight technologies were: (1) Online and virtual learning platforms, (2) Social media and cloud-based platforms for creative work and freelance services, (3) Livestreaming, (4) Cloud-based collaboration platforms, (5) in shared place Cloud-based (project) management tools and Extended reality (XR), (6) 360-degree video and (7) Immersive exhibits and performances.

CONCLUSIONS: Technology priorities varied significantly between core competence areas, although similarities can also be found. Technologies appeared to be well aligned the results of the with Megatrends 2020 report by Sitra. It is assumed that the ability to utilize multiple technologies simultaneously in order to create immersive experience will be emphasized in the future.

Presentation of the technology vision for the creative industries project

THE OBJECTIVE OF CREATECHVISION – Technology vision for the creative industries, a project funded by the European Social Fund, is to (1) determine a technology vision for the creative sector that describes and prioritises new technologies with key relevance to the creative industries, (2) generate ideas and concepts to new business, product and service solutions for the creative industries that utilise the technologies described in the technology vision and (3) issue recommendations from the perspective of the development of education and competence in the creative sector from the perspective of the technology vision. The two-year project is coordinated by the Laurea University of Applied Sciences and implemented in collaboration with the South-Eastern Finland University of Applied Sciences and Ornamo.

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Why should we determine a technology vision right now?

THE OPPORTUNITIES TO earn livelihood in creative industry has significantly declined due to the measures imposed to prevent the spread of COVID-19. On the other hand, the coronavirus crisis has also opened up new earning and business opportunities as the state of emergency has changed the ways individuals and companies behave. Among beneficiaries have been those actors and industries that have been able utilize different technology solutions to transfer their activities to virtual environments. These observations are in line with pre-corona studies that have indicated a correlation between research and development investments and recovery from economic crises. In general, those able to adapt and renew their business operations will have best performance.

As industry actors lack the required technological competence or resources to make use of available technology, many sectors – including the creative industries – have struggled to move their operations to virtual environments. As a result, the creative industries have developed and utilised digital services only to certain extent during Corona pandemic. Instead of taking measures that would generate actual income, the activities undertaken have mostly focused on seeking visibility and maintaining contact with the public.

As technology has become a key part of societal structures and everyday life, the challenges of applying technology and competence affect all sectors of society. This forces us to change our behaviour both as organisations and individuals, and adopt new ways of thinking and operating. However, the range of new technologies is extensive. Thus it is important to identify the key technologies for the creative industries and their related application possibilities now and in the near future. Applications based on automation, virtual interaction, artificial intelligence, virtual and augmented reality, voice control and gesture recognition, the Internet of Things and blockchains are examples of new opportunities and threats brought about by technology.

A publication on the consequences of the coronavirus pandemic (1/2020) by The Finnish Parliament's Committee on the Future paid attention to the lack of technological expertise and resources in the creative industries. The development of digital services in the arts and culture sector was identified as a key development measure and it was allocated supplementary funding. It is necessary to comprehensively understand and chart the technologies available and the business opportunities they offer in order to target companies' investments and public funding to technologies that are relevant to the creative sector. In addition, it is crucial to identify the training that the application of the technologies requires.

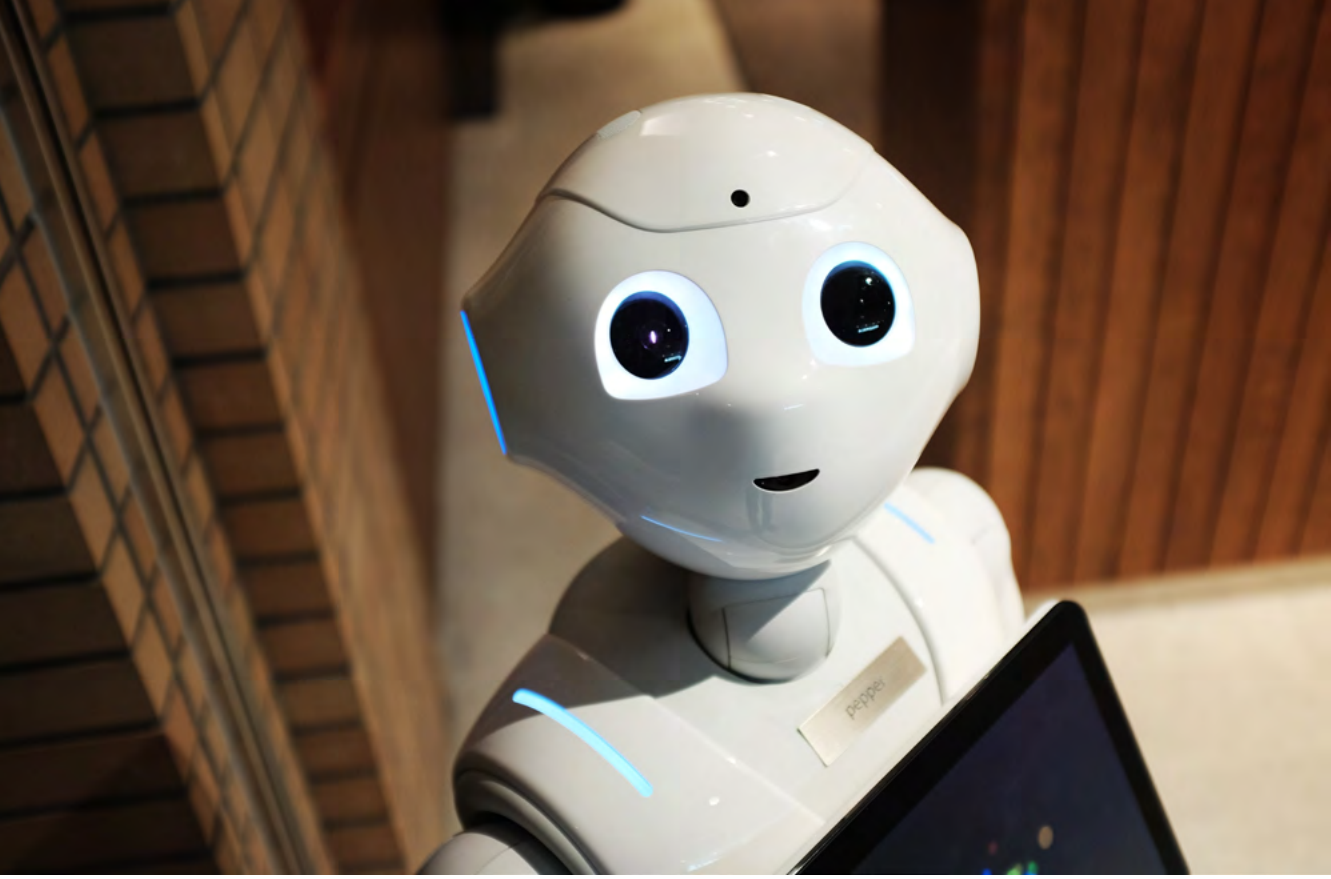
The purpose of this technology vision is to provide guidelines on which technologies should be invested in now and in the near future in the creative sector. The vision takes into account characteristics of different creative sectors. The identification and prioritisation of technologies was carried out with a diverse group consisting of experts of creative industries and technology. The members of the group had experience and/or vision of applying new technology solutions in creative and/or other industries.

Definition of Technology

THE CREATECHVISION PROJECT focuses on identifying technologies from a short-term perspective (0–2 years) and taking into account technologies that can be utilised in the medium term (2–5 years). In the short term, the emphasis is on identifying technologies which actors in the creative sector can use to brainstorm and conceptualise new products and services, and to carry out rapid experiments that enable to better evaluate the functionality and business potential of the technologies in real-life operating environments. However, as the range of new technologies is extensive, it is important to determine the exact technologies and the related applications that are key to creative industries now and in the near future. No technologies were excluded in advance. Instead, the project sought without prejudices different perspectives on the technologies utilised in the creative industries.

In the nine-step *Technological Readiness Level (TRL) scale*, also used by the European Commission, was utilised to identify technological readiness. In the scale 9 stands for the most mature technology. The following section contains a brief description of the criteria for assessing the technological readiness level in relation to the values specified in the TRL scale. Those interested in finding more about the topic are encouraged to familiarise themselves with the *Technology Readiness Levels – TRL NASA's contribution to Horizon 2020* presentation, which provides information about the readiness level criteria and is based on examples from different industries.

Special areas of interest in the CREATECHVISION project included the technologies assessed to levels 7–9. The TRL phase 7 includes technologies that are very close to reaching or have already reached the level required by operational activities. The level can be verified in a demonstration that involves integrating the technology in a real-life operational environment. TRL stage 8 technologies have virtually reached their final form and are ready and functional but not yet commercially available (on a large scale). Meanwhile, TRL stage



9 technologies are freely available on the market and new versions of the technology solution in which the original features have been further developed may exist.

From a medium-term (2–5 years) perspective, the project is interested also in technologies that are at the readiness levels TRL 4–6. However, they may not yet be ready for use in operational activities. These technologies include TRL stage 4 technologies whose functional principles have been validated under laboratory conditions. The prototypes related to TRL phases 5 and 6 are of particular interest, as they can be used to test the performance of technologies in practice. Prototypes at the TRL 5 usually focus on simulating the key features and performance of the solution in a controlled operational environment that simulates real-life conditions. Prototypes in phase 6 of TRL are significantly more advanced compared to the prototypes at the previous level. The features and performance represent the defined target level comprehensively or even reach it and thus enable demonstrating actual use cases and scenarios.

Research method

CONSENSUS-SEEKING DELPHI TECHNIQUE

THE CONSENSUS-SEEKING DELPHI technique (Linstone and Turoff 1975, 2002) was used to define the technology vision. In the Delphi technique, an expert panel presents its assessment of different issues. This method has been widely used in technology foresight and its key features can be summarised as follows: (1) Members of the expert panel are carefully selected specialists in their respective fields of knowledge, i.e. experts (2) who communicate anonymously (3) during several response and feedback rounds. During the rounds, the experts can modify their opinions until consensus is reached (Kuusi 1999, Keeney et al. 2006).

According to a dictionary definition, consensus is a generally accepted opinion or decision among a group of people (Cambridge Dictionary). However, there are no universally accepted rules to determine when a consensus is reached; as a result, different recommendations and decision-making models are applied to determine consensus (World Health Organization 2014). In a Delphi study, "an adequate level of agreement" approach can vary from a simple majority (i.e. more than 50 per cent) to a qualified majority of two thirds or up to 95 per cent of panellists (Heiko 2012).

A study conducted by Vernon (2009) found that a share of 70 per cent is commonly used as the threshold level for consensus among Delphi panel members. We will also comply with this value in our study. In other words, if 70 per cent of panellists select options 3 or 4 on a 5-step Likert scale[1], there is a consensus among the panel members that the technology in question is important/desirable. Similarly, if 70 per cent of the panellists choose options 1 or 2, there is a consensus that this technology is not important/desirable.

1 (1) Not important/desirable at all, (2) Not important/not desirable, (3) Important/desirable and (4) Extremely important/desirable, (5) I do not know/No assessment

DEFINITION OF CREATIVE INDUSTRIES

Defining the creative industries is a challenging task, as they are constantly changing and developing. There are many different classification models (Mangemat et al. 2014, DCMS 2001, UNTAD 2008, Howkins 2002, Hesmondhalgh 2007). In these models, creative industries are typically associated with fields such as advertising, architecture, art, crafts, design, fashion, film, videos, television, radio, literature, publishing, music, performing arts, visual and graphic arts, and video and computer games. Previous studies have also shown that creative industries cannot be perceived as a unified sector, as there is major variation in customer groups, the legal status of companies and business processes (Chapain and Comunian 2011). This makes it difficult to identify a single, unified technology vision covering all creative industries. In addition, there are so many creative industries that covering all of them together in the Delphi study is challenging.

In this study, the challenge described above was solved by utilising a classification model based on core competence in the creative sector (Santonen et al. 2019). The model includes the following core competence areas: (1) Management of creative work, (2) Visualisation and graphic design, (3) Arts and crafts, (4) Writing and storytelling, (5) Performing arts, (6) Music and sound and (7) Solution and concept creation – Creating, developing and designing new things. Each of these individual core competencies comprise a range of skills and competencies that were communicated to the members of the Delphi panel. This allowed us to ensure that the panellists had a consistent understanding of the examined areas of expertise.

ADOPTION AND INTEGRATION OF TECHNOLOGIES INTO EVERYDAY LIFE

The study also aimed to investigate the spread of technologies in creative sectors through the diffusion of innovation classification model. According to the diffusion model (Rogers 2003), the spread of innovations can be examined by classifying the recipients of innovations into five categories:

- Innovators representing 2.5% of the population
- Early adopters representing 13.5% of the population
- Early majority, 34% of the population
- Late majority, 34% of the population
- Laggards, 16% of the population

In this study, a group of non-adopters was also added to the model, as it was assumed that some of the technologies proposed would not attract interest outside the core competence areas.

SELECTION OF EXPERTS

The selection of experts is one of the most important stages of a Delphi study. The present study utilised the multiple-step model developed by Okoli and Pawlowski (2004). *The first phase* involved preparing a Knowledge Resource Nomination Worksheet (KRNW) to define and ensure adequate coverage of expertise in the selected core areas of expertise. *Second*, the KRNW was supplemented with the names of potential participants based on background research and personal contacts of the research team. This step also included identifying

creative industry trade organisations and associations operating in Finland, which play a significant role in advocating for creative industry actors.

