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The future technologies of journalism

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Abstract

The practice of journalism has undergone many changes in the last few years, with changes in technology being the main driver of these changes. We present a *future study* where we aim to get an understanding of what technologies will become important for the journalist and further change the journalist's workplace. The new technological solutions will have to be implemented in the media houses' information systems, and knowledge about what technologies will have the greatest impact will influence IS strategies in the media house. In the study we interviewed 16 experts on how they envision the future technologies of the journalist. We analyzed the interviews with a qualitative research approach. Our analysis shows that technologies for multi-platform news production, automated news content generation, cloud services for flexible production, content search, and content verification are the most important in terms of needs and competitiveness.

Keywords: future study; journalism; information systems technology; interview study

1. Introduction

The media industry, and in particular the news media, has undergone large change in the last decades. The advent of web technologies, social media, smartphones, cloud computing and artificial intelligence has changed how news reporting is done. It has long been clear that innovation is a must in this market [24], and the large media enterprises have taken up the glove and seen the potential and the necessity of new information technologies in the development

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of their news services. Smaller, local newspapers are also at a stage where they need to be more effective in their news production, and interesting avenues for the development have been identified [1, 30].

It is not so that media houses have been studied much in the information systems context [17], and this trend is continued as we find no research in this avenue the last few years. It is, still, very likely that the continuous uptake of new technologies in the production of news has been a challenge for these businesses. In many other industries it has been observed that large innovation investments in information systems are not necessarily profitable [8] and that large investments in new technologies may have costs that cannot be defended.

It was in this context we set out to identify how technologically competent journalists, media technology developers, and media scholars envision the future technologies of journalism. The answers to the question "What are the technologies that will be used in the future newsroom?" may provide some guidelines to where media houses should prioritize their resources in terms of technological focus and investments. We conducted qualitative interviews with 16 media technology experts, aiming to get their understanding of which technologies would be relevant for the future of journalism practice, and how they would be used.

We continue by giving some background for the study of technology use in media and journalism (Section 2) and describe our data in Section 3. The analysis (Section 4) focuses on 3 thematic topics, artificial intelligence, user interaction, and supporting communication and information technologies. We discuss our findings and their consequences (Section 5) before we conclude in Section 6.

2. Technology in journalism

The development of communication and information technologies in the last decades has been a challenge for the media industry and news production, but the media houses have taken up the challenge, changed their business models and developed a plurality of presentation forms. There are many journalism studies of this development, for example Lewis et al. who discuss AI and its relation to journalism from various perspectives [14], Slaček Brlek et al. identify natural language tools as the most important technological contribution to journalism [28], Salzmann et al. describe how the mobile phone has become a tool for the journalist [27], Lewis and Westlund address the use of big data in journalism [15], and Broersma & Eldridge II show how journalism has taken a new form due to social media [2].

There are also examples of more technologically oriented contributions. Diakopoulos book "Automating the News: How Algorithms are Rewriting the Media" [5] presents many examples of AI and computational data analysis in the media. Opdahl et al. have a focus use of knowledge graphs in news production [22]. Leppänen et al. discuss the generation of automated news from highly structured data, today commonplace all over the world [13].

As Lugmayr et al. mentioned there is little research on information systems in the media industry [17], a gap that calls for increased activity in this direction. A few media scholars have studied the combination of technology and strategy. One example is Napoli, who mentions how research on media industry needs to address the influence of algorithms [21]. Küng describes how many media houses have worked strategically with digital technology and succeeded [11]. However, in many media houses the process of technological choice has been less strategic, following trends and expectations more than deeper considerations, with experimental trials of readymade technologies. Very often the strategic focus has been on revenue models rather than technology investments [12,16].

There is an abundance of studies in the information systems literature identifying technologies, problems, approaches related to information systems, for example using Delphi studies [18]. We aim to reduce the gap in studies of the media industry information systems, by establishing knowledge about which information technologies could be valuable for media houses and helpful for journalism practice. By identifying the useful future technologies, media managers and content producers like journalists should be able to make more informed decisions about where to focus their investments on information systems and technologies.

