Report:

Digital Design Media in Norwegian Architect´s current Practice, Survey 2016-2017

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Cultural Heritage Mediascapes – Architecture Museums and Digital Design Media

National Museum of Art, Architecture and Design, Norway

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Foreword

My interest in born digital architecture dates back to 2002-03 when I conducted a survey on digital tools in use in a sample comprising 25 Norwegian architectural firms and a case study of the architectural firm Snøhetta´s design for the new Opera and Ballet Building in Norway. The aim of the survey and study was to enhance knowledge about born-digital and Computer Aided Design (CAD) and thereby contribute towards achieving the objectives of the Norwegian Museum of Architecture.[1]

The digitization of the architecture sector has made great advances during the past 15 years. Although Norwegian architects were eager to take new IT technology into use, the cutting-edge technology two decades ago was limited to 2D models. Currently, parametric design and complex 3D models connected to databases, called Building Information Models, BIM, have become part of everyday life in many firms. The challenges to museums and archives in terms of acquisitions of CAD-material, long-term preservation and public dissemination for various visitors – both experts and laypersons – have grown commensurately along with the growing sizes of data sets in a variety of formats. The need for a broader understanding of the current situation, the use of CAD and the problems faced by organizations with archival responsibilities seemed urgent.

I have been responsible for the design and execution of the survey and for this report. The survey is conducted in close cooperation with the National Archives of Norway. My gratitude goes to Senior advisor Erik Aaberg and Deputy director – digital preservation – Ole Myhre Hansen. Without close collaboration and input from these people, there would be no survey. I would also like to express my gratitude to Eliza A. Leventhal, Librarian and archivist at Sasaki Architects, USA, and a driving force in the CAD/BIM taskforce group of SAA's Architectural Records Roundtable (now Architectural Section) for valuable input regarding the design of the survey and generous sharing of data from a related survey from 2016 meant for the archival community (see chapter 4). Our ambition and hope is that this survey, together with the American survey, will provide a valuable contribution to further efforts in museums and public archives towards defining strategies concerning long-term preservation and dissemination of records of born digital architecture.

I would also like to express my thanks to Dr Kurt Helfridge, former Chief Archivist & Collections Manager at the British Architectural Library, Royal Institute of British Architects, now at the National Gallery of Art, Washington DC, who willingly accepted the invitation to act as an expert advisor for my research project Mediascapes – Architecture Museums and Digital Design Media. Many thanks also go to Associate Director and Head of Collection Martien de Vletter and Digital Archivist Tim Walsh at the Canadian Centre for Architecture in Montreal for generously sharing their experiences learned first-hand from collecting born-digital material from 25 outstanding contemporary international firms, as part of the research project "Archaeology of the Digital". Their contribution to the development of collections of born digital architecture cannot be emphasized enough.

Thanks also to Solveig Dahl Grue, Head of Development at the Association of Consulting Architects in Norway for the interest and support. Last but not but least, my gratitude goes to all the architects who have answered the detailed questions about the digital infrastructure in their firms.

Please address any questions about the survey and the results to me at the following email address: birgitte.sauge@nasjonalmuseet.no

Birgitte Sauge, Dr. Art., Senior curator, The National Museum of Art, Architecture and Design, Oslo.

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[1] Birgitte Sauge: "The New National Opera House by Snøhetta", in *Architecture and Digital Archives. Architecture in the Digital Age: A Question of Memory*, David Peyceré and Florence Wierre, eds., Infolio, 2008.

Content

1. The aim of the survey

This survey is part of the ongoing research project entitled Mediascapes – Architecture Museums and Digital Design Media. The project is part of "MEDIASCAPES – Cultural Heritage Mediascapes: Innovation in Knowledge and Mediation Practices", running 2015–2019, financed by the Norwegian Research Council.

The aim of the project Mediascapes – Architecture Museums and Digital Design Media is to develop new knowledge about how today's architects work in the course of a digital design process and how digital documents (i.e. drawings and models) are communicated and mediated both to clients and to young museum visitors. A central aspect of the project is the shift from analogue to digital, regarding both design tools and architectural representations. Analogue as well as digital material from the architecture sector is a crucial part of our cultural heritage as well as a valuable asset regarding through-life maintenance of built environment. The shift towards born-digital material offers new perspectives regarding both long-term preservation and dissemination. Within the architecture museums and archives sector, there is an expressed need for standards related to acquisitions of digital architecture, to prevent more loss of this important part of contemporary culture. The present survey documents current digital practice in the architecture sector in Norway. We hope that the findings from the survey will contribute to the development of strategies and routines for dealing with born-digital architectural representations both in museums and archives.

Current situation

The report *Preserving Computer-Aided Design (CAD), DPC Technology Watch Report* 13-02 April. Digital Preservation Coalition (Ball, A., 2013)[2] summarizes well the principles and methods related to digital preservation of large and complex CAD, including 3-D modelling. Although the report is four years old, it presents the best overview of software and related digital formats, to this author´s knowledge. It might be worth mentioning that Building Information Models, including the vendor-neutral Industry Foundation Classes (IFC) format,[3] have taken a larger share of the market after the report was written.

The report states that "The current emphasis for CAD development (…) is not so much on geometric modelling as on integrating data and information from across the product (i.e. buildings) lifecycle." … "In architecture and construction, (…) Building Information Modelling (BIM) seeks to integrate into a single authoritative model all the information needed to plan, design construct, maintain and eventually demolish a building."[4]

Another aspect underlined in the report is that one of the attractions of CAD software is its ability to arrange data into layers which can be viewed or hidden as needed. Use of layers is so embedded in the architectural workflow that conventions on what information to include in each one and how to name them are the subject of national and international standards (e.g. United States National CAD Standard 2011; ISO 13567).[5]

The Directorate for Public Building (Statsbygg), the largest public client in Norway, has been a driving force in the digitization of the building sector. They introduced the use of BIM in 2005, and since

[2] http://www.dpconline.org/docs/technology-watch-reports/896-dpctw13-02-pdf/file
[3] https://www.iso.org/standard/51622.html
[4] Ball, p 7
[5] Ball, p 8

2011, BIM has been mandatory for all building projects commissioned by The Directorate for Public Building. The Directorate is also acting internationally, within Building Smart International. In 2016, twelve public clients from ten countries signed an agreement about implementing the use of digital tools non-proprietary and open source formats in the whole life span of a building.[6]

The Architecture department at the National Museum of Art, Architecture and Design has no previous experience in digital acquisitions. A handful of museums have begun collecting born-digital architecture, the most experienced of these probably being The Canadian Centre for Architecture in Montreal. Research-based knowledge of recent digital design methods is growing, but there is a need for still more knowledge. The community of architecture archives and museums has not established common strategies on long-term preservation of born-digital architecture material.

The National Archives has during recent years been challenged regarding the maintenance and preservation of formats that are useful for sectors such as architecture and engineering. The current statutory regulations that govern administration of born-digital files do not specify particular archival formats that are suitable for maintaining complete documentation within these fields, especially 3D formats. Approved archival formats per dd. for long-term preservation of digital architectural records include TIF, JPEG, PDF/A. These are also in use for born-digital data. The 3D modelling programs used by the architects are vector based and accommodate so called parametric modelling, and they use other formats than the approved ones.[7]

Another aspect worth mentioning is that parametric modelling is a powerful technique for making designs easier to adjust. This functionality is lost in approved records / archival formats within the depository. It also entails that information about the final result, the building, is being archived, but not information or data from the design process and the different steps or stages in the building's development. Another issue to be addressed is the possibility to exchange records, either between architects and other practitioners within the building industry, or between museums and archives. It is appropriate to question whether these issues represent a major drawback to future use of the records.

The national regulations for long-term preservation of digital records in Norway have recently been revised, however, and a new set of directives is expected to be effective by the end of 2017. Based on feedback from actual practice, including architects, archival institutions and related public organizations, the IFC format will be included in the set of accepted document formats.

A related task is the ongoing work appointed by the trans-institutional network SAMDOK, a collaboration between Norwegian archival institutions and the Norwegian Ministry of Culture.[8] An appointed working group has delivered their report "Digital long term preservation – Strategy for choosing file formats". As the title says, the aim is not to define specific formats but to give input how to establish a strategy that ensure that digital formats most suitable for long term preservation

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[6] http://www.statsbygg.no/Nytt-fra-Statsbygg/Nyheter/2016/Statsbygg-signerte-internasjonal-avtale-om-digitalisering/

[7] «Parametric modelling implies that certain aspects of the design are made to depend on one or more variables, and a set of constraints is added so the system knows how to accommodate any changes to choose variables». Ball, p 6

[8] https://samdok.com/

are being used in the public sector.[9] The work of the group has also benefited from input and recommendations from related institutions such as the US National Archives.[10]

2. The collected data and methodological questions

The recipients and the respondents

The total number of practising architects in Norway is about 4 000 working in both private and public sector (members of The Norwegian Association of Architects). The survey was distributed to 443 architectural firms, all members of the Association of Consulting Architects in Norway. The size of these architectural firms varies. The small-size firms employ fewer than 20 architects; some firms have between 20–50 architects and some employ more than 50 architects.

Of these, 134 firms responded to the survey, i.e. about 30 % of the total number of the invited firms. Among the respondents are both small and large firms, firms with only architects employed and firms including landscape architects, planners and heritage consultants etc. Five of the respondents represented an architecture department within a larger firm.