In the third phase, the identified experts, trade organisations and associations were contacted by email and/or telephone to investigate their willingness to join the Delphi panel. Additionally, snowball sampling was utilised and the experts identified in the process were also asked to nominate other relevant experts based on the given guidelines (Biernacki and Waldorf 1981). *In the fourth phase*, the experts were requested to confirm their areas of expertise related to technologies and business needs in each of the seven core competence areas defined in advance using a 5-step Likert scale[2] *Finally*, the experts were ranked based on their qualifications and experts fulfilling the set criteria were invited to participate in the study. The process was continued until the necessary number of panellists was reached. Table 1 provides a classification of the profiles of the Delphi panel members based on their industry and technology expertise.

Table 1. *Number of Delphi panel members classified based on their knowledge of needs in their area of expertise and technology**

CORE COMPETENCE AREAS IN CREATIVE INDUSTRIES	KNOWLEDGE OF NEEDS AND TECHNO-LOGY[1]	KNOWLEDGE OF NEEDS[2]	KNOWLEDGE OF TECHNO-LOGY[3]	TOTAL NUMBER OF EXPERTS[1,2,3]	OTHERS
1. Management of creative work (MGMT)	6	6	2	14	5
2. Visualisation and graphic design (VISU)	6	3	2	11	8
3. Arts and crafts (A&C)	2	1	0	3	16
4. Writing and storytelling (TXT)	8	1	0	9	10
5. Performing arts (PERF)	9	4	0	13	6
6. Music and sound (MUSIC)	7	5	0	12	7
7. Solution and concept creation (SOLU)	8	3	0	11	8

[1,2,3] Includes only the experts with a very good or fairly good level of knowledge

2 (1) Very poorly, (2) Fairly poorly, (3) Neither well nor poorly, (4) Fairly well, (5) Very well

DATA COLLECTION PROCESS

An online-based eDelphi application was used for managing the panel and collecting data (Linturi et al. 2013). The research group members carried out a preliminary technology survey before the first data collection round. This survey served as source material for the first round (Mullen 2003).

The first multi-method data collection round took place between 31 May and 9 June 2021. During the round, the panel members were asked to add new technologies to the source material that meet phases 4–9 (Buchner 2019) of the technology readiness level (TRL) defined by the European Commission as described above. In addition, they were asked to evaluate the technologies identified in the preliminary technology survey using the 5-step Likert scale presented above. Each technology option was assessed from the perspective of each of the seven core competence areas. The respondents also had an opportunity to give their open comments. A total of 19 panel members submitted their responses. An inductive content analysis was carried out between the first and second round to confirm the qualitative results (Elo and Kyngäs 2008). The level of consensus was also assessed in this context as previously defined.

The second data collection round was conducted between 16 and 23 June 2021. It included similar response tasks as the first round. The spread of technologies was also assessed using the diffusion of innovation classification model described above (Rogers 2003). As a part of this question, the panel members were asked to pinpoint those of Roger's classes that they felt best described the situation in two and five years from now. The assessment on technology adoption was carried out in all seven core competence areas in the creative industries. Furthermore, the panel members were asked to assess the business potential of the technologies and the impacts of technology on the number of jobs in each core competence area. A 5-step Likert scale was used for this purpose[3]. A total of 14 panel members submitted their responses. An inductive content analysis was carried out between the rounds and the level of consensus was assessed.

The third and final round took place between 28 June and 16 August 2021. In this round, the response time was significantly longer due to the summer holiday season. As a sufficient level of consensus had been reached in the estimates of the importance/desirability of technologies, only the adoption of technologies, their business potential and the number of jobs were assessed in the third round. A total of 15 panel members responded in the third round.

3 (-2) A very high negative impact (-1) Negative impact, (0) No impact, (1) Positive impact, (2) A very high positive impact

Results – Importance/desirability of technologies

THE ORDER OF IMPORTANCE/DESIRABILITY OF TECHNOLOGIES FROM THE PERSPECTIVE OF ALL COMPETENCE AREAS

FIRST, WE WILL examine the importance/desirability of technologies from the perspective of all competence areas. This is illustrated by Figure 1, which presents the order of importance/desirability of technologies from the perspective of the average rate of all core competence areas. Therefore, the results in the ALL columns include the assessments of the all the panel members who had expertise either on needs, technology or both of these at least in one of the core competence areas.

In addition to the average rate, the ALL columns show the comparison results of the Kruskal-Wallis ranking test by core competence area. The technologies marked with an asterisk differ in terms of importance/desirability between the various core competence areas. Meanwhile, the percentage indicates the extent of the share of the difference that is explained by the core competence areas. The colour coding used in Figure 1 indicates the level of consensus among the experts: green means that at least 70 per cent of the experts agreed on the importance/desirability and green that at least 70 per cent of the experts considered the technology non-important/desirable. For individual core competence areas, the median number of assessments of the desirability/importance of each technology has been presented.

Technology	ALL[1]	ALL[1]	ALL[1]	MGMT	VISU	A&C	TXT	PERF	MUSIC	SOLU
	Mean	Sig.	Effect size	Median						
1. Extended reality (XR)	3.56	**	30 %	4	4	3	3	4	3	4
2. Social media and cloud-based platforms for creative work and freelance services	3.54		4 %	4	4	4	3	3	3.5	4
3. Immersive exhibits and performances	3.52	**	35 %	3	4	2.5	3	4	4	4
4. Telepresence	3.50		16 %	3	4	2	3	4	4	4
5. Holograms	3.44	*	25 %	3	4	2	3	4	3	4
6. 360-degree video	3.40	*	19 %	3	4	3	4	4	3.5	4
7. Data driven creative innovations	3.37	**	34 %	4	3	2	4	3	3	4
8. Online and virtual learning platforms	3.35		4 %	3	3.5	3	3.5	3	3	3
9. Distributed (video) production	3.34		18 %	3	4	2	3	4	3	3
10. Livestreaming	3.31		19 %	3	4	3	3	4	4	3
11. Cloud-based collaboration platforms	3.30	*	22 %	4	3	2	3	3	3	4
12. Emotion tracking/sensing/recognition	3.29		14 %	3	4	2	3	4	3.5	4
13. Image GPT-3	3.29	*	26 %	3	4	2.5	4	3.5	3	4
14. Mobilephone based filming and editing	3.29		15 %	3	4	3	3	4	3.5	3.5
15. Crowdfunding	3.25		11 %	3	3	2	4	3	3	3.5
16. Cloud-based (project) management tools	3.24	*	28 %	4	3	3	3	3	3	3.5
17. Realtime hybrid media broadcasting	3.23	*	22 %	3	3.5	2.5	3	4	3	3
18. Next generation motion capture	3.22	**	39 %	2	4	2	3	4	3	4
19. Micropayment	3.20		9 %	3	3.5	3	4	4	4	3
20. Realtime captioning	3.19	*	28 %	3.5	2	3	4	3.5	3	4
21. Cloud-based GUI and UX applications	3.18	**	39 %	3	4	2.5	3	3	3	4
22. 3D scanning	3.06	**	40 %	3	4	2	2	4	2	4
23. Automated AI based metadata generation and management	3.05		22 %	3	3	3	3.5	3	3	3
24. Deepfake	3.00	**	31 %	2	4	2.5	2.5	4	3	3
25. Virtual LED studios	2.98	**	31 %	3	4	1	2.5	4	3	3.5
26. Speech recognition / voice controlling	2.88		12 %	3	2	3	3	3	2	3
27. 4DX movies	2.86	*	23 %	2	3	2	3	3	3	3
28. 3D print	2.85	**	47 %	2	4	3	2	3	2	4
29. Robot and AI art	2.84		23 %	2	4	2	3	3	2	4
30. Generative Pre-trained Transformer 3 (GPT-3)	2.68	*	21 %	3	2	1.5	4	3	2.5	3
31. AI based music technology	2.66	**	41 %	2	2.5	1	2	3	4	2.5

[1] Includes responses from all experts
* sig. 0.05 level, ** sig. 0.001 level

Expert agreement on the importance

Expert agreement on the non-importance

Figure 1. *The technology importance ranking and consensus based on the responses of all experts*

The Kruskal-Wallis test showed that for 19 technologies (61 per cent), perceptions of importance/desirability differed significantly (all ps <0.05) between the core competence areas. For these 19 technologies, the core competencies explained between 19 and 46 per cent of the variation. For the remaining 12 technologies, the perceptions of importance did not differ. As a result, the importance of these technologies can be considered to be similar between the different core competence areas.

LEVEL OF CONSENSUS ON THE IMPORTANCE/DESIRABILITY OF TECHNOLOGIES BY CORE COMPETENCE AREA

Table 2 compares the consensus on the importance/desirability of technologies between different core competence areas. The level of consensus was the lowest in the core competence area "Arts and crafts", where agreement was not reached among the experts in 25 of the 31 technologies.

It should be noted, however, that the number of experts in the competence area of "arts and crafts" was small (N=3). As a result, a response indicating non-importance/desirability from a single respondent was

enough to prevent consensus. The small number of respondents should also be taken into consideration when assessing the reliability of the results obtained.

Meanwhile, the experts in the competence area of "Visualisation and graphic design" were the most unanimous, and 90 per cent (28 out of 31) of the technology assessments in this area reached agreement. A fairly high level of consensus was also reached in other core competence areas, as indicated by the list below: "Writing and storytelling" (84 per cent), "Solution and concept creation" (81 per cent), "Performing arts" (77 per cent) and "Management of the creative work" (71 per cent) and "Music and sound" (65 per cent).

Table 2. *Comparison of the level of consensus between core competence areas*

CORE COMPETENCE AREAS IN CREATIVE INDUSTRIES	CONSENSUS ON IMPORTANCE/ DESIRABILITY[1]	CONSENSUS ON NON-IMPORTANCE/ DESIRABILITY[2]	CONSENSUS IN TOTAL[1,2]	NO CONSENSUS
1. Management of creative work	19	3	22	9
2. Visualization and graphic design	27	1	28	3
3.Arts and crafts	2	4	6	25
4. Writing and storytelling	23	3	26	5
5. Performing arts	24	-	24	7
6. Music and sound	18	2	20	11
7. Solution and concept creation	25	-	25	6

TECHNOLOGY IMPORTANCE/DESIRABILITY RANKING BETWEEN THE CORE COMPETENCE AREAS

Figure 2 shows a heatmap in which technologies are arranged in an order of importance/desirability, broken down by each core competence area. As above, the results in ALL columns include the assessments of all the panel members in total, whereas the response of each core competence area only comprise the responses of the experts in that particular area. As previously noted, the order of importance/desirability differs significantly between the different core competence areas.

Next, we present the technologies deemed most important for each core competence area:

Management of creative work: (1) (a) Cloud-based project management tools and (b) Data-driven creative innovations, (2) Social media and freelance service platforms for creative work and (3) Cloud-based co-creation platforms.

Visualization and graphic design: (1) Social media and freelance service platforms for creative work, (2) 360-degree video and projections and (3) (a) cloud-based project management tools, (b) online and virtual learning platforms, (c) Livestreaming and (d) 3D printing which all shared the same ranking.

Arts and crafts: (1) Immersive exhibits and performances, (2) (a) Extended reality (XR) solutions and (b) holograms and (3) 360-degree video and projections.

Writing and storytelling: (1) Real-time captioning, (2) Image GPT-3, and (3) (a) Micropayment, (b) Crowdfunding and (c) Data-driven creative innovations which all shared the same ranking.

Performing arts: (1) Immersive exhibits and performances, (2) Holograms and (3) (a) Extended reality (XR) solutions, (b) real-time hybrid media broadcasting and (c) Next generation motion capture.

Music and sound: (1) Telepresence and Livestreaming, (2) AI-based music technology and (3) Immersive exhibits and performances.

Solution and concept creation: (1) 3D printing, (2) (a) Extended reality (XR) solutions and (b) Web-based user experience and user interface applications and (b) Data-driven creative innovations.

Based on a comparison of the key technologies in the different core competence areas, the following technologies can be found in the TOP3 of more than one area:

- In three different competence areas: (a) Data-driven creative innovations, (b) Immersive exhibits and performances, (c) Extended Reality (XR) solutions, (d) Cloud-based project management tools.
- In two different competence areas: (a) 360-degree video and projections, (b) 3D printing, (c) Holograms, (c) Social media and freelance service platforms for creative work and (d) Livestreaming.