Today the media houses must continuously reflect on how technological developments can be utilized to support journalism. Firstly, Automated journalism may be more cost efficient but will perhaps conflict with journalism values [20]. The latest GPT-4 tool from OpenAI illustrates an urgent need to assess this [23]. Secondly, artificial intelligence may be needed to discover manipulated images and videos [9]. Further, automated fact-checking may help to flag unreliable information, but will the journalist trust the technology to be good enough [7]? The list of even more challenges includes: The investigative journalist may need advanced data analysis tools [26]. Will the media industry and the journalist be able to get a grip on transmedial journalism [31]? The potential of augmented and virtual reality

journalism may need to be explored [19, 10]. Finally, one must understand how technological infrastructures, external computing services, and mobile journalism practices will influence journalism [27]. We aim to suggest answers to these questions by collecting opinions from a group of media technology experts.

3. Data collection

The data we have collected are 16 in-depth, semi-supervised interviews addressing topics around the technologies to be expected in the future newsroom. Our *qualitative* analysis is thus a textual presentation of the most interesting topics and the gathered insights, presenting selected quotes from the interviews. Finally, we summarize the interviews by discussing a subset of the technological solutions that need to be assessed in a media enterprise's future technological strategy.

The interviews were centered around three main topics. First, artificial intelligence was discussed as a central tool for the future journalist, for example in natural language processing or data journalism. Second, the future production of live news will need new supportive technologies, like cloud services or mobile reporting. Third, the augmenting or virtualization of news stories opens for new formats and presentation forms. We encouraged the respondents to reflect on these technology groups and how they would be used in 5-10 years from now. They were also asked to suggest scenarios describing how the future news user and journalist would interact with these technologies. Finally, they were asked to do a short ranking of the technologies.

The respondents we had were mainly from Scandinavia, and in particular Norway, but we also talked with three respondents from mainland Europe and the UK. There were 13 men, 3 women; 6 from broadcasting, 3 from newspaper, 5 from tech companies, 2 researchers, and 14 with news production experience. One of the interviews included an extra interviewee, who could supplement the technological expertise of the main expert. All interviews, except for two, were conducted digitally, and were recorded. Afterwards they were transcribed automatically and checked for erroneous transcriptions.

4. Data analysis

In the interviews we focused on AI, technological infrastructure, and newer presentation technologies and formats. Of course, there are interactions between these, and we will occasionally see issues that have relevance for more than one of these technology groups. We start with artificial intelligence, perhaps the most important topic. As one respondent said: "I believe that what will cause most change in journalism or require the most of journalism, is AI. It will cost efforts to keep competent, understand what is going on, keeping track of a moving horizon."

4.1. Artificial Intelligence Technologies

Automated content generation. This is the topic that had the most attention during the interviews. The interviews were all conducted before OpenAI announced and made available to the public the last versions of their Generative Pre-trained Transformer (GPT) model services (ChatGPT, and GPT-4). Thus, many responses are relating to the systems that today deliver news stories from very structured data, for example from the stock market, sports events, or house sales [13]. Some of them are a bit critical to the value of such approaches: "if there were 20 shootings in a year, would you end up with 20 scripts that are basically the same thing where it's just replacing numbers and place names? How unique would each story be if AI is creating those stories?" Others are positive because these reduce repetitive work for journalists: "I care about taking away boring work for journalists, […] Actually, we generate over 100,000 news stories a year on that stuff."

However, most of the respondents envisioned a future where these automated stories would have more varied presentations. One refers to the use of so called atomic news units as described by Caswell [4] as a future approach: "I think that in 10 years, the journalist will not necessarily write long articles like they do today, but perhaps write smaller content atoms with well-defined metadata […] so when you have developed the story, and collected these atoms in a package, then it is up to some kind of algorithm to put his together for a target group.» One author envisions these tools as productivity tools for the local journalists: "Support tools that use AI to collect content or write content will have a lot to say. It means that local newspapers with few journalists can produce more content." This also opens

for personalized stories: “If production costs are low, then you can as a media house to make that news story that only seven or 200 users click on. You can imagine a type of news that not yet has a market.”

But the sceptics have serious and very valid concerns: “So can I see artificial intelligence write news stories like articles? I don't think so, because they're based on statistics, and we need to know what our machines are writing. And there is no room for black boxes, because I cannot explain the output to my editor in chief. If the robot has written some gibberish, then, even if it's like a 99% probable, then that's not good enough.”

However, most of the respondents see such tools as supporting: “Maybe in the future the journalist will get a story sketch that can be checked and improved. They will get more and more help with working out the text.”

Technology and journalism experts reflecting on the future after the GPT technologies were released, for example Burrell & Adepoju [3], repeat the potentials and the pitfalls in using the such models in a way that matches with what our respondents think. We will have to accept that they will be tried out and most likely used in content production, both in a systematic way to produce stories automatically and as a tool that the single journalist uses to help with narrative. In both cases, verification of the produced content needs to be done by a human journalist.