Methodological issues regarding the questionnaire and the answers

The questions in the survey are formulated on the model of the US based survey Digital Design Record from 2016, but adjusted to Norwegian conditions. The focus of the Norwegian survey is slightly different from the American, i.e. the Norwegian survey focused on private architectural firms, whereas the US / international survey mainly focused on institutional archives and architecture depositories, either in universities or large architectural firms. We also included some questions about communication and dissemination in the Norwegian survey.

The survey is conducted as a digital questionnaire, in the standard software service "surveyXact". Most of the questions are formulated as multiple choices with predefined options. The participants were encouraged to write additional information. Many of the questions have a second follow-up question, building on the first. To some of the questions, "Not relevant", was an option. The option was not frequently used.

Unfortunately, although the survey was thoroughly tested, we are aware that some functionalities did not work as planned. This may have created some limitations in terms of the comparison of data from different questions.

Another weakness of the data is that 42 of the total 134 respondents did not answer all questions, due to lack of time, missing information etc. I.e. 92 firms posted complete answers. The numbers of answers vary from 92 to 124 at the most, and the number of respondents for each question is therefore mentioned in connection with presentation of the major data findings. Analyses based on

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[9] Erik Aaberg and Birgitte Sauge, two of the authors of this survey, has been members of this group. https://samdokdotcom.files.wordpress.com/2017/04/eforv-2017_2-digital-langtidsbevaring-strategi-for-valg-av-filformater-for-bevaring-oppgavebeskrivelse-endelig-02-12-2016-kf.pdf The final report is yet to be published.

[10] https://www.archives.gov/records-mgmt/policy/transfer-guidance-tables.html

the average number of answers, 92 respondents from 443 architectural firms, makes a total percentage of about 20 % answers.

The questionnaire also asked for comments on the survey itself. The comments varied from very critical to very positive feedback. Some of the critical comments touched upon the fact that small (one-person) firms, as opposed to large firms, face very different challenges regarding digitization. Some respondents mentioned that they did not understand the questions at all, and others commented that in-depth questions were lacking. One interesting feedback item is that the relation between different media, i.e. analogue (both hand sketch and model) and digital, within the design process is scarcely touched upon. There is also a call for more focus on challenges linked to the cooperation between different experts such as engineers and landscape architects.

Another interesting point is the call for better solutions for long-term preservation: "There is a need for stable, acknowledged standards, so-called open source formats. Architecture, like https [files], must be preserved in a long- term perspective. IFC is a beginning, but the national authorities must develop standards for everyone to follow. One also needs to develop simple solutions for conversions when new technology appears", one respondent writes.

Regarding preservation, one respondent claimed that it is no longer important to keep an archive (beyond the mandatory number of years), because the architect´s archive today is not considered an economic asset, as it once was. Hence it is not important to focus on long-term digital solutions.
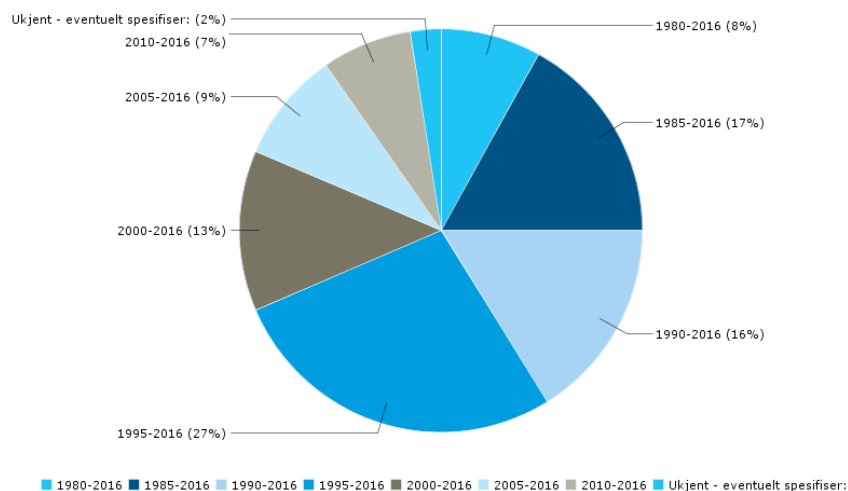
In spite of these few pessimistic comments, we find that the amount of positive and complete answers indicate important trends that hopefully will help us further.

3. Presentation of the major data findings

Part 1: General background

No 4: What is the creation timeframe of the born digital records?

Når ble det digitale materialet dere forvalter skapt?
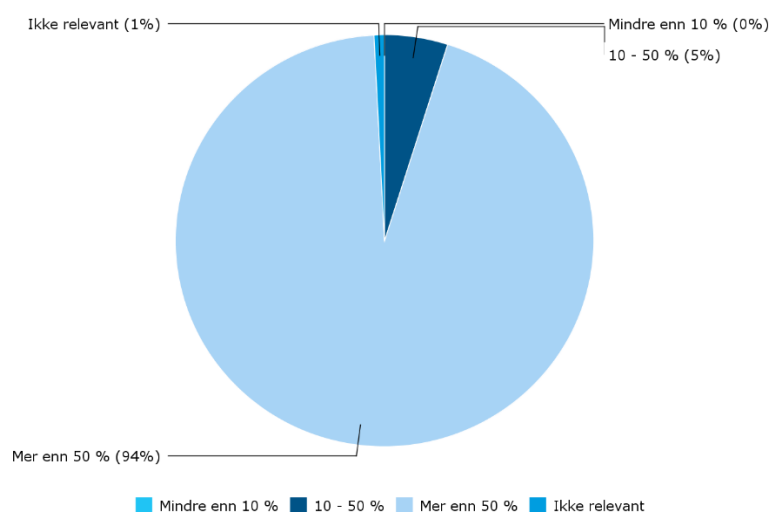

(124 answers)

81 % of the respondents claim to have 15 years or more experience with born-digital data.

8 % of the respondents claim to have data that goes back to 1980 (i.e. 35 years old).

22 % of the respondents have data less than 16 years old.

7 % of the respondents have data less than 5 years old.

No 5: What percentage of production is born-digital?

(123 answers)

94 % answered that more than 50 % of their current production is born-digital.

5 % answered that between 10 – 50 % of their current production is born-digital.

## No 6: What is the size of the digital file holdings?

81 % have digital file holdings larger than 15 GB

9 % have digital file holdings between 5 – 15 GB

The size of the data also depends on the type of data (text / vector graphics / point graphics). 15 GB is perhaps a large size to administrate for a single firm, but it is not considered big in an archival context.

The question was not followed by a question about the planned growth of the size of the digital file holdings.

No 10: In what medium was the digital material born? (Multiple Choice)
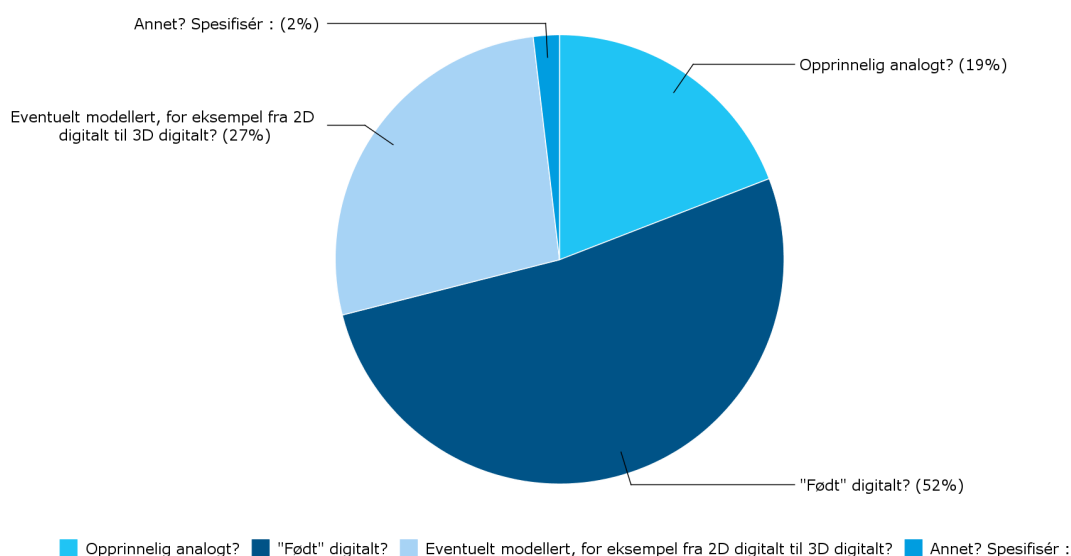
(119 answers)

52 % of the media was born-digital

27 % of the media was modeled from digital 2D to digital 3D

19 % of the media was born-analogue

2 % of the media was characterized as other.

Some respondents explained that they work with in many types of files and formats, with in the design process with in the same project.