Technology	ALL	MGMT	VISU	A&C	TXT	PERF	MUSIC	SOLU
	MEAN	Rank						
1. Extended reality (XR)	3,56	7	9	2,5	9,5	4	15	2,5
2. Social media and cloud-based platforms for creative work and freelance services	3,54	3	1	12	9,5	15,5	7,5	9
3. Immersive exhibits and performances	3,52	13	14	1	17	1	4	8
4. Telepresence	3,50	9	24,5	12	12,5	6	1,5	14,5
5. Holograms	3,44	10	24,5	2,5	20	2	13	10
6. 360-degree video	3,40	15,5	2	4	22	9	17	5
7. Data driven creative innovations	3,37	1,5	24,5	25,5	4	27	14	4
8. Online and virtual learning platforms	3,35	7	4,5	15	7,5	20,5	12	21,5
9. Distributed (video) production	3,34	11	24,5	6	25	7	5	20
10. Livestreaming	3,31	18,5	4,5	19,5	17	8	1,5	26,5
11. Cloud-based collaboration platforms	3,30	4	24,5	25,5	15	25	10	6
12. Emotion tracking/sensing/recognition	3,29	18,5	24,5	15	12,5	10	7,5	18
13. Image GPT-3	3,29	15,5	14	5	2	17,5	24,0	14,5
14. Mobilephone based filming and editing	3,29	15,5	18,5	9,5	20	13,5	6	21,5
15. Crowdfunding	3,25	15,5	9	22	4	15,5	18,5	14,5
16. Cloud-based (project) management tools	3,24	1,5	4,5	27	12,5	26	22,0	14,5
17. Realtime hybrid media broadcasting	3,23	22	14	18	20	4	9	25
18. Next generation motion capture	3,22	27	24,5	7	23,5	4	20	11,5
19. Micropayment	3,20	20	9	19,5	4	19	11	24
20. Realtime captioning	3,19	5	18,5	30	1	17,5	21	11,5
21. Cloud-based GUI and UX applications	3,18	7	14	15	23,5	30	27	2,5
22. 3D scanning	3,06	21	9	8	29	12	30	7
23. Automated AI based metadata generation and management	3,05	12	9	23	7,5	29	26	17
24. Deepfake	3,00	29	14	9,5	27	11	16	30
25. Virtual LED studios	2,98	24	30,5	12	28	13,5	23	23
26. Speech recognition / voice controlling	2,88	23	18,5	28	12,5	22	25	26,5
27. 4DX movies	2,86	31	18,5	24	26	20,5	18,5	29,0
28. 3D print	2,85	26	4,5	17	30	28	31	1
29. Robot and AI art	2,84	28	24,5	21	17	23	29	19
30. Generative Pre-trained Transformer 3 (GPT-3)	2,68	25	29	31	6	31	28	28
31. AI based music technology	2,66	30	30,5	29	31	24	3	31

Figure 2. *A comparison of the ranking of the importance of technologies between different core competence areas*

Results – Technology adoption

SUMMARY OF TECHNOLOGY ADOPTION IN TWO AND FIVE YEARS' TIME

NEXT, WE EXAMINED the experts' assessments of technology adoption over a time span of two and five years. Figure 3 presents the assessment results in a two-dimensional coordinate system, in which the respondents' assessment of the situation two years from this date is presented on the horizontal axis and the assessment of the situation five years from this date is presented on the vertical axis. The scale used was the diffusion of innovation classification model supplemented by the group of non-adopters (Rogers 2003). The location of each technology is based on the average score of the responses of all experts on the following response scale: Non-adopters (= 0), Innovators (= 1), Early adopters (= 2), Early majority (= 3), Late majority (= 4) and Laggards (= 5).

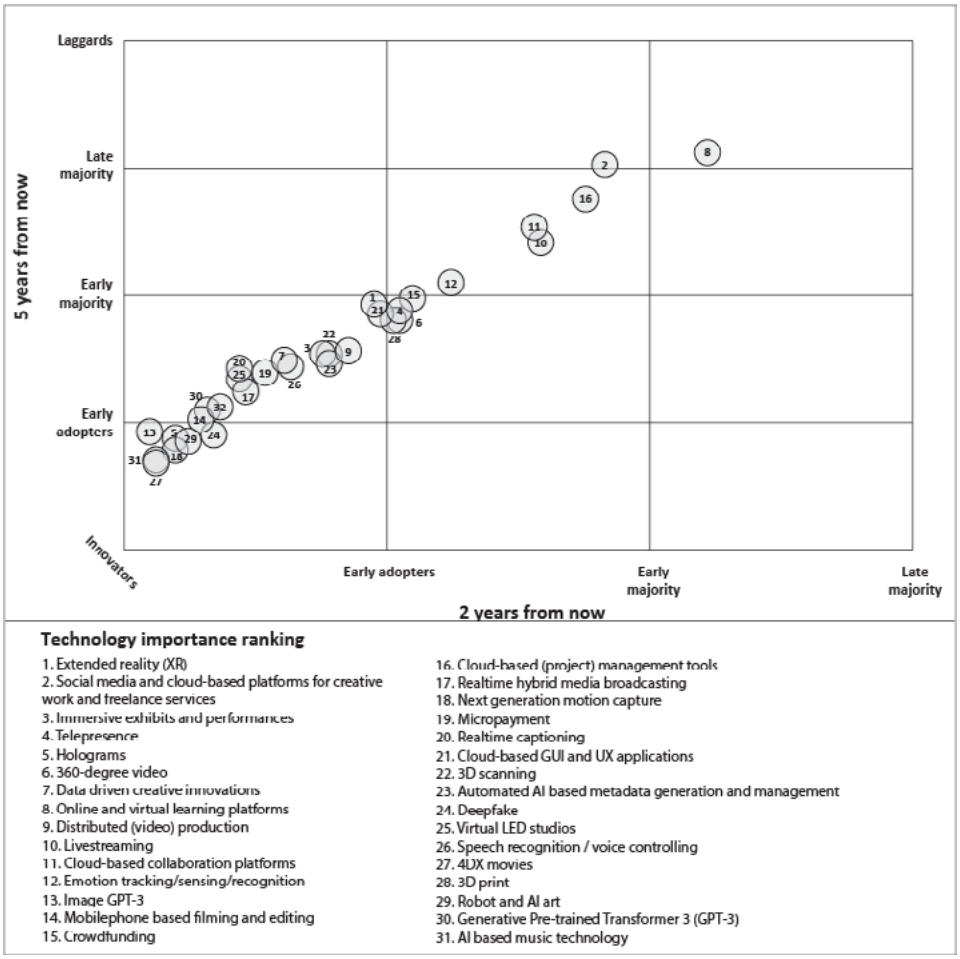


Figure 3. *Summary of technology adoption in 2 and 5 years (all experts)*

Experts estimate that the adoption of the following technologies is progressing most widely: (8) Online and virtual learning platforms, (2) Social media and freelance service platforms for creative work, (16) Cloud-based project management tools, (11) Cloud-based co-creation platforms and (10) Livestreaming. Of these technologies (8), Online and virtual learning platforms slightly stood out from the rest, as based on the average score of the responses, the technology was assumed to have exceeded the threshold set for the "early majority" after two years and for the "late majority" after five years. The level of the adoption of the other technologies mentioned above was estimated to be approaching "early majority" in two years' time and "late majority" in five years' time. An exception to this was (2) Social media and freelance service platforms for creative work, whose evaluation has already exceeded the "late majority" threshold.

Based on the experts' assessments, the adoption of the following seven technologies was estimated to be close to the coordination point for "early adopters" in two years and "early majority" in five years from now. These technologies were: (12) Emotion tracking, (15) Crowdfunding, (6) 360-degree video and projections,

(4) Telepresence, (28) 3D printing, (21) Web-based user experience and user interface applications, and (1) Extended Reality (XR) solutions.

The adoption rate in the following thirteen technologies was estimated to be between "innovators" and "early adopters" and to exceed the threshold for "early adopters" after five years. (9) Distributed (video) production, (22) 3D scanning, (23) Automated AI-based metadata generation and management (3) Immersive exhibits and performances, (26) Voice control/ speech recognition, (7) Data-driven creative innovations, (19) Micropayment, (20) Real-time captioning, (25) Virtual LED studio, (17) Real-time hybrid media broadcasting, (30) Generative Pre-trained Transformer 3, GPT-3, (14) Mobile-phone-based filming and editing, (32) Spatial sound.

On the "innovators – early adopters" continuum, the adoption of the remaining seven technologies was assessed to be close to the "innovators" in two years' time and estimated to approach the threshold set for "early adopters" in five years. These technologies were: (24) Deepfake, (29) Robot and AI art, (5) Holograms, (18) Motion Capture, (13) Image GPT-3, (31) AI-based music technology and (27) 4DX films.

ASSESSMENT OF TECHNOLOGY ADOPTION IN TWO AND FIVE YEARS' TIME BASED ON PERCENTAGES

Figures 4 and 5 illustrate the assessments of technology adoption. The heat map in Figure 4 shows the results of the assessment of the technology adoption rate two years from now. The colours of the heatmap describe the percentage of experts who estimated that each technology would be at that level of adoption in two years' time. Red indicates a low and green a high percentage. Similarly, Figure 5 presents the results five years from now. The results presented in Figures 4 and 5 include the responses of all experts combined.

In relation to Figure 4, the Kruskal–Wallis test showed that for seven technologies (23%), estimates of their adoption in two years' time were significantly different (all ps < 0.05) between the various core competence areas. Similarly, the assessments on technology adoption five years after this date presented in Figure 5 differed significantly (all ps < 0.05) for eight technologies (26%). In the assessments concerning both time frames (two and five years), core competence areas explained the variation in results by 33–51%.

There were no differences in the assessments of the adoption rates of the remaining 24 technologies after two years and 23 technologies after five years between core competence areas. However, it is good to note that in the joint examination of all core competence areas, consensus was only reached on the level of adoption of robotic and artificial intelligence technology in two years' time (in other words, 71 per cent of the experts agreed that technology adoption is in the "innovators" phase).

Technology	Kruskal-Wallis H		2 years from now					
	Effect size	Sig.	Non-adopters	Innovators	Early adopters	Early majority	Late majority	Laggards
1. Extended reality (XR)	24 %		5 %	34 %	37 %	12 %	10 %	2 %
2. Social media and cloud-based platforms for creative work and freelance services	17 %		0 %	10 %	15 %	59 %	17 %	0 %
3. Immersive exhibits and performances	20 %		10 %	37 %	29 %	17 %	7 %	0 %
4. Telepresence	25 %		7 %	20 %	41 %	27 %	2 %	2 %
5. Holograms	33 %	*	12 %	56 %	32 %	0 %	0 %	0 %
6. 360-degree video	30 %		5 %	24 %	37 %	29 %	5 %	0 %
7. Data driven creative innovations	30 %		7 %	46 %	27 %	17 %	2 %	0 %
8. Online and virtual learning platforms	20 %		0 %	10 %	5 %	46 %	32 %	7 %
9. Distributed (video) production	29 %		5 %	32 %	39 %	22 %	2 %	0 %
10. Livestreaming	26 %		5 %	17 %	17 %	37 %	24 %	0 %
11. Cloud-based collaboration platforms	36 %	*	0 %	17 %	27 %	39 %	17 %	0 %
12. Emotion tracking/sensing/recognition	18 %		15 %	63 %	20 %	2 %	0 %	0 %
13. Image GPT-3	35 %	*	17 %	46 %	29 %	5 %	2 %	0 %
14. Mobilephone based filming and editing	27 %		2 %	24 %	32 %	29 %	12 %	0 %
15. Crowdfunding	15 %		0 %	29 %	34 %	34 %	2 %	0 %
16. Cloud-based (project) management tools	27 %		0 %	17 %	17 %	39 %	27 %	0 %
17. Realtime hybrid media broadcasting	27 %		10 %	44 %	37 %	10 %	0 %	0 %
18. Next generation motion capture	34 %	*	20 %	46 %	29 %	5 %	0 %	0 %
19. Micropayment	9 %		7 %	44 %	37 %	12 %	0 %	0 %
20. Realtime captioning	22 %		7 %	46 %	41 %	5 %	0 %	0 %
21. Cloud-based GUI and UX applications	39 %	*	12 %	24 %	24 %	32 %	7 %	0 %
22. 3D scanning	19 %		12 %	29 %	32 %	22 %	5 %	0 %
23. Automated AI based metadata generation and management	15 %		7 %	37 %	32 %	20 %	5 %	0 %
24. Deepfake	51 %	**	12 %	46 %	37 %	5 %	0 %	0 %
25. Virtual LED studios	20 %		12 %	46 %	27 %	15 %	0 %	0 %
26. Speech recognition / voice controlling	15 %		10 %	29 %	49 %	12 %	0 %	0 %
27. 4DX movies	24 %		32 %	27 %	39 %	2 %	0 %	0 %
28. 3D print	36 %	*	10 %	20 %	32 %	37 %	2 %	0 %
29. Robot and AI art	16 %		2 %	**71 %**	27 %	0 %	0 %	0 %
30. Generative Pre-trained Transformer 3 (GPT-3)	8 %		12 %	51 %	32 %	2 %	2 %	0 %
31. AI based music technology	25 %		22 %	46 %	29 %	2 %	0 %	0 %

* sig.0.05 level, ** sig. 0.01 level

Figure 4. *Assessments of technology adoption two years from now*

Technology	Kruskal-Wallis H		5 years from now					
	Effect size	Sig.	Non-adopters	Innovators	Early adopters	Early majority	Late majority	Laggards
1. Extended reality (XR)	39 %	*	2 %	12 %	15 %	44 %	15 %	12 %
2. Social media and cloud-based platforms for creative work and freelance services	17 %		0 %	0 %	10 %	17 %	34 %	39 %
3. Immersive exhibits and performances	25 %		7 %	12 %	34 %	20 %	20 %	7 %
4. Telepresence	27 %		5 %	10 %	24 %	29 %	17 %	15 %
5. Holograms	38 %	*	7 %	20 %	56 %	12 %	5 %	0 %
6. 360-degree video	27 %		5 %	7 %	24 %	37 %	20 %	7 %
7. Data driven creative innovations	28 %		0 %	24 %	37 %	15 %	15 %	10 %
8. Online and virtual learning platforms	16 %		0 %	0 %	12 %	10 %	32 %	46 %
9. Distributed (video) production	31 %		5 %	17 %	24 %	29 %	20 %	5 %
10. Livestreaming	29 %		2 %	5 %	17 %	27 %	22 %	27 %
11. Cloud-based collaboration platforms	31 %		0 %	0 %	22 %	27 %	27 %	24 %
12. Emotion tracking/sensing/recognition	31 %		10 %	22 %	41 %	20 %	7 %	0 %
13. Image GPT-3	33 %	*	17 %	15 %	37 %	12 %	20 %	0 %
14. Mobilephone based filming and editing	23 %		2 %	5 %	32 %	24 %	15 %	22 %
15. Crowdfunding	8 %		0 %	7 %	32 %	32 %	15 %	15 %
16. Cloud-based (project) management tools	19 %		0 %	7 %	10 %	17 %	32 %	34 %
17. Realtime hybrid media broadcasting	36 %	*	7 %	17 %	37 %	24 %	12 %	2 %
18. Next generation motion capture	46 %	**	15 %	29 %	29 %	20 %	5 %	2 %
19. Micropayment	12 %		7 %	10 %	44 %	20 %	15 %	5 %
20. Realtime captioning	27 %		5 %	12 %	34 %	37 %	10 %	2 %
21. Cloud-based GUI and UX applications	38 %	*	7 %	12 %	22 %	20 %	24 %	15 %
22. 3D scanning	28 %		10 %	12 %	20 %	37 %	17 %	5 %
23. Automated AI based metadata generation and management	23 %		5 %	20 %	29 %	24 %	15 %	7 %
24. Deepfake	40 %	*	7 %	24 %	41 %	24 %	2 %	0 %
25. Virtual LED studios	31 %		10 %	7 %	41 %	24 %	15 %	2 %
26. Speech recognition / voice controlling	14 %		5 %	17 %	29 %	27 %	22 %	0 %
27. 4DX movies	20 %		22 %	22 %	27 %	24 %	5 %	0 %
28. 3D print	51 %	**	7 %	10 %	20 %	34 %	17 %	12 %
29. Robot and AI art	26 %		2 %	37 %	39 %	17 %	5 %	0 %
30. Generative Pre-trained Transformer 3 (GPT-3)	16 %		12 %	12 %	44 %	20 %	10 %	2 %
31. AI based music technology	30 %		15 %	24 %	39 %	20 %	2 %	0 %