Content search. This has always been an important part of journalism work, and web search has helped, but now the journalists want tools that do more selective filtering than the standard tools. One respondent believes that the computer supported search will be instrumental in finding interesting angles. “When you get a whiff of a good story, then you think you got a news angle, and then you turn on the computer and it will detect things you never thought about, but which will complement the presentation.”

The media houses have data in the form of images, videos, and sound recordings from decades back, and these are not useful for news production today because they are not searchable. Creating useful **metadata** for these has been a challenge: “This kind of work takes a lot of man hours in a media company, so if we are talking about technology that would support us in the future, it would definitely be a technology which collects metadata and ties it firmly to the media itself.” Current AI, machine learning, and object recognition tools are thought to help with that.

One respondent was enthusiastic about having metadata labeling process for videos starting even at the camera level, continuing it all the way through edits and transmissions into the archive. The respondent imagines: “What if we wanted to find pictures of marching bands in the sunshine in central London. If you had put all that information in immediately, it would come back immediately.”

Content verification. The amount of fake news, images, and videos is a bit worrying to our respondents: “You have a force that is evil in some sense, who wants to undermine the sense of something being true and certain. It is strange, but you may imagine two AIs, the verification AI and the deep fake AI fighting an eternal battle. » Trustworthy media need to emphasize this as it undermines people’s trust in news stories: “To me it is really of democratic importance. If you do not trust your sources, people will not trust anything.”

The technological solutions seem to focus on having content verification more as a service. One respondent from a regional news outlet said: “Tools to verify images and such things is not something we would spend man-months on. But it is a larger need in national and international publications.” International experts think in terms of authenticity documentation [25]: “The journalists need metadata because they want to track the source of information, who's the author and so on. So, they would love to have a kind of centralized database in which they put the content they want to verify and then they will have the author, the publication, where it has been published, where it has been broadcast.”

Natural language processing. Language translation is already a part of the tools used by journalists. And using such tools to present content in many languages is seen as something obvious in the future for large media houses with international followers: “Having the tools and the ability to be able to translate into multiple languages quickly and effectively and accurately will enhance people’s output and enhance the reputation of being trusted”. On the other hand, being able to translate recordings quickly is a helpful tool for the journalist, particularly from languages unknown to the journalist. One respondent even this useful with dialects: “In Norway and Denmark we have a lot of local dialects which we must take care of, and we must ensure that they can coexist with the more generic language. It is not about blurring it out, but it is also to ensure that we understand it and we get the point right from that dialect.”

Text summarization is also a technology that currently is at a level that is useful for journalists. The GPT models do this at a very high level, and quality was already high before GTP-4. One respondent said: “The task of analyzing a text, getting its essence, and rewriting it, is solved”.

Synthetic speech and videos. With the high-quality text generation tools of today we are at a stage where we also could generate synthetic speech from the generated text. This will most likely become a normal way to consume news

texts, also the texts written by journalists: “For the reader it will be a new approach to the news. Instead of reading the pdf or paper version of a newspaper, you will have a synthetic voice local news reader.” There is experimentation going on with synthetic videos, for example, with synthetic news hosts. However, there is an issue of trust when using such technologies: “People do still rely on what they see, and they know that it is real people telling this and that it is really happening. So, when a kind of person who is not real is telling the news, this gives you the feeling of ‘is it happening, or is it not happening?’”

4.2. Technological infrastructure

Automated studios and virtualization. The tools for presentation of the news are highly important for the media houses, and today we have of automated studios with lights, background screens and self-moving cameras.

However, the need for studios fully equipped with advanced technology has become less important. During the COVID pandemic, terms like *virtualization* and *IP production* (here meaning news production enabled through high-capacity communication on the internet) became important, and TV companies are investing in such technology with the aim of enabling more live and field reporting: “I think that is something that we will head for. We are now building a fully virtualized studio, and we have a project where we plan to start cloud-based production tests. This part will be central in the future.” It also enables the journalist to work produce content away from the media house’s locations: “It could be that the journalist will make the news from a cottage or from a vacation.” The goal of all this is of course to reduce the staff for technical support, making the journalist take responsibility for not only the content, but also for the production itself.