No 22: What guidelines do you follow when you decide upon type of CAD technology?
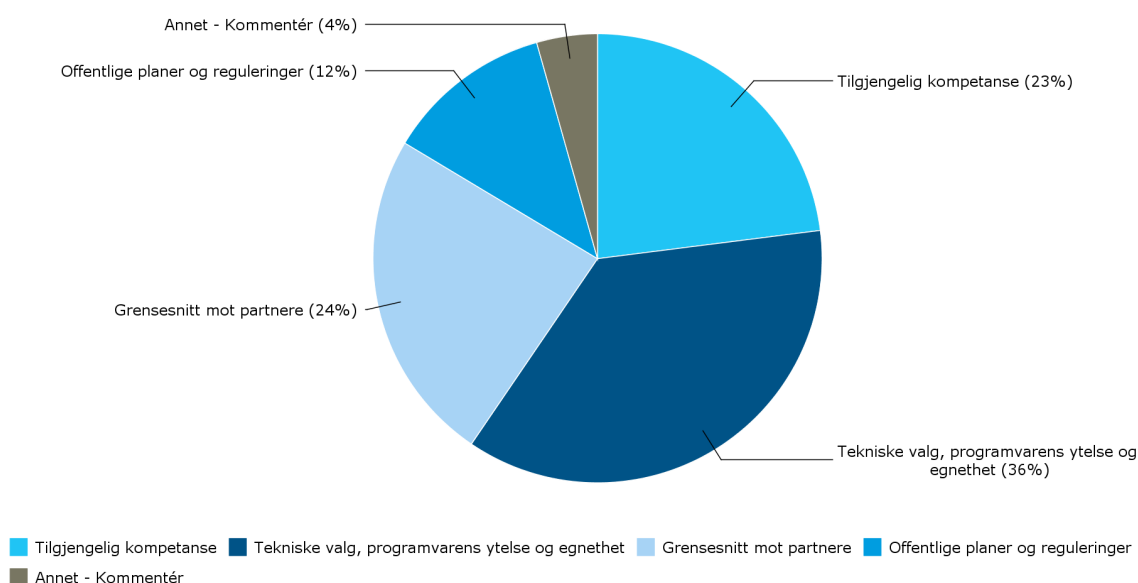
(115 answers)

36 % answered technology and the performance and suitability of the software
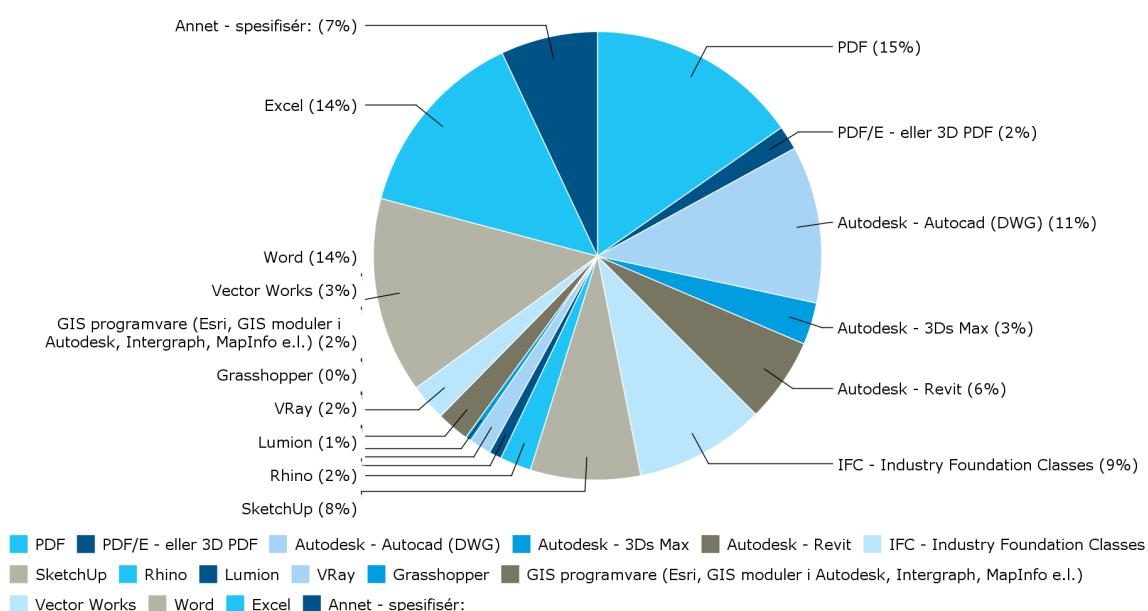
24 % answered cooperating partners

23 % answered competence and skills

12 % answered public regulations

Additional information: Depends on client and type of project, costs and which software is available.

Part 2: Work flow, design methods and CAD formats

No 12: Which digital file formats are in use (Multiple Choice)

(119 answers)

20 % Autodesk, various

9 % IFC

18 % various modelling formats

Additional information of file formats in use, not specified in the multiple choice question:

ArchiCad and DWG formats); Photoshop; Illustrator; InDesign; CorelSuite; DGN, BricsCAD; Octane Render, Adobe CC, Libreoffice, DDS; G-prog; Solibri viewer; Microstation (dgn); Pages; PLN.

It is noteworthy that many respondents answered ArchiCad format(s), but since this was not included in the multiple choice, there are no statistics of the actual use.

No 13: Which software are used for processing digital data (Multiple Choice)
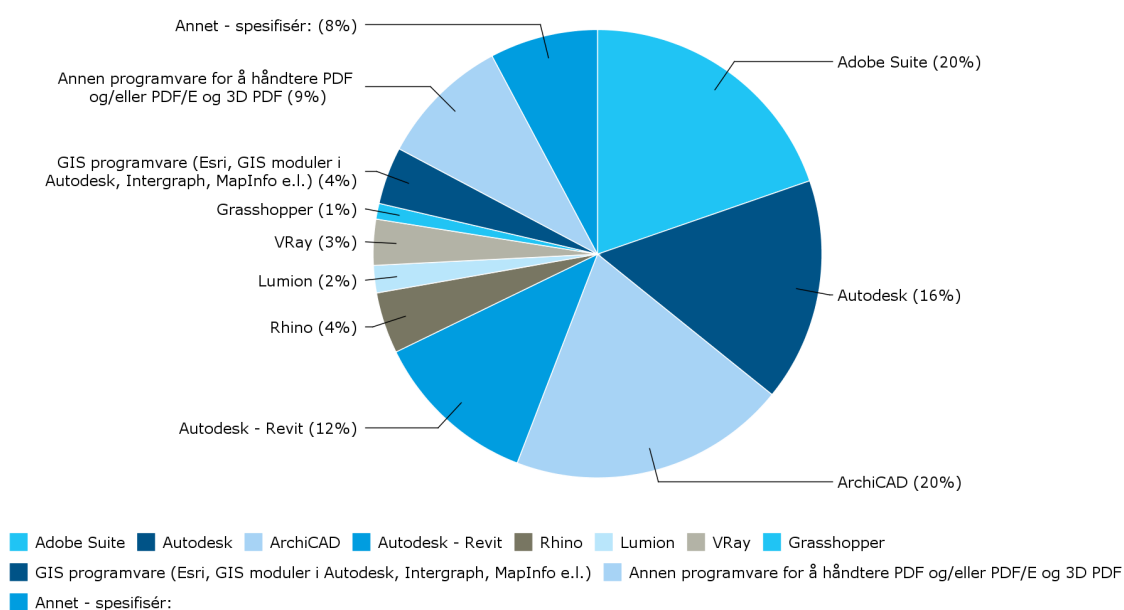
(119 answers)

20% ArchiCad

20% Adobe Suite

16 % Autodesk

12 % Autodesk Revit

The answers reveal that three different CAD software (suites) dominate 3D-modeling and with Autodesk as the most frequently used. In addition, software with other qualities are used for other, specific design purposes.

No 14: Do you print paper copies of drawings in digital formats?

(119 answers)

62 % answer sometimes

35 % answer yes

4 % answer no

The large amount of paper copies made might be of interest for museums and archives.

No 11: Do you work within a BIM-framework?
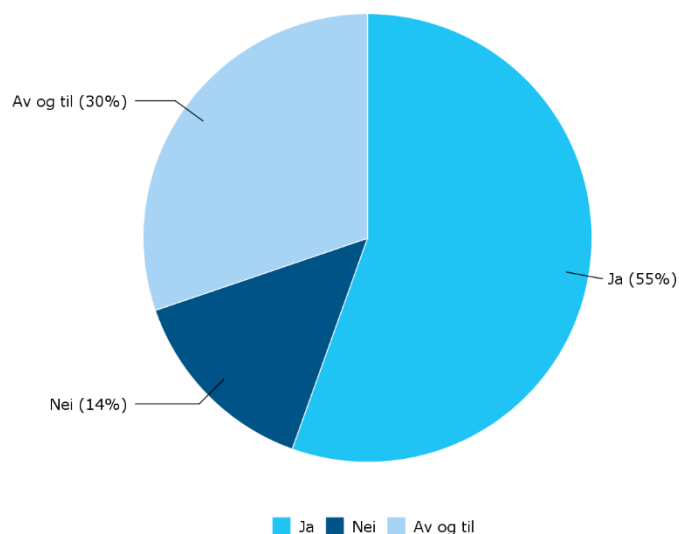
(119 answers)

55 % answered that they work with in BIM framework
14 % answered that they never use BIM
30 % answered that they sometimes use BIM

85% of the respondents work with in BIM framework when it is appropriate for the task and for the end result.

No 7: How is digital data transferred physically to/from the firm? (Multiple choice)

(123 answers)

47 % answered that data is attached to an email

45 % answered that they use Internet file transfer, (e.g. ftp)

7 % answered other solutions (Dropbox, web hotel, sky, server, Google Drive, LAN-network etc.)