* sig.0.05 taso, ** sig. 0.01 taso

Figure 5. *Assessments of technology adoption five years from now*

CONSENSUS ON THE TECHNOLOGY ADOPTION RATE BY CORE COMPETENCE AREAS

Next, we will look at the consensus reached on the technology adoption rate by core competence areas. Table 3 (two years from now) and Table 4 (five years from now) show the number of assessments of technology adoption rates in which consensus was reached in each core competence area. Consensus was reached more often when assessing the situation in two or five years' time.

Consensus on technology adoption was best reached among the experts in arts and crafts. They agreed on the adoption rate for nine technologies (29% of all technologies) over a two-year period and six technologies (19% of all technologies) over a five-year period. The assessments of the experts in "Arts and crafts" concerning technology adoption rates were notably focused on the "innovators" phase.

Consensus among the experts in the "Management of creative work" was the second most common; they reached consensus on the spread of six technologies (19% of all technologies) in the next two years and on the spread of two technologies (6% of all technologies) in the next five years. The "Visualization and graphic design" experts were the third most unanimous, reaching consensus in their assessments of the adoption rates four technologies (13% of all technologies) over a two-year period and the adoption rate of two technologies (6% of all technologies) over a five-year period. In the other core competence areas, the

assessors reached consensus on the adoption rate of only one or two technologies in the examination of a two-year period, and only one technology in the core competence area of Writing and storytelling in the examination of a five-year period.

Table 3. *Technologies * on whose adoption rate consensus was reached (time frame: two years from now)*

	MGMT	VISU	A&C	TXT	PERF.	MUSIC	SOLU
1. Non-adopters							
2. Innovators	5, 12, 24, 29		1, 5, 6, 13, 14, 20, 23, 29, 30	29		24, 29	
3. Early adopters		5, 24, 27			6, 26		
4. Early majority	11, 15	28					
5. Late majority							11
6. Laggards							
Total (N)	*6*	*4*	*9*	*1*	*2*	*2*	*1*

*ID numbers refer to the numbering used for the technologies in Figures 1–5

Table 4. *Technologies * on whose adoption rate consensus was reached (time frame: five years from now)*

	MGMT	VISU	A&C	TXT	PERF.	MUSIC	SOLU
1. Non-adopters							
2. Innovators			3, 12, 17, 18, 24				
3. Early adopters	5		14	24			
4. Early majority		1, 24					
5. Late majority							
6. Laggards	8			2			
Total (N)	*2*	*2*	*6*	*2*			

*ID numbers refer to the numbering used for the technologies in Figures 1–5

Results – Business potential and the impact on the number of jobs

SUMMARY OF THE BUSINESS POTENTIAL AND IMPACT ON EMPLOYMENT OF TECHNOLOGIES

FINALLY, WE WILL look at estimates of the impact of technologies on the business potential of creative industries and the number of jobs. Figure 6 presents an estimate in a two-dimensional coordinate system whose horizontal axis represents the sum of the average "business potential" of all experts and the vertical axis represents the "number of jobs".

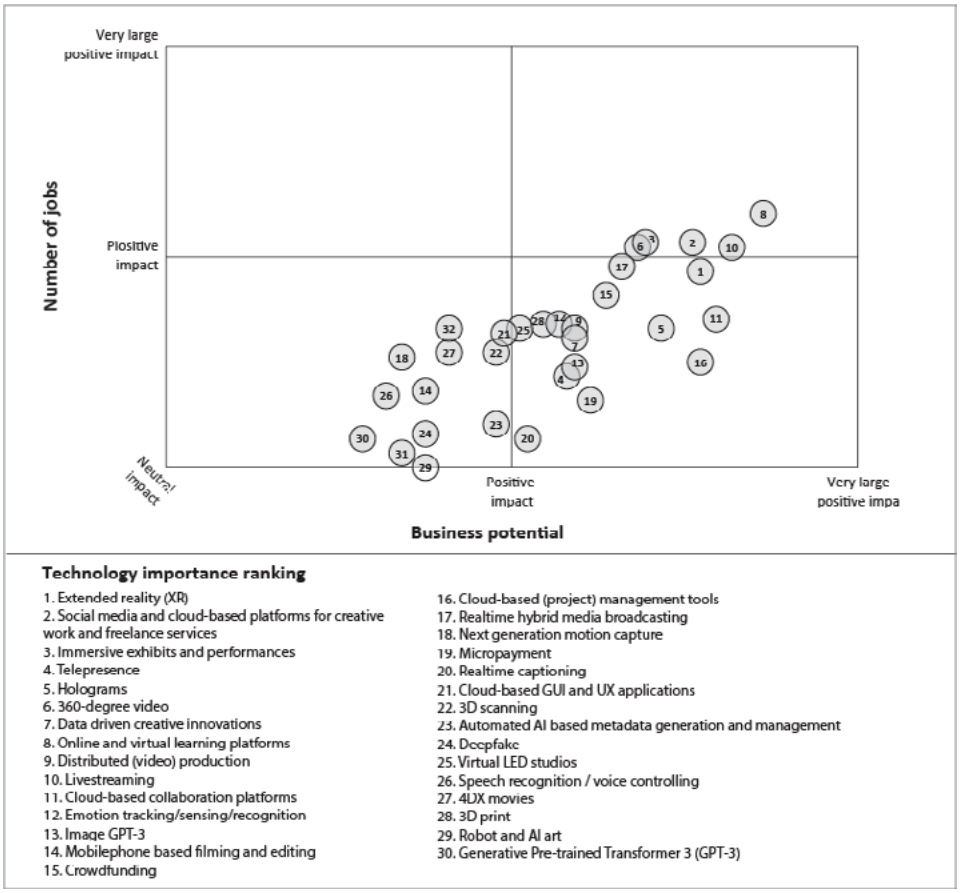


Figure 6. *Summary of the business potential and impact on employment of technologies if the given technology will be widely adopted*

The most interesting technologies from the perspective of business potential and the number of jobs are placed in the upper right corner of the coordinate system. The technologies located there were estimated to have a positive impact on both the business potential and the number of jobs. The following five technologies were included in this group: (8) Online and virtual learning platforms, (10) Livestreaming, (2) Social media and freelance service platforms for creative work, (3) Immersive exhibits and performances and (6) 360-degree video and projections.

The impact of technologies on business potential was estimated to be clearly higher than their impact on the number of jobs. In the "positive – highly positive" impact continuum, the estimates of the business potential were placed in the middle of the scale, whereas the number of jobs only slightly exceeded the threshold for a positive impact. In addition, (1) Extended Reality (XR) solutions and (17) Real-time hybrid media broadcasting were also expected to have a positive impact on business potential, and the estimates of their impact on jobs were only slightly below the threshold of positive impact.

From the perspective of business potential, (11) Cloud-based co-creation platforms (16) Cloud-based project management tools and (5) Holograms were also among the above-mentioned group, but the

estimates of their impact on the number of jobs were less positive, although they were still closer to positive than neutral. Also (15) Crowdfunding can be included in this group. However, its profile is reversed compared to the others, as its business potential was estimated to be weaker than its impact on the number of jobs.

The impact of the following ten technologies on business potential was also estimated to be positive, but less significant compared to the technologies described above. The assessments of the impacts of these technologies on workplaces are placed around the halfway point on the "neutral– positive" continuum. These ten technologies were: (19) Micropayment, (4) Telepresence, (13) Image GPT-3), (7) Data-driven creative innovations, (9) Distributed (video) production, (12) Emotion tracking, (25) LED virtual studio, (28) 3D printing, (21) Web-based user experience and user interface design applications, and (22) 3D scanning. In terms of business potential, (23) Automated AI-based metadata generation and management and (20) Real-time captioning could also be considered as a part of this group, although their impact on the number of jobs was mainly assessed to be neutral.

The estimates of the remaining nine technologies passed the midway point on the "neutral–positive" continuum from the perspective of business potential. These technologies were: (32) Spatial sound, (27) 4DX films, (18) Motion Capture, (14) Mobile-phone-based filming and editing and (26) Voice control/ speech recognition, (24) Deepfake, (29) Robot and AI art, (31) AI-based music technology, and (30) Generative Pre-trained Transformer 3, GPT-3. The impact of the last four technologies on the number of jobs was mainly assessed as neutral, while the assessments of the impacts of other technologies were around the midway point of the "neutral–positive" continuum.

When examining the findings, it is good to note that from the perspective of averages, none of the technologies seems to have a negative impact on the number of jobs in the creative industries.

Results – Summary

DETERMINING THE RANKING OF THE TECHNOLOGIES

IN THE RESULTS sections presented above, the technologies were assessed from the following perspectives: (1) the importance/desirability of technologies, (2) technology adoption based on the diffusion of innovation classification model in two and five years' time, and (3) the impacts of the technologies on (A) business potential and (B) the number of jobs. Based on the results, it can be concluded that the "ranking" of the technologies varies between both the five different assessment perspectives as well as the core competence areas. In other words, according to the estimates provided, the technologies assessed as the most important/most desirable are not the most widely adopted nor do they possess the greatest business potential. Indeed, we may ask, what the ranking of the technologies is, when we take into account the perspectives and the responses of all the experts?

To determine the ranking, a standard score (z-score) was created for all five perspectives. The standard score is the observed value presented in the standard deviation (SD) units, calculated by subtracting the mean from the variable and then dividing the difference by the standard deviation. The standard score allows making comparisons between variables measured using different scales and forming a sum variable. To facilitate the interpretation of the results, the standard scores for each technology were changed to percentile values (also known as percentiles). The percentiles are interpreted as follows: if the percentile of a particular technology is 90%, then 90% of all the other technologies on the list rank more poorly from the perspective of the overall analysis.

TECHNOLOGY RANKING

Figure 7 shows the ranking of the technologies and the percentile score of each technology. In this review, the highest-ranking technologies were "Online and virtual learning platforms" with a percentile of 97 and "Social media and freelance service platfsorms for creative work" with a percentile value of 95.

There was a relatively substantial difference between the two top-ranking technologies and the third-ranking one, "Livestreaming", with a percentile of 89. "Cloud-based co-creation platforms" (85), "Cloud-based project management tools" (83), "Extended Reality (XR) solutions" (83), "360-degree video and projections" (78), and "Immersive exhibits and performances" (76) all fit within the percentile of 75.

Technologies that were above the middle of the ranking included "Crowdfunding" with a score of 70, and "Mobile-phone-based filming and editing" with 68, "Telepresence" with 64, "Distributed (video) production" with 59, "Real-time hybrid media broadcasting" with 57, " Data-driven creative innovations" with 54, "Web-based user experience and user interface design applications" with 53 and "Holograms" which scored the lowest of this group at 51.

	Technology	Percentile			Technology	Percentiles
1	Online and virtual learning platforms	97		17	3D printing	47
2	Social media and cloud-based platforms for creative work and freelance services	95		18	Micropayment	41
3	Livestreaming	89		19	3D scanning	40
4	Cloud-based collaboration platforms	85		20	Virtual LED studios	35
5	Cloud-based (project) management tools	83		21	Emotion tracking/sensing/recognition	35
6	Extended reality (XR)	83		22	Automated AI based metadata generation and management	31
7	360-degree video and projections	78		23	Realtime captioning /translating	31
8	Immersive exhibits and performances	76		24	Image GPT-3	26
9	Crowdfunding	70		25	Next generation motion capture	23
10	Mobilephone based filming and editing	68		26	Speech recognition / voice controlling	21
11	Telepresence	64		27	4DX movies	16
12	Distributed (video) production	59		28	Deepfake	16
13	Realtime hybrid media broadcasting	57		29	Robot and AI art	10
14	Data driven creative innovations	54		30	Generative Pre-trained Transformer 3 (GPT-3)	9
15	Cloud-based GUI and UX applications	53		31	AI based music technology	6
16	Holograms	51		32	Spatial sound*	

* Importance/desirability of spatial sound was not evaluated and therefore perentile value cannot be presented

Figure 7. *The ranking of technologies taking into account all five perspectives (standard score, percentile)*

CLASSIFICATION OF TECHNOLOGIES

The study resulted in identifying a total of 32 different technologies, which are examined below using the following classification:

1. **Cloud services** are easily scalable information technology services that can be accessed over the Internet and are produced at the service provider's servers.
2. **Presentation technologies** are technologies used to present creative output and make it available to users, consumers and the public.
3. **Production technologies** are technologies used in different stages of the creative production process to produce an actual creative solution.
4. **Artificial intelligence (AI) applications** are computer programs that enable computers to automatically perform functions that require intelligence and human-like thinking.