Cloud computing. Virtualization is enabled using cloud computing services on high capacity tele networks. To one respondent this has been a game changer: “The application of 5G IP for broadcast and the cloud as well, gives us the ability to do anything, anytime, anyplace.” Another respondent is completely sure that cloud technologies will be a must for the journalist: “I’m completely sure that in the next ten years, for journalists they will include being moved over to tools based on modern cloud technology.” One agrees with trends but sees some problematic issues in the power of the cloud providers: “The drawback of this technology is you are bound to the cloud provider. You use their framework to generate applications and there is no cross-cloud platform compatibility.” The respondents are also quite clear that much of the AI to be used must be bought from service providers. The cost reduction relating to technology will be significant, as all of this also enables less need for equipment like desktop and laptop computers.

Security and protection. Although cloud computing is an enabler, it also has problematic sides for journalism. Source confidentiality is central in journalism, and we may not know 100% where data handled by providers like Google and Microsoft will end up. They may, for example, be bound by national regulations that allow governments access to their data. One respondent highlights this issue: “What I think will become a central topic in the future is modern security technology supporting protection against foreign powers, but also own national government and what they may come up with. The security technologies that are needed to do free and independent journalism.”

4.3. New presentation formats and platforms

Content augmentation. This topic includes both graphical overlays on a TV production and augmented reality. Graphical overlays are already done in sports like basketball and tested in a royal wedding in UK: “Sky News did that for Prince Harry's wedding. They had a thing where you could tap at the guests coming into the church. It takes an awful lot of work. They had to get a list of all the guests there, facial recognize them, then get the bios and make sure that those two things married up.” The respondent mentioned the work needed to make this work, and the cost of preparation was also an issue mentioned by another respondent: “It’s so advanced today, and it's highly skilled specialists who have to line up the stuff.”

Augmented reality (AR) is more problematic because it may require specialized equipment like glasses or even masks, and there are doubts about the willingness of users to invest in this. But the respondents expect it to be important in the future: “When it comes to AR there are so many possibilities that I expect the technology to move quickly forward. It will become very important. You walk through the city and get an arrow towards the place where you can get the fast food you prefer.” But the use of AR in the news may not have much economic value, an issue mentioned by several respondents.

Virtual reality. When it comes to virtual reality the respondents were even more skeptical compared to augmented reality. They expressed the same doubts regarding the equipment as we referred to earlier, and many users do not feel comfortable with the masks needed to exploit this technology to its full extent. Further, production of content is costly and requires specialist competence. One respondent suggest that it is possible only in very special cases: "It would be rather extravagant in a hectic everyday to spend a lot of resources on creating 3D visualization." The same respondent had done 3D visualization for the web of two cases; the spread of a large woodfire and a deadly accident with a rowboat ending up in waterfalls in a narrow canyon. The potential for use is there, but production costs and the lack of virtual reality technology among the public reduces the value.

Multiplatform production. An issue that is repeated among the respondents is the production of news for media houses that produce for many platforms: TV, print, web browsers, mobile web browsers, sound media, etc. and at the same time making summaries, short versions, and in-depth versions of the same story. All this opens for extensive personalization not only based on your interests, but also relating to time and place: "When you have the good story, you must ensure it goes on all platforms, so it's not about one edited piece. It will need to target different platforms, the different outputs, and that might also mean that it would be even more personalized. So, it would be more object based what we must produce as output." The reference to object-based production refers to the news content units that can be used to create the right story for the current platform and moment. One respondent said: "You need a news factory with a production line that can manage all this." One claims that we are still missing the tools for this: "It is this whole story management that we are missing and that we are looking for. Because how do we keep track of this?"

One respondent thinks that the news outlets need to work more and more with multiplatform publishing, as that is necessary to keep you customer base: "I think that Washington Post is probably a leader in this now in terms of how they present their articles in a very concise way. But they've also got the option to play audio, so I no longer must watch a news bulletin. I can listen to it on the train or walking down the street without having to take the phone out of my pocket. And I think that that's the kind of diversification that the newspapers will have to go through to be able to bring people in" And the whole spectrum of formats should be available, even the long in-depth presentations may be of interest: "If you have the right story, right tools, and time to spend."

A few respondents are skeptical of too much personalization: "I do not think that is what we need. We still need the editors and the newspapers to set the agenda, so you get a curated picture of reality. To ensure that we are not in each our reality. We do all need some of the same information." And there are also some doubts about the business in this: "Many users are not so interested in engaging in the story and do not want to navigate into all sorts of rabbit holes. They want the final package".