No 16: Which formats are used for exchange of data with external partners? (Multiple choice)

Pie chart data:
- PDF (33%)
- PDF/E - eller 3D PDF (2%)
- Autodesk - Autocad (DWG) (25%)
- Autodesk - 3Ds Max (2%)
- Autodesk - Revit (9%)
- IFC - Industry Foundation Classes (19%)
- STEP (0%)
- STL (0%)
- IGES (0%)
- Annet - spesifisér: (7%)
- Ikke relevant (2%)

Legend: PDF | PDF/E - eller 3D PDF | Autodesk - Autocad (DWG) | Autodesk - 3Ds Max | Autodesk - Revit | IFC - Industry Foundation Classes | STEP | STL | IGES | Annet - spesifisér: | Ikke relevant
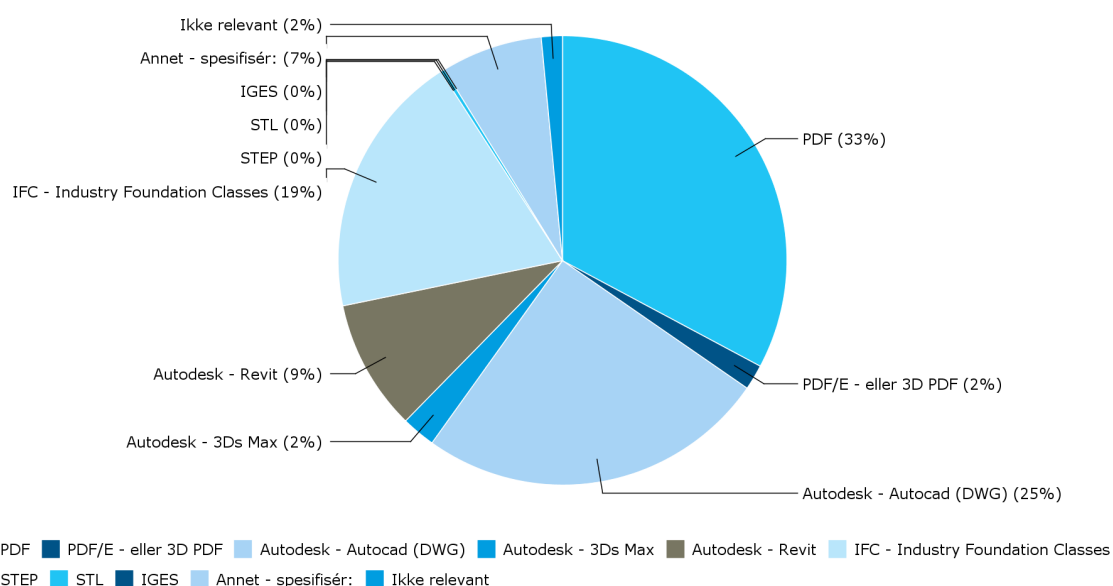
(119 answers)

36 % Various Autodesk formats

35 % PDF or PDF/E or 3D PDF (Standard archival format)

19 % IFC (The Open Source format IFC

7 % Others

Interestingly, the open format IGES is not in use among the respondents.

Part 3: Short and long-term preservation of data: Preservation strategies

No 8: Long-term preservation strategy 1: On what medium are digital files stored?
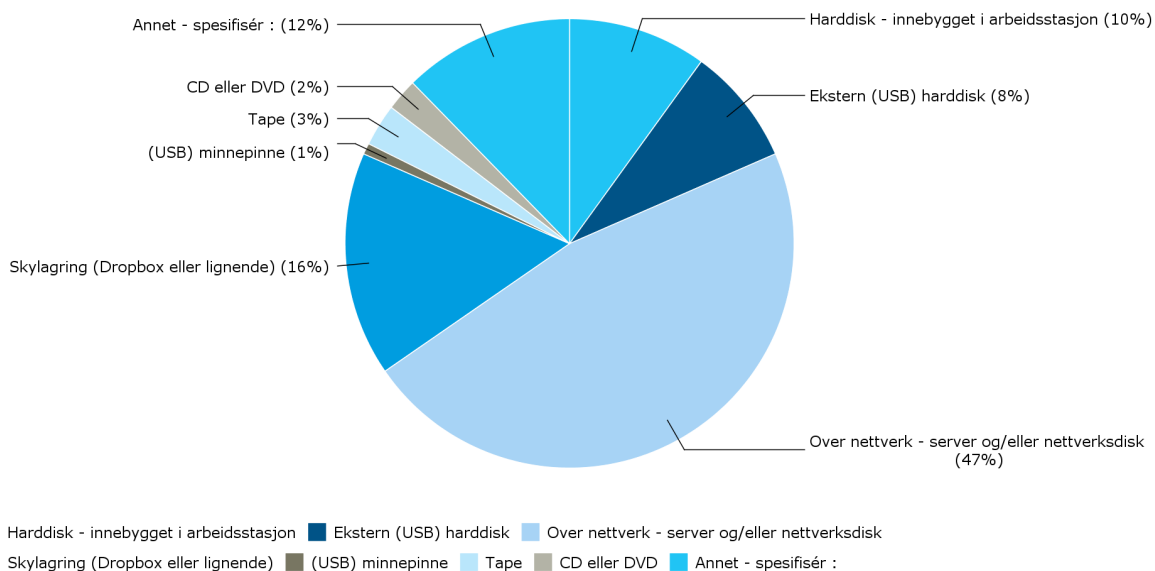
(123 answers)

47 % Network: server or disk

16 % The sky (Dropbox etc)

10 % Internal harddisk

9 % External harddisk

12 % Other

OBS: Multiple choice functionality did not work as planned. Several respondents used the "others" category to note this.

One respondent commented: "Due to the everyday working process project files are preserved in old software in order to ease the access without extra work. In a long term perspective files are converted to new software in order to ease future work flow".

No 17: Long-term preservation strategy 2: What file formats does your firm use for long-term data preservation? (Multiple choice)
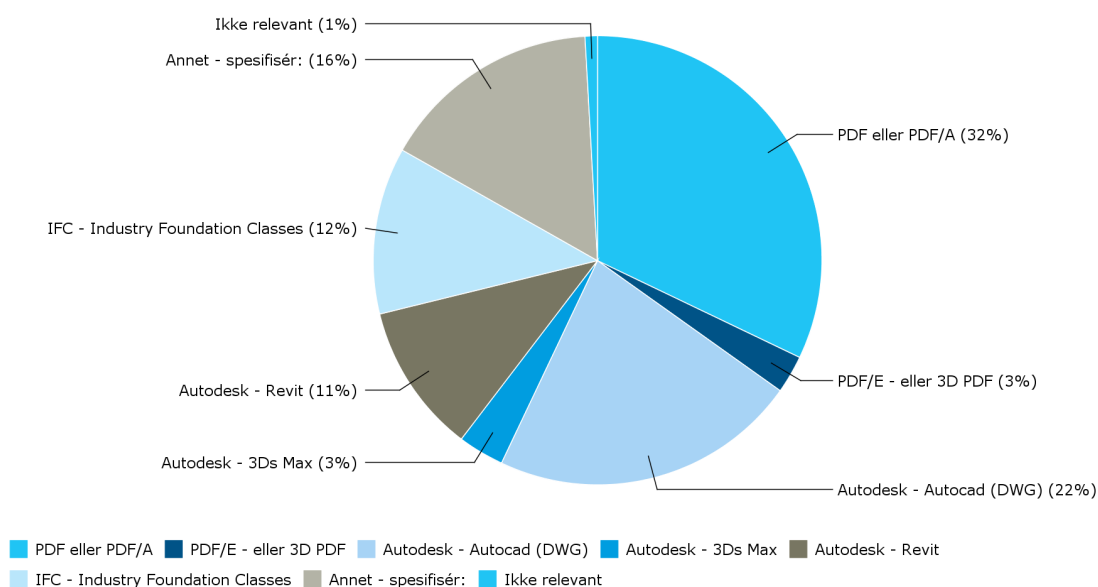

(119 answers)

36 % answered different Autodesk file formats (i.e. vendor specific formats for 3D models)

32 % answered PDF; PDF/A (e.g. classified as archival long term file formats)

12 % IFC (i.e. Vendor neutral formats for 3D models)

16 % Others (e.g. ArchiCad – PLN/PLA, Vector Works, Word, Excel, Microstation, Sketchup)

ArchiCad is apparently much in use, and should have been part of the multiple choice.

No 9: Do you have access to all old digital material?

(123 answers)

87 % answered yes.

Is this credible, regarding the age and file formats of some of the data? Needs to be followed up.

No 25: In your opinion, which formats are most suitable for long-term preservation?
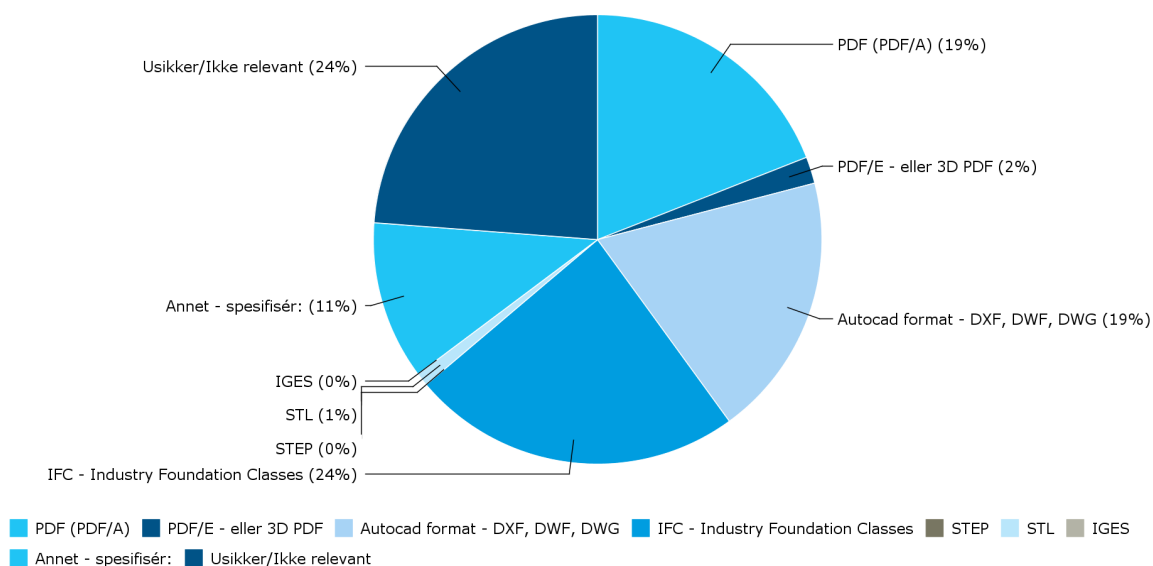
(98 answers)

24 % answered IFC

19 % answered Autocad formats

19 % answered PDF (PDF/A)

24 % answered uncertain / not relevant

11 % answered Other

Some of the respondents would have preferred additional options and multiple choice. Others answered that the solutions are dependent on maintenance and upgrades, and that these file formats can be read in the future.