Figure 8 shows the ranking of the technologies in each of the categories and the percentile score of each technology. However, before proceeding to the examination, it is important to note that many of the technologies identified in the study contain characteristics from more than one of the categories described above. In Figure 8, the technologies are placed in a specific category depending on which category best describes the characteristics of the technology in question.

Based on the calculations of the mean percentiles for the technologies in each category, cloud services emerge as the "best" technology. The mean percentile for cloud services is 77. Presentation technologies emerge as the second-ranking category based on means with a mean percentile of 61 for the technologies contained by the category. Although the mean scores of cloud services and presentation technologies differ, the difference between the two is not statistically significant.

Production technologies rank third with a mean percentile of 50 for the included technologies. The mean score of the production technologies differs statistically significantly from the mean of cloud services, but not from the mean of presentation technologies. AI applications rank clearly lowest, with a statistically significant difference between the three other categories and a mean score of 24.

	Cloud services	Percentile
1.	Online and virtual learning platforms	97
2.	Social media and cloud-based platforms for creative work and freelance services	95
3.	Livestreaming	89
4.	Cloud-based collaboration platforms	85
5.	Cloud-based (project) management tools	83
9.	Crowdfunding	70
15.	Cloud-based GUI and UX applications	53
18.	Micropayment	41

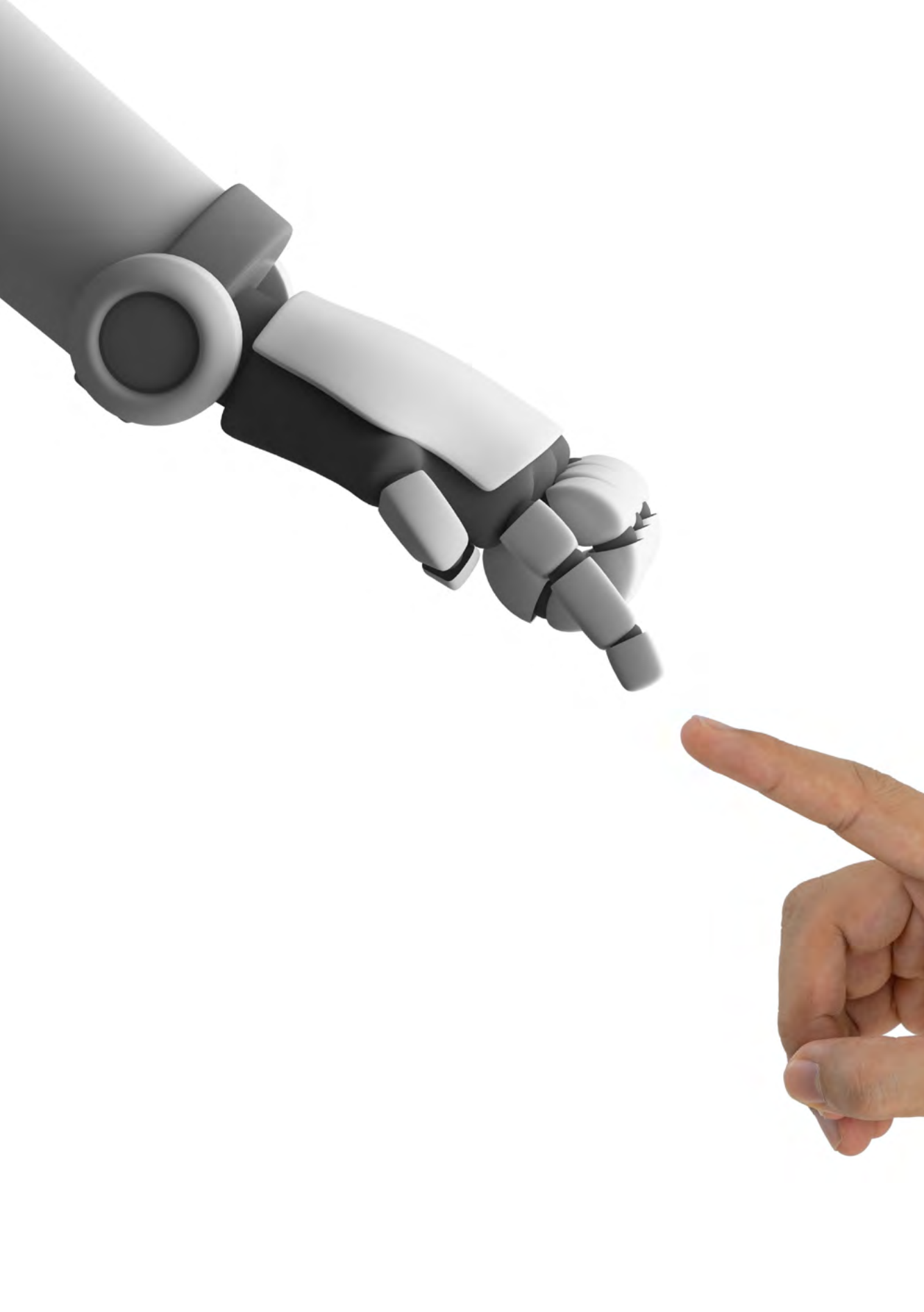
	Presentation technologies	Percentile
6.	Extended reality (XR)	83
7.	360-degree video and projections	78
8.	Immersive exhibits and performances	76
11.	Telepresence	64
13.	Realtime hybrid media broadcasting	57
16.	Holograms	51
27.	4DX movies	16
	Spatial sound*	

	Prouction technologies	Percentile
10.	Mobilephone based filming and editing	68
12.	Distributed (video) production	59
17.	3D printing	47
19.	3D scanning	40
20.	Virtual LED studios	35

	Artificial inttelligence (AI) applications	Percentile
14.	Data driven creative innovations	54
21.	Emotion tracking/sensing/recognition	35
22.	Automated AI based metadata generation and management	31
23.	Realtime captioning /translating	31
24.	Image GPT-3	26
25.	Next generation motion capture	23
26.	Speech recognition / voice controlling	21
28.	Deepfake	16
29.	Robot and AI art	10
30.	Generative Pre-trained Transformer 3 (GPT-3)	9
31.	AI based music technology	6

* Importance/desirability of spatial sound was not evaluated and therefore perentile value cannot be presented

Figure 8. *Ranking of technologies by category*



Brief introduction of the technologies and selected open comments from experts

CLOUD SERVICES

CLOUD SERVICES ARE easily scalable information technology services that can be accessed over the Internet are produced at the service provider's servers and can be accessed over the Internet. Table 5 presents the cloud services identified in this study their ranking order. The ranking is based on the percentiles the technologies scored.Table 5 describes the most typical distribution channels, interaction opportunities and other special features related to technology.

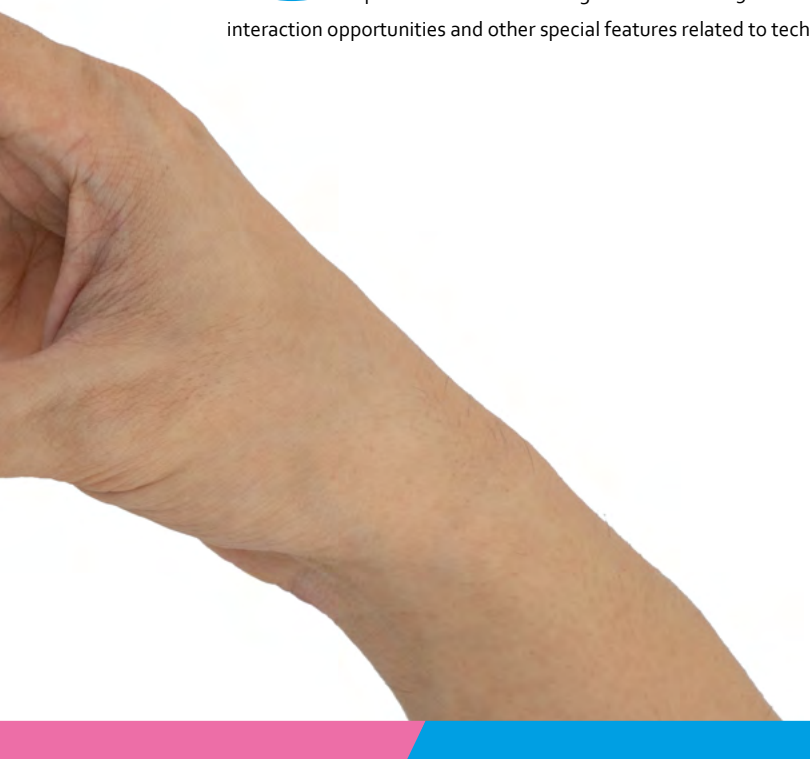


Table 5. *Cloud services: ranking and main purpose*

OVERALL RANKING	PERCENTILE	TECHNOLOGY	MAIN PURPOSE
1.	97	Online and virtual learning platforms	Education and learning
2.	95	Social media and freelance service platforms for creative work	Job-seeking, marketing your competence and managing cooperation networks
3.	89	Livestreaming	Distribution channel for media content
4.	85	Cloud-based co-creation platforms	Brainstorming, concept creation, planning and visualisation of information in a group
5.	83	Cloud-based project management tools	Project planning, implementation and monitoring and management of project-related files
9.	70	Crowdfunding	Getting funding for your idea from a large group of people
15.	53	Web-based user experience and user interface design applications	Designing concepts and prototypes and testing user experience
18.	41	Micropayment	The payment of a very small amount of financial compensation and the transfer of the payment from a customer to the service provider

The five most popular technologies were all included in the cloud services category. The comments given by experts repeatedly emphasised the fact that the COVID-19 pandemic led to integrating cloud services into regular activities, and all actors across industries had to adapt to this change. Cloud-based services have spread in the creative sector, covering all stages of the creative process, from brainstorming to selling and distributing a ready-made solution. Whether dealing with learning new things, project management, obtaining funding, developing creative solutions or presenting and selling finished works to the general public, cloud services will play a major role in the creative sector in the future.

Online and virtual learning platforms was considered the most important cloud service technology. While online and virtual learning platforms have already been part of everyday life in many fields for a long time, it was not until the COVID-19 crisis that online learning solutions became considerably more widely utilised. Online and virtual learning platforms enable creative industry actors to either acquire new competences for themselves or serve as instructors in these platforms. Despite the popularity of online teaching and virtual learning platforms, the experts also believe that there are some challenges related to the platforms such as the wide range of available solutions and variations in the quality of content.

> *"They've always had potential".*
> *"The biggest problems concern the high variation in content, the large number of available platforms and gradual boredom similar with social media platforms."*

Social media and freelance service platforms for creative work are a two-way networking channel that enables creators to present their competence and find creators for their projects. The challenges associated with social media and freelance platforms also seem to be related to their large number. In connection with networking, the experts also called for new global solutions not based on social media platforms:

> *"The biggest problem at the moment is the number of available platforms that makes them get lost behind one another."*
> *"What we now have demand for is the next global networking method that would not be a social media platform."*

Livestreaming services bring live broadcasts to users' computers, smartphones, tablets or smart TV. Viewers can watch livestreams as live broadcasts or later as recorded videos. At the most basic form, the technical implementation of livestreaming only requires a smartphone with a camera and microphone and free streaming software, such as Facebook or Youtube, which serves as the distribution channel. Livestreaming makes it possible to reach a large audience in a very cost-effective manner. At the other extreme of livestreaming, tickets are sold to interactive concerts utilising multi-camera technology as well as opera and theatre performances. The coronavirus crisis has forced livestreaming to become more widespread, and as a result, creative industry actors have gainedexperience of this technology[4,5]. The experts described livestreaming as a good way to reach large masses simultaneously and in an environmentally friendly manner, and, if implemented well, livestreaming offers also an opportunity for social interaction.

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4 PALVELUIDEN KÄYTTÄMINEN EPIDEMIAN AIKANA JA RAJOITUSTEN POISTAMISEN JÄLKEEN Tuhat Suomalaista / Kesäkuu 2020 (The use of services during the epidemic and after the removal of restrictive measures, One thousand Finns / June 2020). https://www.palta.fi/wp-content/uploads/2020/12/Palta_kyselytutkimus_koronan_vaikutuksesta_palvelujen_kayttamiseen_kesakuu_2020.pdf

5 Keikalla.fi is an event livestreaming service established by Rockway in collaboration with Lippu.fi and Musicians' Union of Finland in March 2020. More information https://www.keikalla.fi/

> *"A very important way to reach large numbers of people simultaneously and cost-effectively and in a climate-friendly manner. It's also an ecological and social approach if implemented successfully."*
> *"An opportunity to record and watch events after a delay."*
> *"Livestreams and other remote solutions have completed the test run brought on by the coronavirus pandemic."*

Cloud-based co-creation platforms are online applications that allow a group of people to create, develop, design, evaluate and visualize solutions to different problems and challenges regardless of time and place. Online applications cover a wide range of areas, such as simultaneous co-authoring, digital whiteboards and blackboards, polls, graphic design, recording music and editing.