5. Findings

This study shows that the technological opportunities for journalism are in abundance, and that journalists will have to relate to many technologies in their daily work. The pace of change in social media, interaction technology, visualization, and language processing is very high. Consumers adopt many of the new technologies, forcing the media houses to reflect on platforms to use and how to present the news. Their information system strategy therefore needs to be very flexible, and they need to respond in an agile way, with exploration, innovation, and realization of uses.

In this study we have focused on getting insights into the technological possibilities and their future importance for journalism. To summarize we give five technological developments that we think will be of the highest importance and will be used in most newsrooms. The sequence is somewhat arbitrary because there are many dependencies, but we still consider technologies for multiplatform production to be the most important.

1. **Multiplatform content production.** We expect that the media houses will need to get tools that will help with this. Development of the technology has started but is not at the level that our respondents think it should be. The inner workings of such systems may be based on the use of news units or news objects [4], as mentioned by several respondents. This will also enable personalization. The complexity makes it a challenging task and may be based on advanced AI techniques like planning or case-based reasoning. But it also requires platforms for structured data and knowledge organization [6]. The media houses need to follow the development of this technology closely, as competitiveness may depend on being available on many platforms.
2. **Automated content generation.** This includes text generation, but also high-quality speech, image and video generation. The technology for most of this is already there, and will most likely be used extensively in

journalism, particularly for text content. The journalist's productivity and work focus will change radically. However, photographic quality artificial images and videos will conflict with the guidelines of photojournalism. Further, the likely development of even more fake content using such technology will perhaps reduce the public's trust in media.

3. **Cloud services.** Cloud services are already included in media production processes, but many of our respondents think that the whole content production flow will be done on such systems. The journalist may work from anywhere at any time and enable one single person to do live field reporting themselves. There are issues around this, like the data that a media house produces and needs to protect. Further, journalists may keep personal data that is sensitive. Where is that data stored and is the journalist able to secure the data?
4. **Content search.** The media companies have enormous amounts of content from earlier production. Much of this has high value for current news production but is hard to find. Metadata generation for this content is of high priority for the companies and would enable smarter search for reusable content. AI technologies will be used for decomposition of this content making it available at units of news level.
5. **Content verification.** Serious media need to be trusted, and presenting content in a trustworthy manner is a must. Thus, the news outlet needs to invest in tools that are helpful in discovering fake content. This will most likely become cloud services. If generative AI is used to overwhelm the web with misinformation, solid verification processes may give the new outlets competitive advantages compared to social media where all sorts of content are spread. Technologies for certifying authenticity will also be used.

We believe that other topics also may become important but will struggle in comparison with those mentioned above. The development of generative AI going on right now already influences the three topics automatic content generation, content search, and content verification. However, generative AI may have consequences also in other approaches to journalism and will most likely enable applications not mentioned by the respondents.

The results here are based on interviews with journalism technology experts. All are from countries where trust in journalism is comparably high, and it is an important motivation for them to maintain their trustworthiness. Further, consumer technology is advanced and widespread in those countries. This may have consequences for how the findings would be interpreted in other parts of the world. Still, technological change no longer takes much time to spread all over the world. So, even if things go slower in certain parts of the world, these technologies will most likely be used everywhere. We should also ask if such a study will stay relevant in a few years, as tech developments may themselves make the results obsolete. At the same time, we should see this study for what it is. It is not necessarily a certain prediction of the future, but a guideline for businesses and for researchers interested in understanding how information systems in the media industry are constructed.

6. Conclusion

We have interviewed 16 media tech experts about what will be the future technologies of news journalism. The aim has been to suggest which of these are most critical for the media house to invest in. Our highest ranked technology of importance are tools for production of a story for various platforms and personal preferences. From history, we know that technological developments and societal trends may very well change how industries develop. Disruptive innovations will move new players into the market, and others will disappear. In that context, our results indicate status about how future journalism is envisioned, and the likely implications, but there is also a lot of uncertainty around the issue.

This work is a contribution supporting information systems strategy for media houses. Research studies of the media houses IS are few, and to understand how they can most effectively develop their tech infrastructure, we need to know more about how they work with IS strategy. We encourage more studies in that direction.

Finally, we may ask if the future will only bring news made by robots. We think that it will not be like that, which is a view that is supported by one respondent, who said about a news producer: "They have gone completely in the other direction; they have put deep journalism into it. All the text writing is manual, very witty and with humor etc. Because they see that the world is flooded with solutions with automated texts".

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