Part 4: Communication and dissemination of digital architecture

No 23: What channels are suitable for dissemination of your born-digital material?
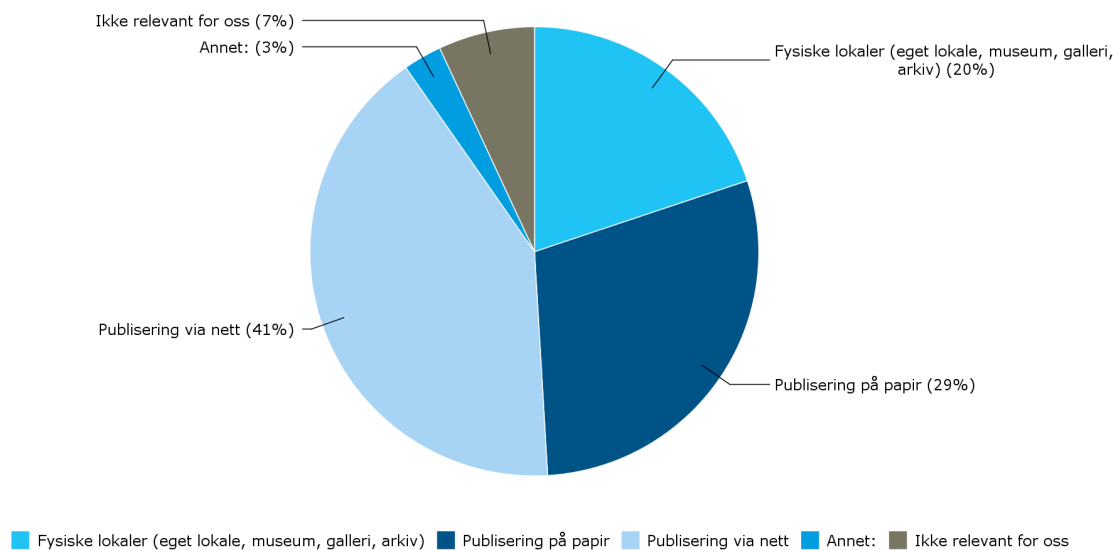
(107 answers)

41 % internet publication

29 % paper publication

20 % Physical premises (museum, gallery, archive etc.)

Traditional mediation channels are still considered valuable and efficient for half of the respondents.

No 26: What is the best way of disseminating the preserved material in the future?

Andre tanker: (12%)

Bevare gammel programvare, for å kunne vise gamle formater (26%)

Konvertere gamle formater til nye for å visualisere i ny programvare (62%)

■ Bevare gammel programvare, for å kunne vise gamle formater ■ Konvertere gamle formater til nye for å visualisere i ny programvare ■ Andre tanker:
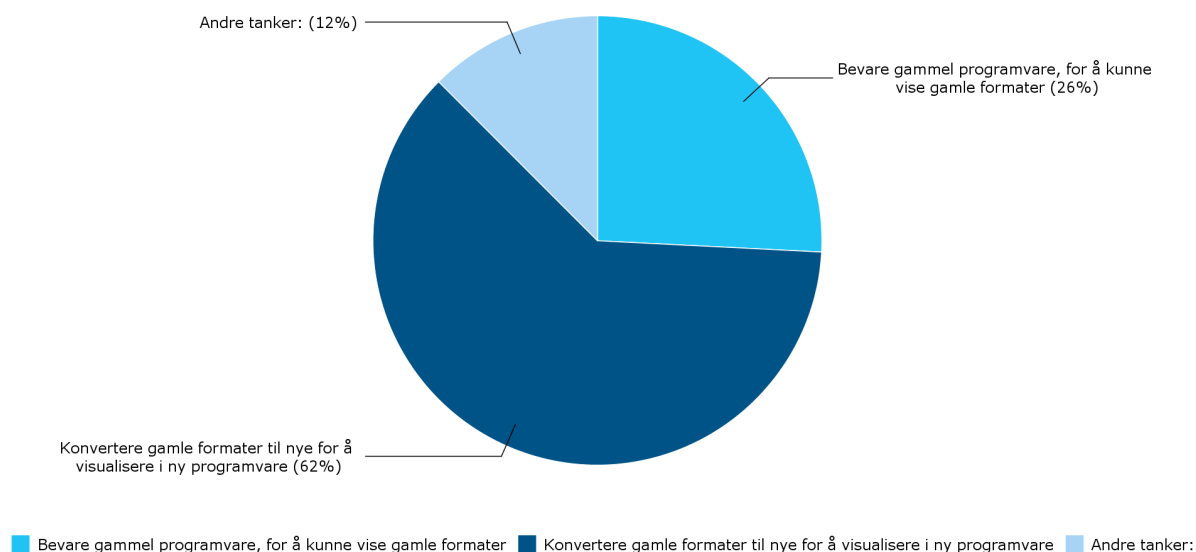
(97 answers)

62 % Convert old file formats for visualization in new software

26 % Preserve old software in order to communicate old formats

12 % expressed other thoughts or suggestions, i.e. frustrations about dependence on vendors and the development of the technology and the lack of open source and common archive formats.

No 24: Which media is best for presenting your work? (Multiple Choice)

(97 answers)

80 % 3D models

46 % Videos and animations

18 % Interactive digital installations

23 % Others (photos, drawings, panels, physical models, presentation drawings)

4. Analysis and comparisons

The survey was posted to the approximately 400 architecture firms based in Norway. Of these, 134 responded. Some of the firms have data digital depositories dating from the 1980s. The majority of the firms in the survey have data going back 15–20 years. The questions covered four themes: General background of the firm and the digital status; the design process and work flow; holdings and preservation strategies and communication and dissemination of digital architecture. Finally we asked for thoughts about file formats for preservation in the future and the best way to communicate born-digital architecture in the future.

The survey confirms that the digitization of the Norwegian architects' sector is comprehensive and started a long time ago. Eighty-one per cent of the respondents claim to have 15 years or more experience with born-digital data. Ninety-four per cent answered that more than 50% of their production is born-digital and that more than 50% of their holdings are born-digital. Regarding the design-and work flow, a variety of different file formats and software are in use. Yet, more than 60% of the respondents sometimes print paper copies. Eighty-five per cent answered that they work within a BIM framework. Formats used for exchange of data with external partners varies greatly: Autodesk formats (36%), standard archival formats such as PDF, PDF/E or 3D PDF (35%), and the open source format IFC (19%), and finally 7% others like ArchiCad and BIMx. When it comes to preservation strategies, the picture given is similarly heterogeneous. Regarding which medium digital files are stored, nearly 50% answered network-based server, 16% cloud-based platforms such as Dropbox and 10% computer hard disc. The main file formats in use are PDF or PDF/A (32%), Autodesk's DWG (22%), Autodesk Revit / 3Ds Max (14%), IFC (12%) and ArchiCad.

Regarding strategies concerning communication and dissemination, the answers reflect that internet, traditional publications and museum galleries are all considered appropriate arenas. The respondents answered that all of 3D models, videos and animations, interactive digital installations might be interesting means of communicating digital architecture.

How digital are the architecture firms?

A correlation analysis was executed based on the question "What is the age of the preserved files?" in order to shed light on how digital Norwegian architecture firms today are. Among the seven given alternatives, the firms with digital holdings dating back to 1995 turned out to be the most comprehensive. These firms constitute the majority of the firms where more than 50% of the production is born-digital and the majority of holdings with the size of more than 15 GB. These firms also confirm that they work within the BIM framework to a larger extent than the rest of the

respondents. Despite of this, these firms are also the ones that most often print paper copies and have the largest amount of originally analogue material in their holdings.

Regarding software used for processing digital material, there is a strong tendency to use Adobe Suite, Autodesk and ArchiCad within this group. The use of Autodesk Revit is also noteworthy, but many types of software are in use e.g. Rhino, Lumion, VRay, Grasshopper, Solibri, Sketchup and Graphisoft. The main file formats in use for processing digital material are PDF, DWG, IFC and PLN/PLA.

Regarding file formats used for long-term data preservation, PDF or PDF/A dominate, before DWG, IFC, PLA/PLN and Autodesk Revit. The data is stored on network servers or network discs, and the firms claim they have access to the data.

Digital Design Record, Survey 2016

The survey Digital Design Records was conducted in 2016 by the CAD/BIM taskforce.[11] The survey was distributed to depositories with large architecture holdings such as institutions and schools (55 %), architectural firms (28 %) and government entities (3 %). The administrator of the survey has not extracted and analysed the responses from the architectural firms. Hence, the presentation below are based on all answers.