> *"As a result of the coronavirus pandemic, these have become a permanent part of the activities and all industries have been forced to get used to it."*

Cloud-based project management tools can be used to manage and plan project tasks, resource allocation and archive documents related to the project. The benefits are particularly concrete in large projects where the work extends over a long period of time or geographical area and among employees. Cloud-based project management tools are easy-to-use, cost-effective and secure solutions that help improve communication among project staff. This saves time that can be used for actual creative work.

> *"I agree with the use of technology to help manage projects. It brings efficiency andsaves time for the creative part."*

Crowdfunding is a way of obtaining funding by collecting small sums of money from a large number of people and, promising a product or creative work that is produced with the help of the collected funding in return. Crowdfunding will only be actualised if the campaign manages to attract the desired amount of money. In practice, funders buy a product or work that does not yet exist. However, attracting funding is not a guarantee that the work or output will ever be completed. Typical crowdfunding areas in the creative sector include films, music albums, books, cartoons and games for which independent authors apply for funding.

> *"Crowdfunding has been increasingly an opportunity for independent actors."*
> *"An absolutely positive opportunity, given that millennials are particularly interested in new funding channels."*

Web-based user experience and user interface design applications are a part of the same set of web applications as "Cloud-based co-creation platforms". They are particularly focused on prototyping and simulating user experiences. A web-based application allows the designer or group of designers to quickly and easily combine visual and navigation elements and create a prototype without coding skills. Web applications often include tools that can be used to gather user feedback about the simulated user experience. Some user experience and user interface design applications can even produce an application that is ready for publication. The experts found that there were extensive possibilities for applying the technology.

> *"Practically all sectors that can benefit from a visual prototype in any way can benefit from the technology."*

Micropayment is a technology that can be used to transfer small payments from the customer to the service provider and the seller of the product. There is no established definition of the monetary value of a micropayment. Some define all payments below the price of one euro as a micropayment, while others set the limit at five euros. The object of purchase is often an individual set of content, such as music, e-book/magazine, or a one-off or time-barred access rights to an online service.

> *"Best suited for a situation where users pay to get some sort of an individual piece of intellectual property."*

PRESENTATION TECHNOLOGIES

Table 6 describes the presentation technologies identified in the study in the ranking order based on the percentiles afforded to them. The table also shows the most typical distribution channels of technologies, opportunities for interaction and other possible special features.

Table 6. *Presentation technologies: Ranking, distribution channels, interactivity, other features.*

OVERALL RANKING	PERCENTILE	TECHNOLOGY	MOST TYPICAL DISTRIBUTION CHANNELS	MOST TYPICAL WAYS OF INTERACTING	OTHER FEATURES
6.	83	Extended Reality (XR) solutions	PC, smartphone, VR glasses	Free or almost free movement and interaction in a simulated world.	An opportunity to simulate realistic and fantasy worlds where users can move and interact safely.
7.	78	360-degree video and projections	PC, smartphone, VR glasses	Activity buttons, changing the angle of view.	Creates a realistic impression of images (and sound) to listeners that they are in the same space as the sound source. Shooting the videos is easy as angles are only decided at the editing stage.
8.	76	Immersive exhibits and performances	On-site at the performance space	Provide an opportunity to move around in the space, engaging the audience in a way that affects the course of the performance, social interaction.	The aim is to create multi-sensory experiences involving all five senses (visual, hearing and touch, but also increasingly the senses of smell and taste).
11.	64	Telepresence	PC, smartphone, VR glasses	Provides an opportunity for users to interact directly through remote access as if they were physically on site.	Very small latency in information flow.

OVERALL RANKING	PERCENTILE	TECHNO-LOGY	MOST TYPI-CAL DISTRI-BUTION CHANNELS	MOST TYPI-CAL WAYS OF INTER-ACTING	OTHER FEATURES
13.	57	Real-time hybrid media broadcasting	Computer, smartphone, (hybrid) TV	Chat, private messages, Q&A, polls, surveys, audience participation/ inclusion, purchasing.	Allows displaying graphics (e.g. ads) in the right scale, direction, and integrating their movements into the 3D world of the live broadcast.
16.	51	Holograms	On-site at the performance space	Rotating and moving the hologram to portray different viewing angles, scaling, activity buttons.	Viewers can see a 3D image without having to use separate glasses.
27.	16	4DX- films	On-site at the performance space	No genuine interactivity that would enable viewers to influence the course of the film.	A multi-sensory approach (vision, hearing, touch and sense of smell), including motion seats and effects simulating various natural phenomena that utilise water, wind, fog, fragrances and snow.
	(6)	Spatial sound	Headphones, Surround speakers, On-site at the performance space	A world of sounds that changes as viewers wearing headsets move their heads. The sound follows the user's movement in XR and 360 videos.	Creates a realistic impression to listeners that they are in the same space as the sound source.

6 The importance of spatial sound was not assessed, so its percentile could not be determined.

Extended Reality (XR) includes Virtual Reality (VR), Augmented Reality (AR) and Mixed/Merged Reality (MR)[7]. Virtual reality is an artificial environment created using a computer simulation, which has increased its popularity in recent years, for example, as VR glasses aimed at consumers have entered the market. Various actors have also invested heavily in the development of AR solutions in Finland[8,9]. In Virtual Reality, the user is transported into a separate world that can simulate the real environment or present a fantasy where everything is possible. In Augmented Reality, the real world plays a major role, but it is complemented by digital information and content that can be viewed, for example, through a smartphone screen. In 2016, AR surged into the public consciousness after the launch of the Pokémon Go free mobile game[10]. Mixed/Merged Reality (MR) is a seamless and interactive combination of real and virtual worlds, in which the two worlds interact with each other, forming an immersive experience. Despite developments in technology and processing power, the experts still find that technology sets limitations to the implementation of creative solutions.

> *"It enriches art forms and can create a whole new world of experience", "combined with holograms and projection, for example, it can offer brand-new innovations."*
> *"Right now, the biggest problem concerns the restrictions related to hardware."*
> *"We've been working around this for years, considering various solutions that aim at the same result."*

360-degree video and projection technologies are part of extended reality technologies, so it is no surprise that they rank second. 360-degree video differs significantly from the previous video-recording and presentation methods, which require carefully determining in advance what the recording will include. Meanwhile, in 360-degree video technology, the camera records video from all directions at the same time, allowing video editors or viewers to decide on the viewing angle later. Using VR glasses enables the viewer to enter the virtual world and get a more realistic experience, for example, from an art exhibition than from a traditional video image. According to the experts' comments, the technology has extensive applications.

> *"The opportunities brought by 360-degree video are diverse."*

Immersive exhibits and performances are multi-sensory and participatory events where participants are embedded in the world of the performance[11]. The immersive exhibits and performances create an immersive experience for the participants, which is also the aim of XR solutions. Immersive exhibits and performances

7 Hannele Laine ja Pilvi Dufva. 7 Kysymystä virtuaalitodellisuudesta (7 questions about virtuall reality). *https://virtual.outdoorsfinland.com/2018/03/7-kysymysta-virtuaalitodellisuudesta/*
8 HXRC is the largest virtual reality hub in Europe. Further information: *https://helsinkixrcenter.com/*
9 Alanko Leena, Sinerma Olli, Suominen Santeri (2018) Virtuaalitodellisuuden sisällöillä liiketoimintaa (Business through virtual reality). Yrityskatsaus, syyskuu 2018: Kasvun uusia mahdollisuuksia. TEM oppaat ja muut julkaisut 13/2018. Further information: *https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161045/TEM_13_2018_oppaat_Yrityskatsaus_1_2018web.pdf*
10 Pokémon GO. Further information: *https://fi.wikipedia.org/wiki/Pok%C3%A9mon_GO*
11 The Helsinki Term Bank for the Arts and Sciences 10 January 2022: Designation: immersive theatre. *http://www.tieteenter-mipankki.fi/wiki/Nimitys:immersiivinen esitys*

can be roughly divided into (1) linear performances that aim to create an experience that is almost similar in structure for all members of the audience and (2) free-roaming performances that enable the audience to move freely in the performance space, in which case their choices affect the experience.[12]. In both strategies, the audience rarely has the opportunity to influence the course of the performance. Combinations of gamification and performance, or gamified performances, are emerging alongside these, involving stronger interaction and dialogue between the audience and performers[13]. While creative industry actors are as such familiar with immersion as an approach, producing immersive experiences with new technologies opens up completely new opportunities related to both interaction and a multi-sensory approach.

> *"The immersive approach is an old trick that has been used by theatres and museums for a long time. However, it's a highly effective trick and often easy to produce."*

Telepresence utilises a low-latency audiovisual system that enables real-time remote presence. When taken to its extreme, telepresence means that people can feel and act as if they were there. In practice, telepresence is created through various remote activities, such as orchestra members located in different places playing music together. Telepresence is also considered to foster a climate-friendly approach as it reduces the need for travel.

> *"We cannot ignore this technology in the post-COVID era. It is good also from the perspective of climate, even though we still need encounters, empathy and emotions. Planning international productions reduces travel and increases communication."*

Real-time hybrid media broadcasting is a programme broadcast on TV or the Internet that combines (1) a live broadcast, (2) diverse interaction opportunities for the audience to participate in the broadcast, and (3) computer-generated graphics that seamlessly integrate into the three-dimensional world of live images in the right scale, direction and motion, for example, using a LED virtual studio or virtual advertising technology

> *"It is practically self-evident in all performance scenarios where technology can be used to make the performance more interactive and lively."*

12 Mikä on peliesitys? (What is a gamified performance) https://www.centerforeverything.com/fi/julkaisu/mika-on-peliesitys/
13 Teatteriin haetaan lisää elämyksellisyyttä pelillisyydellä (Seeking new experiential features to theatre through gamification) https://www.kaleva.fi/teatteriin-haetaan-lisaa-elamyksellisyytta-pelilli/1720164

Holograms are three-dimensional images that can be viewed from more than one viewing angle. To see the hologram, the viewer does not need to use special glasses to see the image in 3D. As early as 2012, hologram technology attracted a great deal of attention when the rap artist Tupac Shakur, who died in 1996, appeared as a hologram at the Coachella festival as part of a performance by Snoop Dogg.[14] Experts from the Delphi panel also felt that the technology had extensive applications once the technology is developed slightly more and the difference between the hologram and real performers becomes blurred.

> *"Very extensive application possibilities."*
> *"Holograms are also a form of technology that can become highly popular once they've been developed a bit more."*
> *"You can still tell the difference between a hologram and the real deal.", You cannot produce a hologram in real-time yet."*

4DX films are the next technological step in cinemas. The term 4DX refers to a technology that enables synchronising motion-seats and effects simulating various natural phenomena utilising water, wind, fog, scents and snow with the image displayed on the screen. Compared to the other broadcasting, media and distribution technologies described above, the experts were much more indifferent to 4DX films, comparing the phenomenon with 3D films previously on the market that did not meet the set expectations.

> *"Nevertheless, I'm not convinced of the staying power of this technology."*
> *"In practice, this is the same uncertain rodeo as 3D technology, which was supposed to irreversibly change movies."*

Spatial sound/audio captures a variety of sound reproduction technologies that allow you to detect sounds around you as if you were in the same space with them without a need to special settings for multiple speakers. When using headphones, the sound follows head movements, making the sound change according to the movements of the head.

14 https://www.youtube.com/watch?v=TGbrFmPBVoY

PRODUCTION TECHNOLOGIES

The production technologies category includes the technologies used to convey creative work. Table 7 shows the production technologies identified in this study and their percentiles and the main purpose of the technology in the creative process.

Table 7. *Production technologies: Ranking and main purpose*

OVERALL RANKING	PERCENTILE	TECHNOLOGY	MAIN PURPOSE IN THE CREATIVE PROCESS
10.	68	Mobile-phone-based filming and editing	Agile video and photography solutions that enable using smartphones and cloud-based web applications to produce picture and video content at a low cost and quickly.
12.	59	Distributed (video) production	A post-production process for video materials using shared storage space (incl. backup, editing, distribution formats), which can be used to manage the work processes of several project team members simultaneously using a remote connection.
17.	47	3D printing	Printing a digital model in a 3D file as a physical object using a separate 3D printer.
19.	40	3D scanning	Analysing a real-world object (e.g.object, space, terrain) and modelling it into a digital format that can later be used to produce a three-dimensional model.
20.	35	LED virtual studio	A studio environment that utilises large LED displays, XR technologies and a game engine, where people, real objects, and a computer-generated environment and objects can be combined into a single, seamless entity in real time.

Mobile-phone-based filming and editing emerged as the most important production technology in the overall examination. A significant share of social media videos is currently made using smartphones, as these provide an inexpensive and user-friendly way of producing video content. Smartphones can also be currently used to produce professional results, even if the image quality they produce does not reach the level of

professional cameras. This is evidenced by, for example, Unsane[15], a film directed by Oscar winner Steven Soderbergh, which was fully shot on mobile devices as well as the 2020 NFL draft in which mobile devices played a key role in the implementation of production[16]. Based on the experts' comments, mobile-phone-based filming is estimated to bring broad benefits to the creative industries.

> *"It's very important to produce mobile solutions."*
> *"Basically everyone can benefit from this."*
> *"In teaching, for example, this can be a convenient method at times in individual contextual moments."*

Distributed (video) production is a post-production process for video materials using shared storage space (incl. backup, editing, distribution formats), which can be used to manage the work processes of several project team members simultaneously using a remote connection. The key features of the technology are related to reducing the required storage space and faster production, as there is no need to transfer large files between team members. During the COVID-19 pandemic, distributed production has also been used in connection with major sports events, such as NASCAR broadcasts[17]. The experts noted that this was an already familiar operating model.

> *"Who hasn't run into these by now. In one way or another, we all came across it already before the pandemic."*

3D printing involves printing a physical object from a digital 3D model using a special 3D printer. Materials such as plastic, metal, ceramic or glass can be used as the printing material. Typically, 3D printing has been used in the manufacture of prototypes, small series, spare parts or moulds. In creative industries, 3D printing has been utilised in jewellery design, architectural design, sculpture and product design, among other applications. The experts of the Delphi panel considered 3D printing beneficial in the construction of models and prototypes, but they were sceptical about its suitability for contexts such as set design and equipment.

> *"The greatest benefit of 3D printing is that is makes it easier to produce models and prototypes."*
> *"It probably works for demonstration purposes."*
> *"Not yet a viable technology in performing arts, e.g. in the production of sets or equipment. Some pilots have been carried out related to equipment."*

15 https://momofilmfest.com/soderberghs-unsane-making-of-an-iphone-film/
16 https://www.sportsvideo.org/2020/04/23/nfl-draft-2020-nfl-media-deploys-iphone-production-kits-coordinates-600-live-feeds-to-bring-virtual-draft-to-fans/
17 https://www.haivision.com/resources/webinars/behind-the-streams/fox-sports/customer-spotlight/

3D scanning is realised using a 3D scanner that analyses a real-world object and models it in a digital format. 3D scanning enables accurate and fast 3D modelling of complex objects and spaces. In the creative sector, 3D scanning has been utilised in modelling sculptures and works of art, among others. The modelling makes it possible to present digital versions of works in virtual galleries or make sculptures accessible in a tactile form for persons with visual impairments. 3D scanning of the human body has been utilised in the design of made-to-measure clothing and jewellery as well as in creating special effects in films. In product design, 3D scanning has been widely used in connection with reverse engineering. Some of the experts perceived 3D scanning mainly as a design tool.

> *"The greatest benefit of 3D scanning is that is supports 3D-printed models and prototypes."*
> *"Very useful tool that makes it easier to familiarise yourself with spaces, for example in co-productions. The documentation of set design, especially in the repertory theatre, will also be improved through scanning."*
> *"Creative industries usually involves creating something new rather than modelling something that already exists. For the demo phase or as a design tool."*

The **LED virtual studio** is a studio environment that utilises large LED displays, XR technologies and a game engine, where people, real objects, and a computer-generated environment can be combined into a single, seamless whole in real-time. The virtual world shown on LED screens adapts to the camera's movements and settings, significantly reducing the cost of post-production compared to traditional green screen technology. The LED virtual studio enables a faster production process as it enables changing backgrounds and modifying them in a blink of an eye. The director sees the take on the screen in real-time, and the actors get the impression that they are filming on location. The technology is already commonly used in Hollywood productions and is expected to become the industry standard in the future.

> *"There are some innovative trends in this area."*

AI APPLICATIONS

The ranking of AI technologies at the bottom of the overall assessment list, even though AI has received considerable attention in public debate in recent years, can be considered one of the most significant findings of this study. A policy statement[18] produced for the EU Commission's Committee on Culture and Education notes that AI will transfer some of the work previously performed by people to AI, while at the same time

18 Caramiaux, B., 2020. *Research for CULT Committee-The Use of Artificial Intelligence in the Cultural and Creative Sectors* (Doctoral dissertation, CULT Committee, European Parliament).

empowering individual creative industry actors, as tasks requiring special expertise can be managed by AI. An example of this is the editing and tracking features of the Insta360[19] camera are included in the camera's editing application.

A recent study[20] took an in-depth look at the AI application areas in the creative industry and identified the following five areas where AI has already been utilised in creative ways: (1) content creation where AI is employed to generate original work, (2) information analysis where statistics are used to improve productivity, (3) technological content enhancement and post-production workflows in which AI is used to improve the quality of creative work, (4) information extraction and enhancement where AI assists in interpretation, clarify semantic meaning, and creates new ways to exhibit hidden information, and (5) data compression where AI helps reduce the size of the data while preserving its quality.

Table 8 shows the AI-based technologies identified in this study in accordance with the classification model presented in the figure above. The data compression category has been omitted from the table, as none of the technologies related to it emerged in this study. The ranking and percentile of each technology in the overall examination is also given before the name of each technology.

Table 8. *AI applications: Ranking and areas of application.*

CONTENT CREATION	INFORMATION ANALYSIS	TECHNOLOGICAL CONTENT ENHANCEMENT AND POST-PRODUCTION	INFORMATION EXTRACTION AND ENHANCEMENT
24. (26) Image GPT-3	22. (31) (Automated AI-based) metadata generation and management	25. (23) Motion Capture	14. (54) Data-driven creative innovations
28. (16) Deepfake			21. (35) Emotion tracking
29. (10) Robot and AI art			23. (31) Real-time captioning
30. (9) Generative Pre-trained Transformer 3, GPT-3			26. (21) Voice control/ speech recognition
31. (6) AI-based music technology			

In numerical terms, the AI solutions focus on "content creation" (5 technologies) and "information extraction and enhancement" (4 technologies). In relative terms, the latter of the two, i.e. "Information extraction and enhancement", attracts clearly more interest. In this category, "Data-driven creative innovations" seemed to particularly attract support from the respondents. In simple terms, these mean new innovations and solutions

19 https://www.insta360.com/
20 Anantrasirichai, N. and Bull, D., 2021. Artificial intelligence in the creative industries: a review. *Artificial Intelligence Review*, pp.1–68.

that are created by analysing (big) data and utilising the results of that analysis[21]. Another key interest in this category seems to be recognition technologies that can be used to identify emotions, translate language and voice control, which requires speech recognition. These features can be mainly perceived as "support functions" of a creative solution that enable a new kind of interaction or improve the quality of the viewing/listening/user experience in relation to creative content such as gaming.

> *"We could test text, speech or music with a test audience and make corrections based on their reactions", "We could create a personalised experience that takes into account emotions, imagination and emotional experiences."*
> *"Language barriers are an obstacle and the removal of these barriers by technology is a great opportunity with major impacts."*
> *"Gaming is perhaps the most natural platform voice control, but the technology could also be applied to such things as meeting applications, mixing consoles and graphic software."*

Technologies related to "content creation" cover all key aspects of the creative sector, namely image, text and sound. However, as pointed out above, there is clearly less interest in these than the technologies related to "information extraction and enhancement". In the future, it would be interesting to study this observation in more depth and to seek clarification on what explains these differences. For instance, is this a matter of creative industry actors' doubting the capacity of artificial intelligence to produce actual creative work due to immature technology:

> *"There have been experiments with AI technology,..., still far too primitive for any more serious work."*

Or do they perceive AI as a future threat that may transfer the work done by people to a machine, even making people redundant in the future?

> *"Artificial intelligence cannot replace humans, empathy and emotion", "AI technology certainly has potential, but this will only come to fruition in the future."*

21 Luo, J., 2022. Data-Driven Innovation: What Is It? IEEE Transactions on Engineering Management 70 (2).

Or are the technologies in question still so expensive that they can only be utilised in large-scale productions, such as The Irishman[22] film, a Netflix production, and Abba's[23] comeback, both of which involved creating younger versions of the performers based on older video material.

The interpretation of the role of AI as a support feature that makes work easier seems to attract support, as "(Automated AI-based) metadata generation and management", included in the "Information analysis" category received more support than any of the AI technologies related to the "Content creation" theme. Such AI applications often work in the background and are not directly visible to end users.

> *"Would make everyday routines easier.", "Happens invisibly in the background."*

"Motion Capture", which was part of the "Technological content enhancement and post production" category follows the same line, rising almost to the same level with the highest-ranking "Content creation" technology ("Image GPT-3").

> *"Highly implementable technology, which may succeed in the future in solving the barriers in hologram technology, for instance.","In the future, motion capture can be better combined with clothing industry products."*

A publication[24] that identified AI application areas in the industry also included "Extended Reality solutions (XR)" in the "Content creation" category. While XR solutions are often based on artificial intelligence to achieve an immersive experience, in the present study, it makes more sense to examine XR solutions as a part of other presentation technologies.

22 https://variety.com/2020/film/awards/technology-turns-back-time-on-the-irishman-1203488843/
23 https://yle.fi/uutiset/3-12082665
24 Anantrasirichai, N. and Bull, D., 2021. Artificial intelligence in the creative industries: a review. *Artificial Intelligence Review*, pp.1–68.

Conclusions

THE PURPOSE OF the CREATECHVISION – Technology vision for the creative industries, a project funded by the European Social Fund (ESF) was to set out a technology vision for the creative sector that identifies and prioritises new technologies relevant to the creative industries from a short- and medium-term perspective. The technology vision provides guidelines on which technologies creative sector should invested in now and in the near future, taking into account the characteristics of different creative sectors. The consensus-seeking Delphi method helped identify a total of 32 different technologies, which were classified as either cloud services, AI applications, and presentation or production technologies.

According to the Megatrendit 2020 study produced by Sitra, one of the key megatrends is "technology is becoming embedded in everything". This megatrend includes the following trends relevant to the technology vision:

- **Technology transforms operating methods**, which includes automating and decentralising operations in virtual environments and remote work.
- **AI applications permeate society**, which emphasises the adoption of AI applications and the transfer of decision-making power to computers.
- **The next wave of digitalisation**, in which the use of digital technology in services and human interactions is part of everyday activities, and there is an increase in virtual and augmented realities, voice control and gesture recognition in the short term.
- There is an **emphasis on understanding technology** as transactions take place on digital platforms and require new skills from individuals, for example in connection with data use, rights and utilisation.

In their statements, the experts placed the most priority on cloud services, whereas there was clearly less interest in AI applications compared to the other technologies. The low priority given to AI applications can be considered somewhat surprising, and it would be interesting to study the underlying reasons in more detail among creative industry actors. In the context of AI applications, the prioritisations of the experts emphasised the use of AI mainly in functions supporting the creative process rather than in the production of creative content itself. Some of the experts estimated that AI is currently too primitive and mostly suitable for experimentation, but will have potential in the near future. However, it is good to point out that utilising AI is already a daily occurrence in Hollywood productions, for instance. The application areas include motion capture, de-ageing or ageing actors with visual effects and predicting a film's success.

Many Finns also unknowingly read news produced by artificial intelligence. The Finnish Broadcasting Company's Voitto robot tirelessly produces texts about sports and politics, and provides information such as the achievements of your MP during the previous month. However, interest in AI varies based on the core competence areas in creative industries. In the core competence area of "Music and sound", AI-based music technology was given high priority. Finland also has top-level competence in developing sound and music technology. Quad cortex developed by the Neural DSP company has been a topic of much discussion among guitarists in the past year, and there is hot debate on whether the digital solution has already made traditional tube amplifiers obsolete.

The "*next wave of digitalisation*" and "*Technology transforms operating methods*" trends were also strongly present in the identified technologies. The five most important technologies were specifically related to cloud services. Cloud computing technologies extensively covered the different stages of the creative process, from brainstorming to distributing and selling a ready-made solution. Learning new things, managing projects and obtaining funding is also on the cusp of change as a result of the introduction of new technologies. Technologies related to remote work and distributed operating methods clearly attracted support from the experts, and may even lead to a genuine remote presence in the future.

Indeed, there is reason to argue that new technologies will change the work of the creative sector in all core competence areas. The coronavirus crisis has significantly accelerated this change, as we have been forced to find new solutions. There are already plenty of experiences available on which solutions work well and which do not. Large operators with money to invest in new technology have gotten a head start compared to others, and small players should catch up with them. Rapid technological development gives hope to small operators, as it reduces costs and makes technologies available to everyone, including consumers. This is evidenced by the high priority given to mobile-phone-based filming, among other things. With this technology, high-quality production of creative content is no longer a matter of cost.

There was fierce competition between presentation technologies and cloud services for the top position. The experts strongly believe that Extended Reality (XR) solutions, 360-degree videos, immersive performances, telepresence and holograms will challenge traditional presentations in the future. A look at these presentation technologies inevitably brings to mind media convergence and technological convergence. Technological convergence is a tendency in which unrelated technologies become more integrated and similar. Textbook examples of technological convergence include computers and smartphones, in which several, originally disconnected technologies have merged into a single, smooth user interface. Meanwhile, media convergence refers to the integration and merging of different types of media. The aim of the described technologies is to create a better immersive experience in which the audience or user is so immersed in the performance that they forget about actual reality. This is a great goal, but it is challenging to implement without a diverse group of creative industry experts, who can create immersion by combining different technologies and artificial

intelligence. As a result, the ability to utilise several different technologies simultaneously in the creative process is expected to be further emphasised in the near future until individual technologies have merged into a comprehensive solution. The LED virtual studio is one of the interesting production technologies involving convergence used to create an immersive experience for actors and directors, while at the same time significantly improving the cost-effectiveness and speed of production.

In addition to the mobile imaging and LED virtual studio mentioned above, the production technologies included distributed (video) production, 3D printing and 3D scanning. Of these, the experts working in the context of visualisation and the development of solutions were mostly interested in 3D printing. Meanwhile, in addition to this group, 3D scanning also attracts interest among those working in arts and crafts.

A surprising finding related to the "*emphasis on understanding technology*" trend could be considered to include the lack of blockchain technology and its applications, such as non-functional tokens (NTF) in the technologies identified in the study. However, blockchains were addressed in questions from the audience when the results of the study were presented at an innovation conference organised by the International Society for Innovation Management[25]. Undoubtedly blockchains play an important role in copyright issues, as demonstrated by the platform solution launched by Teosto a few years ago that was recently sold to Germany. Data-driven creative innovations received the highest priority out of all AI applications. Consumer migration to streaming services and hybrid media broadcasts also contributes to the production of data-driven creative content. These technologies enable real-time monitoring of consumer behaviour, thus enabling dynamic content production and presentation that takes into account individual preferences. Meanwhile, automatic metadata generation operating in the background creates the prerequisites for understanding what content the audience is watching at any given time and makes it easier to find creative content.