Some relevant major findings:

Education: There is an even split between those who have had workshops and those who have not. There is a high number of people who do not feel equipped to address born-digital design files and low levels of confidence in managing born-digital files.

Preservation: A significant number of repositories maintain born-digital design records that predate 2000. The main corpus dates from period 1995 until today.

Adobe & Autodesk are the dominant file types and software in the respondent´s holdings. Still there is a remarkable variety of file formats being accessioned by collecting institutions.

Challenges for the future include navigating proprietary file types, recovering data from increasingly obsolete removable media, and obtaining legacy/emulation software platforms for cultural heritage institutions. A very high number rate of institutions are employing bit-level preservation (distributed

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[11] A Pecha Kucha presentation was made at the conference ICAM 19, Copenhagen, 13th Sept. 2018.

storage, disk imaging, backups, and fixity checks) + print PDF of design files. A very small number have created preservation friendly derivatives of 3D models and emulation.

To the question "What preservation strategies would you like to implement in the next few years?" the majority answered to improve bit-level preservation; and then migration to vendor-neutral and/or standard formats / software preservation/emulation.

To the question "How are we supporting researchers?" the vast majority answered that files are provided directly to researcher on request. The next answer was reading room access / remote access. Some answered that digital files are not accessible to researchers, and even less that files can be accessed by open web.

Comparative findings:

The data from the two surveys in many respects supplement each other. All though one difference in the context is that Norwegian architecture firms do not yet have digital archivists as members of their staff. An interesting question to be looked into is therefore whether there are crucial differences in perspectives between archivists and architects.

The creation timeframe of the born-digital design records follow more or less the same pattern as the Norwegian data.

The same file formats appear in the holdings in the American survey, except for the PDF / PDFA format that appears in the Norwegian survey.

Regarding the currently used preservation strategies, the most frequently used is bit-level preservation (63 %) (Distributed storage, disk imaging, backups, fixity checks) and print PDF of design files (52 %). Also migrating to lightweight access formats (e.g. PDF/E, DXF and DWF) is used (36 %).

5. Concluding remarks

In spite of methodological reservations and weaknesses in the collected data, the Norwegian survey has given valuable information about the current practice among Norwegian architecture firms. The survey has confirmed the impression that the digitization process in Norwegian architectural firms began rather early, that software for 3D models are dominant, and that a variety of software and file formats are in use, both in the actual design process and as part of preservation. It is interesting to notice that the questions about dissemination and future preservation has the smallest number of answers.

How should museums and archives relate to this? "Archives should first establish why they are preserving CAD models, and then which aspects of the CAD models should be targeted for preservation in order to accomplish that aim," is Alexander Ball's advice. "If the preserved CAD models only will be held for visualization, the preservation effort should be concentrated on lightweight, standard formats rather than the native format. If the preserved CAD models might be used to reconstruct how a particular product was designed, and software licenses allow, the archive should perhaps invest in a secure emulated platform for accessing the native model," he continues. The report also recommends to include specification documents, process reports, file and layer naming conventions, drawing conventions and catalogues.[12]

Ball, speaking from the depository perspective, also stresses the complexity of the situation: "The success of CAD means that a great deal of vital, valuable and irreplaceable information (such as architecture designs), is stored as CAD models. It also means that CAD is an area of constant innovation and intense competition between vendors, resulting in CAD systems that are ephemeral and largely incompatible with each other. It is the disconnection between these two – the value of the models and the ephemeral nature of systems – that makes CAD preservation at once important and challenging."[13]

He continues: "It is vitally important then, that effective methods for preserving CAD models are developed and used, but there are many obstacles. The nature of the CAD marketplace, with its many incompatible and short-lived systems, is not conductive to the long-term usability of CAD models. When one considers the range of non-CAD systems that use CAD-models, the problem multiplies. Certain characteristics of CAD formats, such as their ability to span many files and dynamically link to data sources, make them hard to transfer between systems, and the commercial sensitivity of industrial CAD data introduces some non-technical challenges."[14]

In the Norwegian survey some architects expressed their frustration about the situation. One of the respondents summarizes the situation facing both architect firms and repositories: "With various software platforms and the early upgrades it is hard to keep up with the different version and ensure that older files will still be able to be accessed with newer versions. To keep a copy of a software version is getting out of control and takes up space as well with new versions coming out every year. Also, there is a concern about using cloud storage and its security as a back-up catalogue that is not on site in the event of a major incident (fire, earthquake, etc.)."
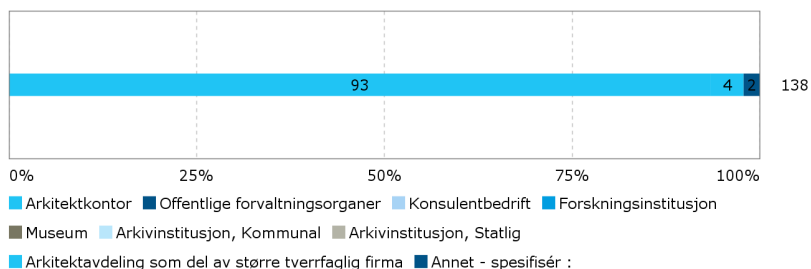
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[12] Ball, p 29-30
[13] Ball, p 2
[14] Ball, p 9

All though the *Preserving Computer-Aided Design (CAD), DPC Technology Watch Report* dates back to 2013, the situation by and large is the same. In Norway there have been some developments the last couple of years that may point in a positive direction regarding the issue of long-term preservation of CAD models. First of all, the intension of BIM in IFC formats requirement in connection with design for public clients. Next, there is the expected new set of directives for long-term preservation of digital records which will include IFC format in the set of accepted document formats. These directives might also be useful to consider for architecture collections in museums.

Legal issues (e.g. copyright) is another subject to be looked into, for example in connection with publication or making material accessible in the study room. Yet another issue is the researcher´s possibilities to study the development of the design process, when reiterative processes have been superseded by the very nature of the digital software and the file formats for preservation.

Digitization affect the understanding of and research on visions, design processes and realized buildings, i.e. our understanding of contemporary architecture. In the case of the Norwegian context, it is of utmost importance that cooperation between the National Archive and The National Museum take place. We might have different agendas and collection strategies but the goal to preserve CAD models that will still be readable and reusable long time into the future we have in common.

6. Appendix: The total set of collected data

1. Litt om dere
Type organisasjon

93	4 2	138

0% 25% 50% 75% 100%

- Arkitektkontor ■ Offentlige forvaltningsorganer ■ Konsulentbedrift ■ Forskningsinstitusjon
- Museum ■ Arkivinstitusjon, Kommunal ■ Arkivinstitusjon, Statlig
- Arkitektavdeling som del av større tverrfaglig firma ■ Annet - spesifisér :

Om svarpersonens faglige bakgrunn:

| 78 | 4 | 18 | 137

0% 25% 50% 75% 100%

- Arkitekt ■ Ingeniør/Siv.Ingeniør ■ Kurator ■ Arkivar ■ Annet - spesifiser
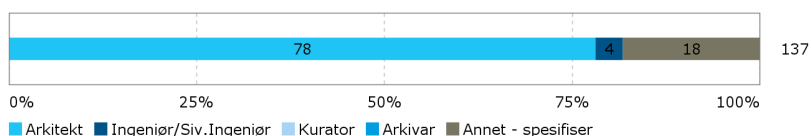
Organisasjonens erfaring med digitale formater eller strukturer

4 7 | 88 | 136

0% 25% 50% 75% 100%

- Mindre enn ett år ■ 2-5 år ■ 5-10 år ■ Mer enn 10 år

Når ble det digitale materialet dere forvalter skapt?

8 | 17 | 16 | 27 | 13 | 9 | 7 2 | 124

0% 25% 50% 75% 100%

- 1980-2016 ■ 1985-2016 ■ 1990-2016 ■ 1995-2016 ■ 2000-2016 ■ 2005-2016
- 2010-2016 ■ Ukjent - eventuelt spesifiser:
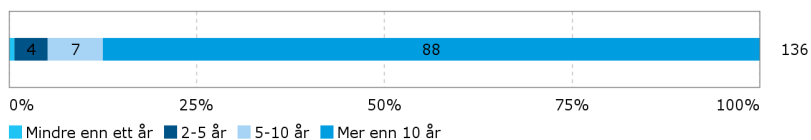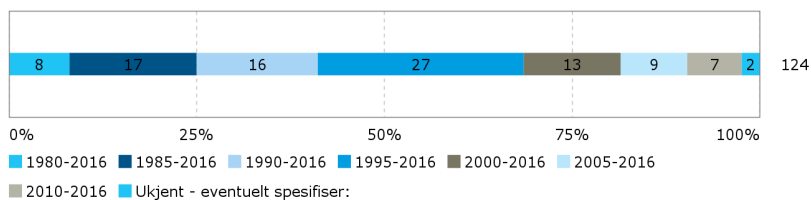
Hvor stort prosent av produksjonen er digital?

5 | 94 | 123

0% 25% 50% 75% 100%

- Mindre enn 10 % ■ 10 - 50 % ■ Mer enn 50 % ■ Ikke relevant
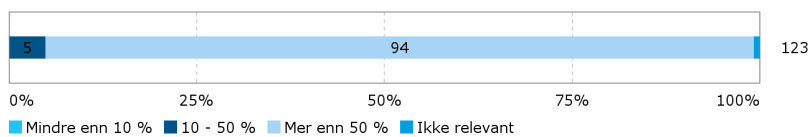
Hvor stort datavolum utgjør det digitale materialet?