Finally, we note that the results of the study showed clear differences in the prioritisation of technologies between the different core competence areas in the creative industries. Therefore, the idea of a single technology vision covering all creative industries cannot be considered a realistic objective. Of course, similar priority was placed on several technologies in many different areas, but typically at least one of the competence areas was different from the others.

The desktop study carried out for this research also provided clear indications of the inequality resulting from the new technologies. Major players with access to significant funds are able to produce impressive non-mainstream experiences, which particularly place small operators in a difficult position. As a result, particular attention should be paid to ensuring that the technologies now identified will be made widely available to all actors in the creative sector, regardless of their size, in the future. Correspondingly, it should also be ensured that creative industry actors have the necessary competence to apply these technologies as part of the creative process.

As a result, the next phases of the CREATECHVISION – Technology vision for the creative industries project will focus on generating ideas and concepts for new business, product and service solutions in the creative industries that utilise the technologies described in the technology visions. The project also provides recommendations for developing education and competence in the creative sector from the perspective of the technology vision.

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LIMITATIONS OF THIS STUDY

The consensus-seeking Delphi research method was utilised in determining the technology vision. In this study, the experts were considered to have reached a consensus if 70% of them agreed on a given matter. This is a rather typical limit value used in a Delphi study. When interpreting the results of the study, it is good to note that the level of consensus can easily be manipulated by increasing or decreasing the limit value. The level of consensus when assessing the importance/desirability of technology ranged from 65 to 90 per cent between the different core competence areas. The only exception was "arts and crafts" where consensus was reached on the importance/desirability of only six technologies (19%). As a result, a new study for arts and crafts is recommended to complement the results of this study.

Technology adoption was examined using the five-step the diffusion of innovation classification model, which was complemented by a category of non-adopters. Reaching a consensus on technology adoption remained weak: when adoption was assessed from the perspective of all core areas of expertise, a consensus was only reached on the degree of adoption of one technology. The degree of consensus improved only slightly when examining technology adoption by core competence areas.

However, the level of consensus improved significantly if technology adoption was examined by combining two categories of the diffusion model. The experts assessed that, in two years, for a significant share of the technologies, the technology adoption rate will be in the "innovators" or "early adopters" category. In five years' time, the focus shifted between the categories "early adopters" and "early majority". The aim of the study was to identify technologies that would enable at least the leading actors in the creative sector to start brainstorming and testing new product and service concepts. Despite the low level of consensus on adoption, we can conclude that the technologies meet the objective described above.

The recruitment of experts to participate in the study proved challenging. Among other things, the recruitment process included contacting over thirty Finnish creative industry organisations. The organisations were asked to appoint their own representatives to the panel and to forward information about participating to their members. In the end, a representative from only one organisation participated in the panel activities. An open invitation also had a modest impact on recruitment. Therefore, the results of this study do not lend themselves to determining perspectives and making comparisons at the level of non-governmental organisations.

A significant number of experts were recruited with the help of a desktop study carried out by the project group and through snowball sampling. The snowball sampling method increases the risk of bias in the group of respondents. When sampling is based on recommendations, there is a tendency for the participants to name persons they know the best and who share their views. This risk was minimised by asking the experts to assess their own knowledge of the technologies and business needs in each of the seven core competencies. In addition, the experts' backgrounds were checked using open sources where possible.

Based on the self-assessment and the background check, many of the experts had knowledge of several different core competence areas in the creative sector, which made it possible to examine the topics extensively. Nevertheless, the application and commercial utilisation of new technologies require special enthusiasm for the technology in question and a comprehensive understanding of existing alternative solutions. This could not be completely verified in the studies. The number of respondents varied between 14 and 19 in the three rounds, which is in line with the number of respondents typical in Delphi surveys. However, in the area of arts and crafts, the low number of experts (3) can be considered a clear limitation.

When assessing the business potential of technologies and their impact on the number of jobs, it is important to take into account the rapid development of technologies. The introduction of new technology that is significantly cheaper and easier to use than its predecessors can also rapidly and radically change the adoption rate. In this case, the estimates presented here may quickly become irrelevant. In the context of technology adoption, a significant share of the technologies are located at the earlier stages of the diffusion of innovations model, where innovators are still only looking for and piloting new business opportunities. The actual, industry-wide business potential will only be revealed years later.

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References

Alanko, L., Sinerma, O. & Suominen, S. 2018. Virtuaalitodellisuuden sisällöillä liiketoimintaa. Yrityskatsaus, syyskuu 2018: Kasvun uusia mahdollisuuksia. TEM oppaat ja muut julkaisut 13/2018. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161045/TEM_13_2018_oppaat_Yrityskatsaus_1_2018web.pdf

Anantrasirichai, N. & Bull, D. 2021. Artificial intelligence in the creative industries: a review. Artificial Intelligence Review, pp.1–68.

Biernacki, P. & Waldorf, D. 1981. Snowball sampling: Problems and techniques of chain referral sampling. Sociological methods & research, 10(2), pp.141–163.

Buchner, G.A., Stepputat, K.J., Zimmermann, A.W. & Schomäcker, R. 2019. Specifying technology readiness levels for the chemical industry. Industrial & Engineering Chemistry Research, 58(17), pp.6957–6969.

Cambridge Dictionary. Haettu 30.1.2022. https://dictionary.cambridge.org/dictionary/english/consensus

Caramiaux, B. 2020. Research for CULT Committee-The Use of Artificial Intelligence in the Cultural and Creative Sectors. Doctoral dissertation, CULT Committee, European Parliament.

Center for everything. n.d. Mikä on peliesitys. Haettu 30.1.2022. https://www.centerforeverything.com/fi/julkaisu/mika-on-peliesitys/

Chapain, C. & Comunian, R. 2011. Dynamics and differences across creative industries in the UK: exploring the case of Birmingham. REDIGE, 2(2).

DCMS. 2001. Creative Industries Mapping Document 2001 (2 ed.), London, UK: Department of Culture, Media and Sport.

Dufva, M. 2020. Megatrendit 2020. Sitran selvityksiä 162. Haettu 30.1.2022. https://www.sitra.fi/julkaisut/megatrendit-2020/

Eduskunnan tulevaisuusvaliokunta. 2020. Koronapandemian hyvät ja huonot seuraukset lyhyellä ja pitkällä aikavälillä. Eduskunnan tulevaisuusvaliokunnan julkaisu 1/2020. Helsinki. Haettu 30.1.2022. https://www.eduskunta.fi/FI/naineduskuntatoimii/julkaisut/Documents/tuvj_1+2020.pdf

Elo, S. & Kyngäs, H. 2008. The qualitative content analysis process. Journal of advanced nursing, 62(1), pp.107–115.

Heiko, A.V.D.G. 2012. Consensus measurement in Delphi studies: review and implications for future quality assurance. Technological forecasting and social change, 79(8), pp.1525–1536.

Hesmondhalgh, D. 2007. The cultural industries (2nd edition). Thousand Oaks, CA: Sage

Howkins, J. 2002. The creative economy: How people make money from ideas. Penguin UK.

Horizon. 2020. Work Programme 2014–2015. General Annexes G. Haettu 30.1.2022. https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

Kauppinen, E. 2019. Teatteriin haetaan lisää elämyksellisyyttä pelillisyydellä – etenkin nuoret odottavat mukaansa tempaavaa elämystä. Kaleva 14.4.2019. https://www.kaleva.fi/teatteriin-haetaan-lisaa-elamyksellisyytta-pelilli/1720164

Keeney, S., Hasson, F. & McKenna, H. 2006. Consulting the oracle: ten lessons from using the Delphi technique in nursing research. Laeding Global Nursing Research, 53 (2), 205–212.

Kuusi, O. 1999. Delfoi-metodi. Metodix. Haettu 30.1.2022. https://metodix.fi/2014/05/19/kuusi-delfoi-metodi/

Laine, H. & Dufva, P. 2018. 7 Kysymystä virtuaalitodellisuudesta. Virtual Outdoors Finland. Haettu 30.1.2020. https://virtual.outdoorsfinland.com/2018/03/7-kysymysta-virtuaalitodellisuudesta/

Linstone H. A. & Turoff, M. (eds.) 1975. The Delphi method: techniques and applications. Addison-Wesley.

Linturi, H., Linturi, J. & Rubin, A. 2013. "e-Delfoi – metodievoluutiota verkossa", Haettu: 10.01.2022. https://metodix.fi/2014/11/26/edelfoi-metodievoluutiota-verkossa/

Luo, J. 2022. Data-Driven Innovation: What Is It. https://arxiv.org/ftp/arxiv/papers/2201/2201.08184.pdf

Mangematin, V., Sapsed, J. & Schüßler, E. 2014. Disassembly and reassembly: An introduction to the special issue on digital technology and creative industries. Technological Forecasting and Social Change, 83 (2014), pp. 1–9.

Mullen, P.M. 2003. Delphi: myths and reality. Journal of health organization and management, 17 (1), pp. 37–52.

Okoli, C. & Pawlowski, S.D. 2004. The Delphi method as a research tool: an example, design considerations and applications. Information & management, 42(1), pp.15–29.

Rogers, E. 2003. Diffusion of Innovations, 5th Edition. Simon and Schuster.

Santonen, T., Harmoinen, P., Laitinen, J., Meristö, T., Jokinen, M., Karimäki, K., Leino, T., Sirkesalo, S., Ikkonen, T., Lehtinen, L. & Silvola, K. 2019. CityDrivers – Teemme luovan osaamisen myynnistä ja ostamisesta helppo. Laurea Julkaisut 119. Haettu: 10.01.2022. https://urn.fi/URN:ISBN:978-951-799-527-6

Santonen, T. & Kiviranta, J. 2021. Technology vision for creative industries: a Delphi study in Finland. In ISPIM Conference Proceedings, 1–13. The International Society for Professional Innovation Management (ISPIM).

Tieteen termipankki. n.d. Nimitys:immersiivinen esitys. Haettu: 10.01.2022. http://www.tieteentermipankki.fi/wiki/Nimitys:immersiivinen_esitys

Tietoykkönen. 2020. Palveluiden käyttäminen epidemian aikana ja rajoitusten poistamisen jälkeen. Tuhat Suomalaista / Kesäkuu 2020.

UNCTAD. 2008. Creative Economy Report 2008. New York and Geneva:

Vernon, W. 2009. The Delphi technique: a review. International Journal of Therapy and rehabilitation, 16(2), pp.69–76.

World Health Organization. 2014. Decision-making for guideline development at WHO. WHO handbook for guideline development, pp.201–14. Haettu: 10.01.2022. https://apps.who.int/iris/bitstream/handle/10665/145714/9789241548960_chap16_eng.pdf?sequence=7&isAllowed=y

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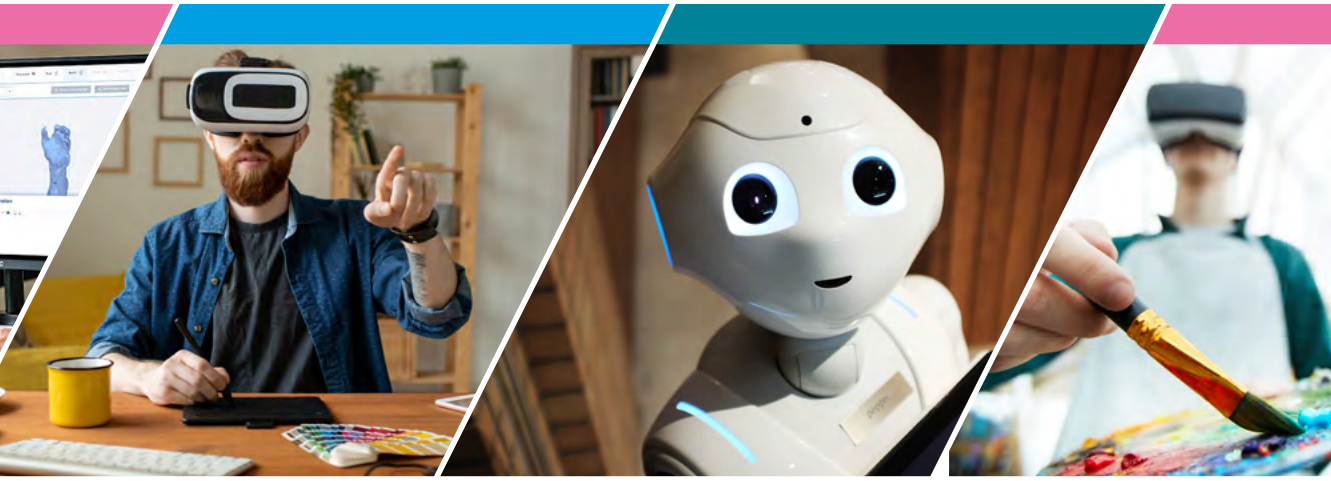

THE OBJECTIVE OF CREATECHVISION – Technology vision for the creative industries, a project funded by the European Social Fund, is to (1) determine a technology vision for the creative sector that describes and prioritises new technologies with key relevance to the creative industries, (2) generate ideas and concepts to new business, product and service solutions for the creative industries that utilise the technologies described in the technology vision and (3) issue recommendations from the perspective of the development of education and competence in the creative sector from the perspective of the technology vision. The two-year project is coordinated by the Laurea University of Applied Sciences and implemented in collaboration with the South-Eastern Finland University of Applied Sciences and Ornamo.

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