6 9 | 81 | 3 | 123

0% 25% 50% 75% 100%

- Mindre enn 1 GB ■ 1 - 5 GB ■ 5 - 15 GB ■ Mer enn 15 GB ■ Ikke relevant
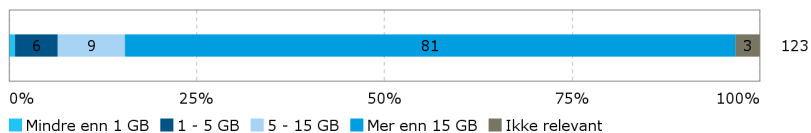
Hvordan overføres digitale data fysisk til/fra dere?

12	31	80	83	13	123

0% 25% 50% 75% 100%

■ USB harddisk ■ Minnepinne ■ Over nett via filoverføring/ftp eller lignende ■ Som epost vedlegg
■ Annet - spesifisér : ■ Ikke relevant
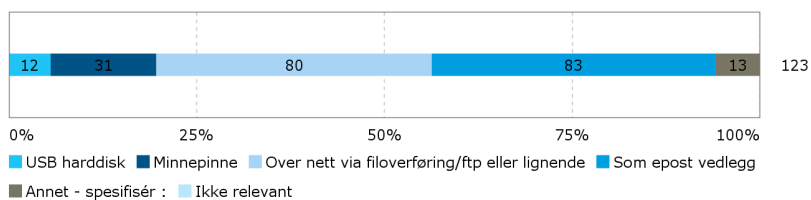
På hva slags medium oppbevares digitale data hos dere (flere kan angis)?

11	9	50	17	3	2	13	123

0% 25% 50% 75% 100%

■ Harddisk - innebygget i arbeidsstasjon ■ Ekstern (USB) harddisk
■ Over nettverk - server og/eller nettverksdisk ■ Skylagring (Dropbox eller lignende)
■ (USB) minnepinne ■ Tape ■ CD eller DVD ■ Annet - spesifisér :
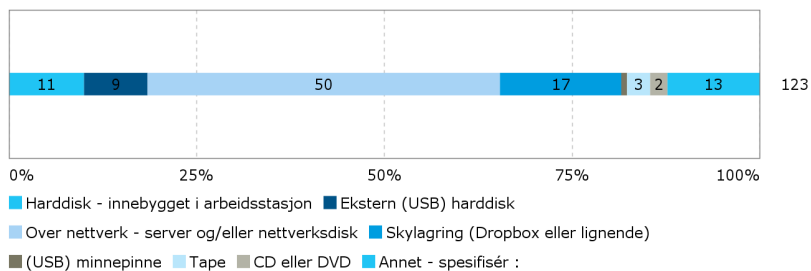
Har dere tilgang til alle gamle digitale data?

87	4	9	123

0% 25% 50% 75% 100%

■ Ja ■ Nei ■ Hvis nei: Kan dere angi årsak?
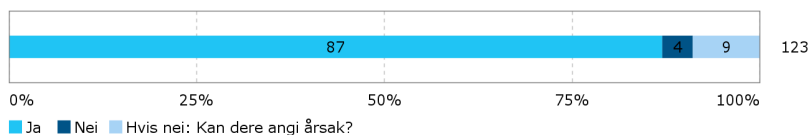
Det digitale materialet dere arbeider med - er det (flere kan velges):

34	93	49	3	119

0% 25% 50% 75% 100%

■ Opprinnelig analogt? ■ "Født" digitalt?
■ Eventuelt modellert, for eksempel fra 2D digitalt til 3D digitalt? ■ Annet? Spesifisér :
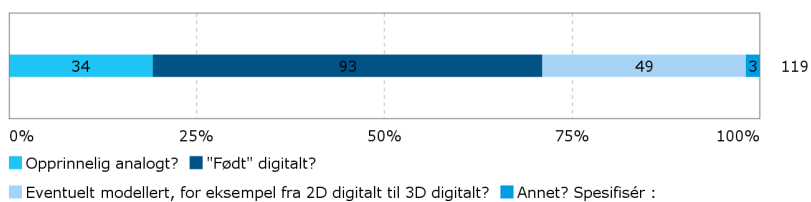
Arbeider dere innenfor et "BIM" rammeverk ?

55	14	30	119

0% 25% 50% 75% 100%

■ Ja ■ Nei ■ Av og til
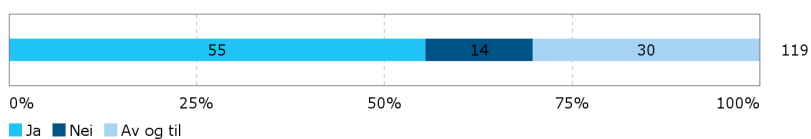
Hvilke digitale filformater er i bruk hos dere internt (flere kan velges)?

97	72	19	39	60	50		17	90	88	45	119

0% 25% 50% 75% 100%

■ PDF ■ PDF/E - eller 3D PDF ■ Autodesk - Autocad (DWG) ■ Autodesk - 3Ds Max
■ Autodesk - Revit ■ IFC - Industry Foundation Classes ■ SketchUp ■ Rhino ■ Lumion ■ VRay
■ Grasshopper ■ GIS programvare (Esri, GIS moduler i Autodesk, Intergraph, MapInfo e.l.)
■ Vector Works ■ Word ■ Excel ■ Annet - spesifisér:
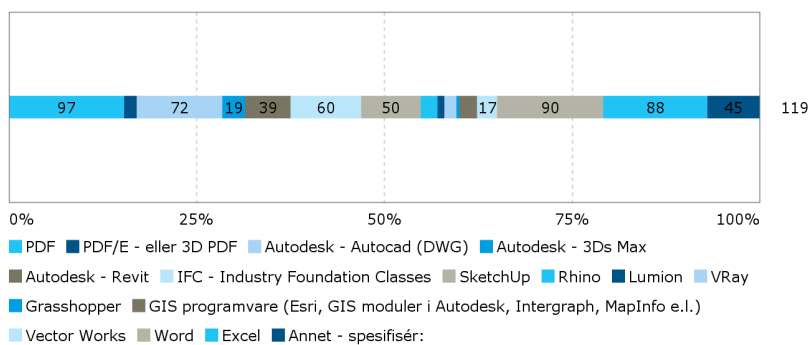
Hvilken programvare brukes av dere for bearbeiding av digitalt materiale (flere kan velges)?

60 | 49 | 61 | 36 | 13 | 6 | 10 | 13 | 29 | 24 | 119

0% 25% 50% 75% 100%

- Adobe Suite
- Autodesk
- ArchiCAD
- Autodesk - Revit
- Rhino
- Lumion
- VRay
- Grasshopper
- GIS programvare (Esri, GIS moduler i Autodesk, Intergraph, MapInfo e.l.)
- Annen programvare for å håndtere PDF og/eller PDF/E og 3D PDF
- Annet - spesifisér:
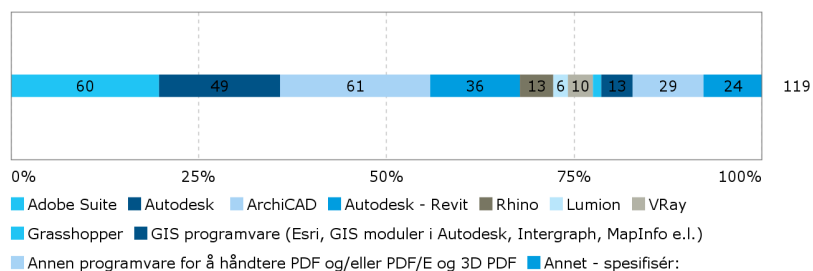
For digitale formater - tas det også analoge (papir) kopier av tegninger og lignende?

34 | 4 | 62 | 119

0% 25% 50% 75% 100%

- Ja
- Nei
- Av og til

Hvis ja, angi formål

80 | 69 | 41 | 10 | 116

0% 25% 50% 75% 100%

- Intern bruk
- Ekstern bruk
- Lagring/arkiv
- Annet, spesifiser:
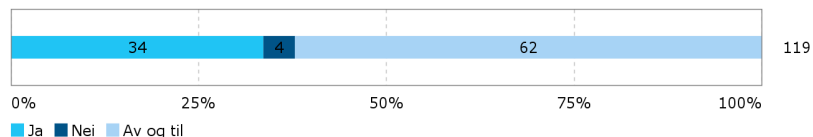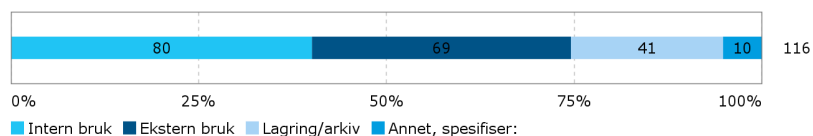
Hvilke filformater brukes eventuelt til utveksling av data mellom partnere?

91 | 5 | 70 | 7 | 26 | 53 | 20 | 4 | 119

0% 25% 50% 75% 100%

- PDF
- PDF/E - eller 3D PDF
- Autodesk - Autocad (DWG)
- Autodesk - 3Ds Max
- Autodesk - Revit
- IFC - Industry Foundation Classes
- STEP
- STL
- IGES
- Annet - spesifisér:
- Ikke relevant
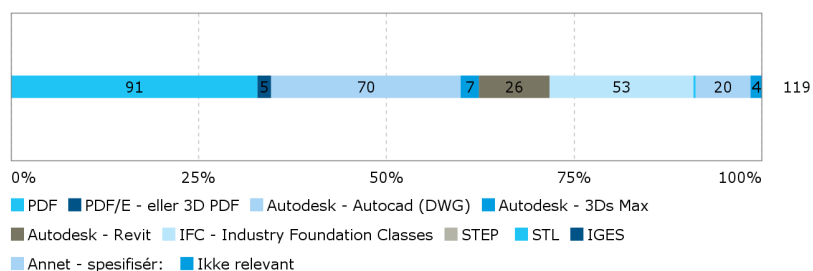
Hvilke filformater brukes til langtidsbevaring (over 5 år) av data hos dere?

90 | 8 | 62 | 9 | 30 | 34 | 45 | 119

0% 25% 50% 75% 100%

- PDF eller PDF/A
- PDF/E - eller 3D PDF
- Autodesk - Autocad (DWG)
- Autodesk - 3Ds Max
- Autodesk - Revit
- IFC - Industry Foundation Classes
- Annet - spesifisér:
- Ikke relevant
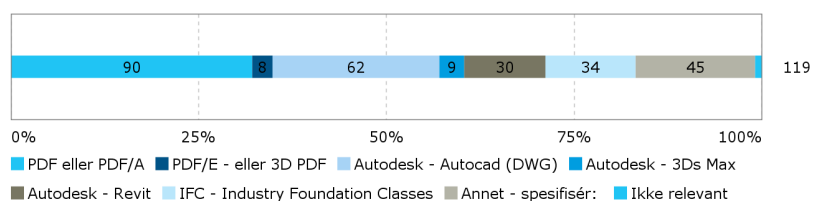
Hvilke typer partnere samarbeider dere med og/eller utveksler data med?

78 | 84 | 94 | 32 | 117

0% 25% 50% 75% 100%

- Underleverandører - arkitekter
- Statlige eller kommunale organer, reguleringsinstanser etc.
- Entreprenører
- Andre:
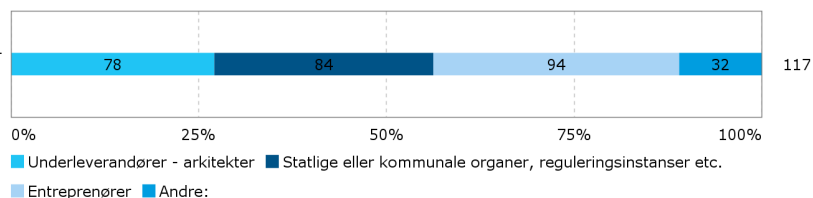
Hvilke rettigheter gjelder for eget produsert digitalt materiale?

7 | 18 | 62 | 8 | 7 | 2 — 117

- Åpent tilgjengelig for alle - eksternt og internt hos mottager
- Åpent tilgjengelig internt hos mottager
- Tilgjengelig for mottaker for spesifikt prosjekt
- Tilgjengelig for utvalgte personer internt hos mottager
- Annet - spesifisér:
- Ikke relevant
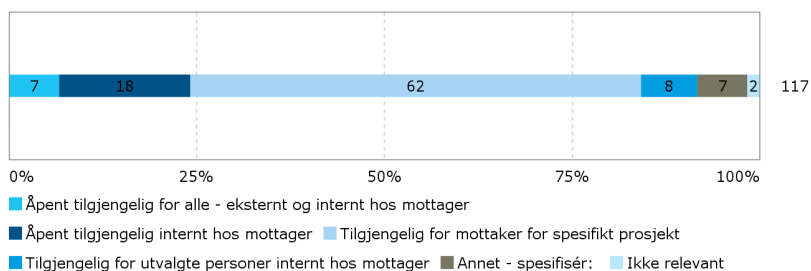
Hva vedlegges av dokumentasjon ved leveranse av digitalt materiale?

10 | 7 | 41 | 7 | 9 | 30 — 116

- Opprinnelse (proveniens) og bakgrunn
- Programvare for produksjon - og versjon
- Format - og evt. versjon
- Eksterne avhengighet (lenker, omkringliggende programvare)
- Andre metadata, eller kommentarer ut fra hvem det leveres til:
- Ikke relevant
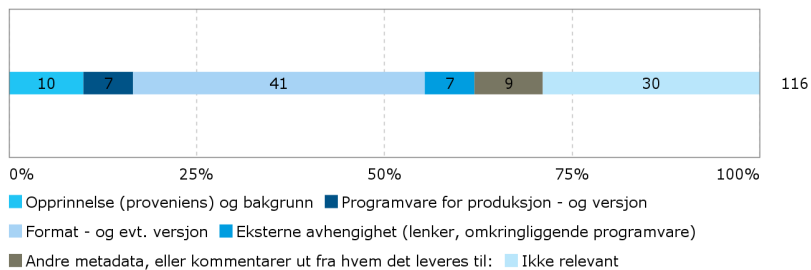
Hvilke rettigheter gjelder for materiale som er avlevert for permanent fremtidig bevaring?

13 | 69 | 8 | 10 — 117

- Åpent tilgjengelig for alle
- Tilgjengelig for personer i mottagende institusjon
- Annet - spesifisér eventuelt også rettigheter i forhold til tidsperiode(r):
- Ikke relevant
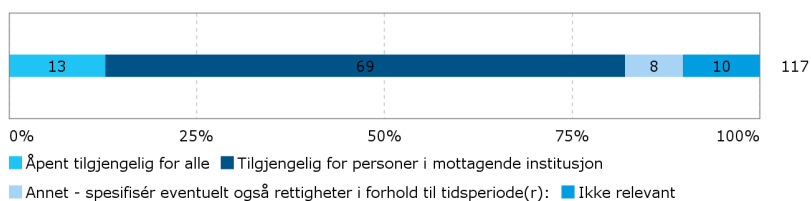
Hvilke føringer legges til grunn ved valg av teknologi for prosjektering?

55 | 87 | 57 | 29 | 10 — 115

- Tilgjengelig kompetanse
- Tekniske valg, programvarens ytelse og egnethet
- Grensesnitt mot partnere
- Offentlige planer og reguleringer
- Annet - Kommentér
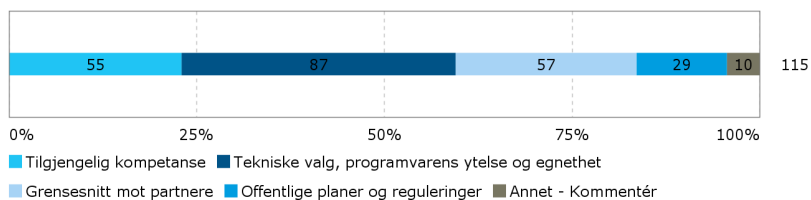
Hvilke kanaler kan være egnede for formidling av det digitalt skapte materialet dere forvalter (evt. flere)?

40 | 59 | 83 | 6 | 14 — 107

- Fysiske lokaler (eget lokale, museum, galleri, arkiv)
- Publisering på papir
- Publisering via nett
- Annet:
- Ikke relevant for oss
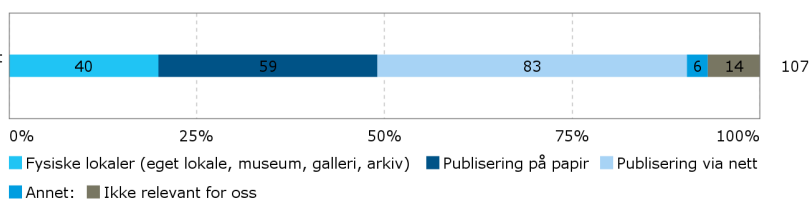
Hvilke presentasjonsformer kan være aktuelle for de 3 prioriterte prosjektene? (flere kan nevnes)

80 | 46 | 18 | 25 — 97

- 3D modeller
- Video og animasjoner
- Interaktive digitale installasjoner
- Annet - spesifisér:
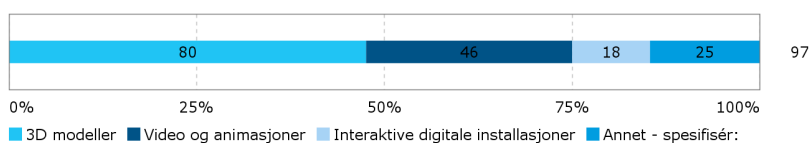
Hvilke formater tror dere egner seg best for digital lagring i et langsiktig perspektiv?

					98
20	2	20	26	12	26

0%   25%   50%   75%   100%

■ PDF (PDF/A) ■ PDF/E - eller 3D PDF ■ Autocad format - DXF, DWF, DWG
■ IFC - Industry Foundation Classes ■ STEP ■ STL ■ IGES ■ Annet - spesifisér:
■ Usikker/Ikke relevant
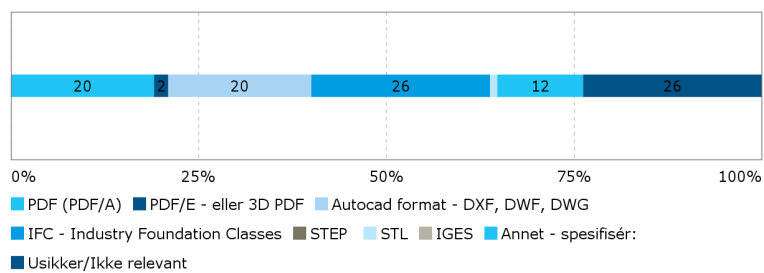
Hvordan tror dere det bevarte materialet best kan formidles i fremtiden?

			97
32	76	15	

0%   25%   50%   75%   100%

■ Bevare gammel programvare, for å kunne vise gamle formater
■ Konvertere gamle formater til nye for å visualisere i ny programvare ■ Andre tanker: