RIT | College of Art and Design
Image Permanence Institute

Findings from 3D Printing and 3D Printed Objects in Collecting Institutions Survey

Introduction

The Institute of Museum and Library Services awarded the Image Permanence Institute (IPI) at Rochester Institute of Technology a National Leadership Grant for Museums to support a three-year research project aimed at building a foundational understanding of how museums are creating, collecting, and consuming 3D printed objects.

In May-June 2022, IPI conducted an online survey assessing how collecting institutions are using 3D printing and interacting with 3D printed objects and materials. The survey covered three major areas: 3D printed objects and artwork found in collections, conservation treatments of 3D printed objects, and 3D printing in preservation and access activities, including its use as a tool in conservation treatments of non-3D printed objects, exhibition and display, and collections transportation. Participants were able to choose which sections of the survey to take depending upon their professional experience with 3D printing.

The survey was developed over a seven-month period and tested by a focus group of preservation colleagues with expertise in 3D printing prior to public distribution.

The link to the online survey, created using SurveyMonkey software, was shared in IPI's newsletter, website, and social media accounts, the Global Conservation Forum (ConsDistList), and across distribution lists for different groups serving museum professionals, such as the International Council of Museums – Committee for Conservation (ICOM-CC), the American Alliance of Museums (AAM), The Society for the Preservation of Natural History Collections (SPNHC), and the Preparation, Art Handling, and Collections Care Information Network (PACCIN).

In total, the final analysis sample consisted of 95 individuals who completed at least one section of the survey.

A preliminary report containing a few of the survey highlights was released in August of 2022. The full-length report presented here provides a more comprehensive list of the questions asked in the survey and summarizes the survey findings.

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Key Findings

3D Printed Objects in Collections

- 73% of respondents indicated their institution began acquiring 3D printed objects after 2010.
- 3D printed plastic materials represent the overwhelming majority of 3D printed objects in collections, although the type of plastic is often unidentified or unknown. Respondents who provided conservation treatments were also more likely to do so on a 3D printed plastic object.
- Discoloration was the most commonly identified form of deterioration among 3D printed objects in collections. However, most 3D printed objects that underwent conservation treatment required a physical repair.

3D Printing in Preservation and Access Activities

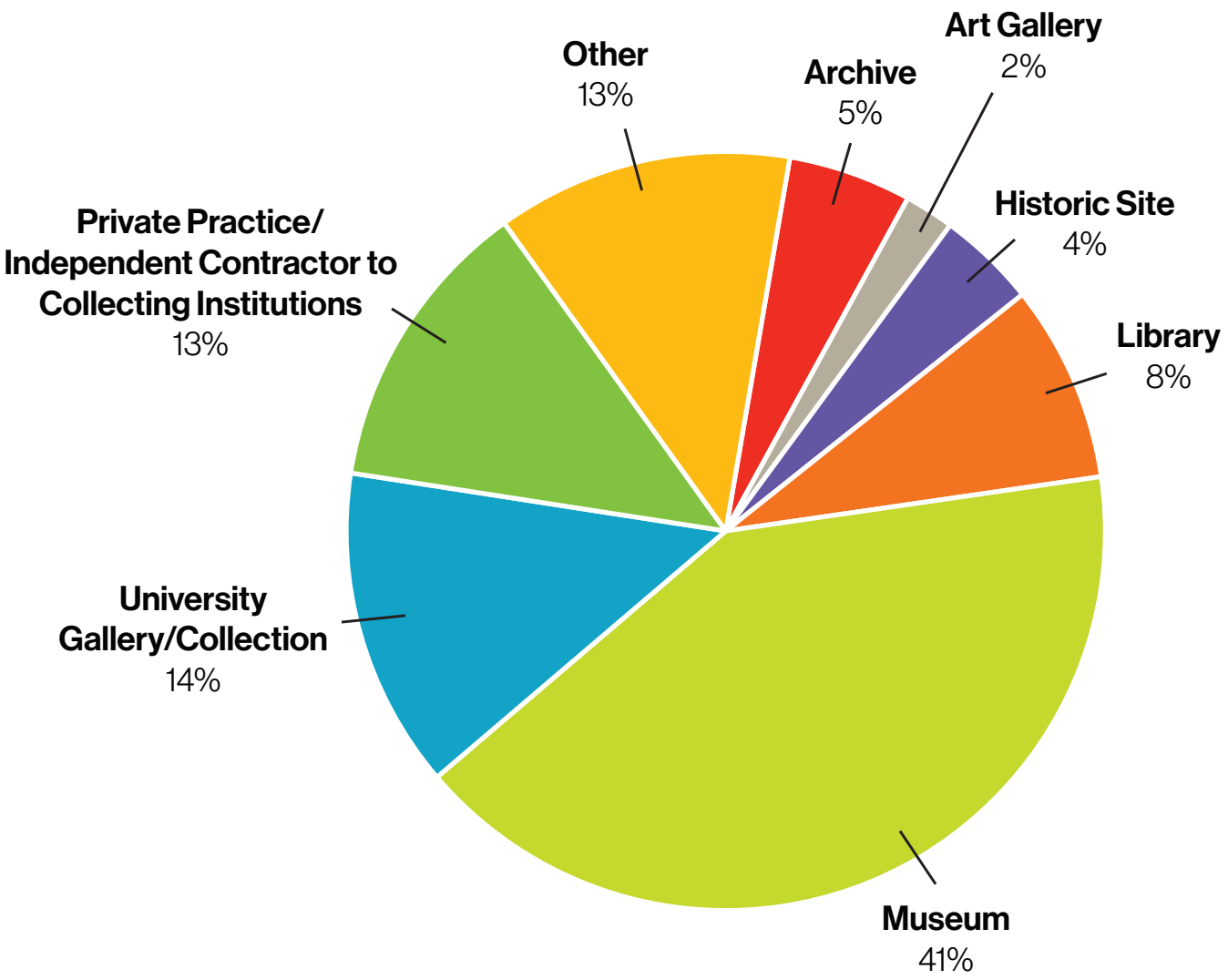
- 87% of respondents began using 3D printing for preservation and access between 2012-2022.
- Among respondents, the most common use of 3D printing for preservation and access activities is for exhibition and display purposes.
- Among respondents, inorganic objects have been treated using 3D printing twice as frequently as organic objects.
- There is no single 3D printed material that is in use more frequently than others for treatment projects. A wide range of materials are in use, for an almost equally diverse set of objects. A fair number of respondents do not know what materials were used.
- Survey results suggest the use of 3D printing for collection transit related activities is very limited at this time.

Overall Findings

- There was almost an even distribution of institutions using in-house 3D printing equipment or collaborating with outside vendors to meet 3D printing goals.
- Across all survey sections, the most common reason for selecting 3D printing was it allowed for a new/innovative approach.
- Across all survey sections, the most common approaches to assessing the longevity and safety of 3D printed materials were literature reviews or no assessment.

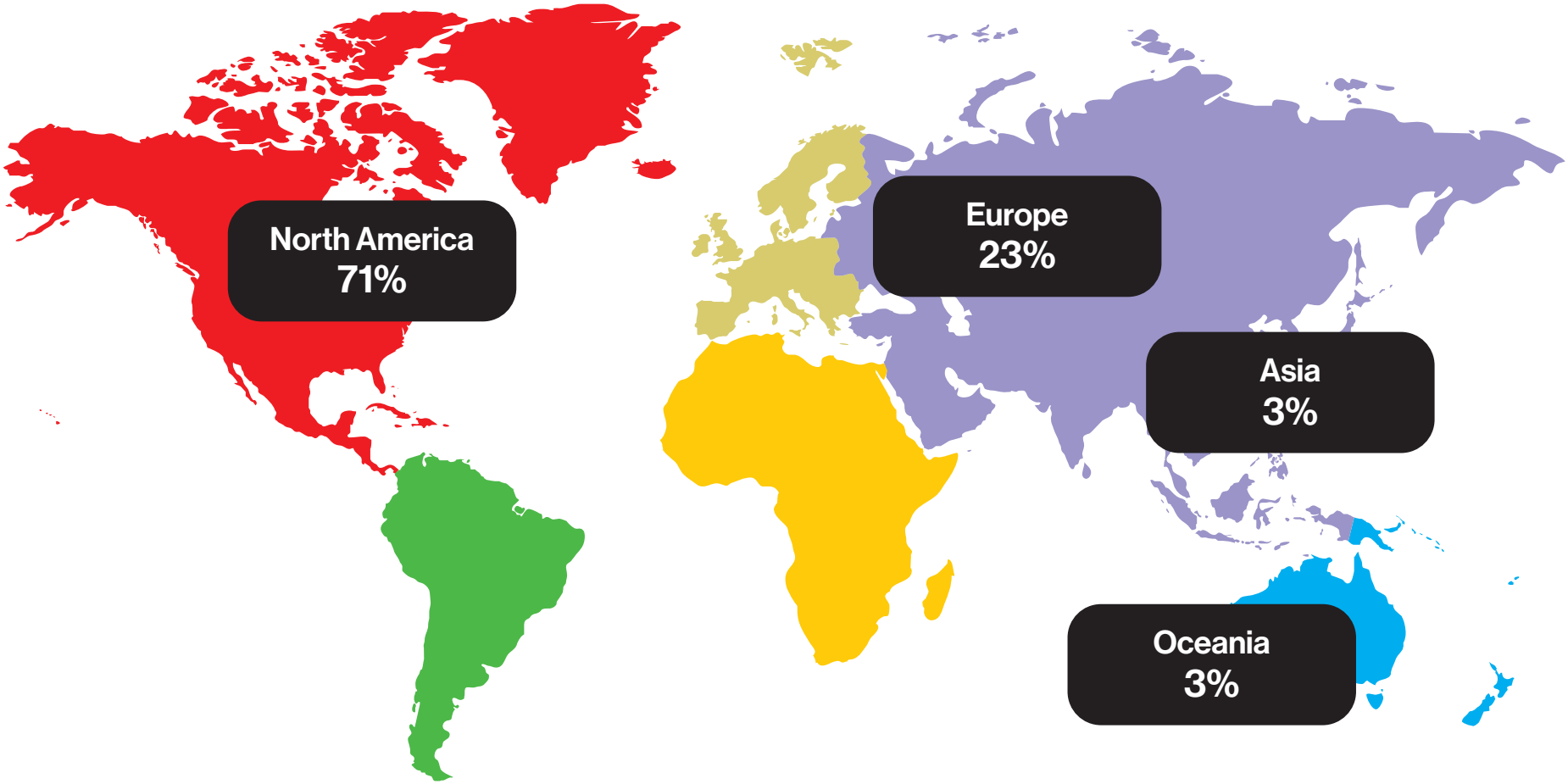
Overall Survey Demographics

What type of institution do you work for?



95
Respondents

Where is your institution located?

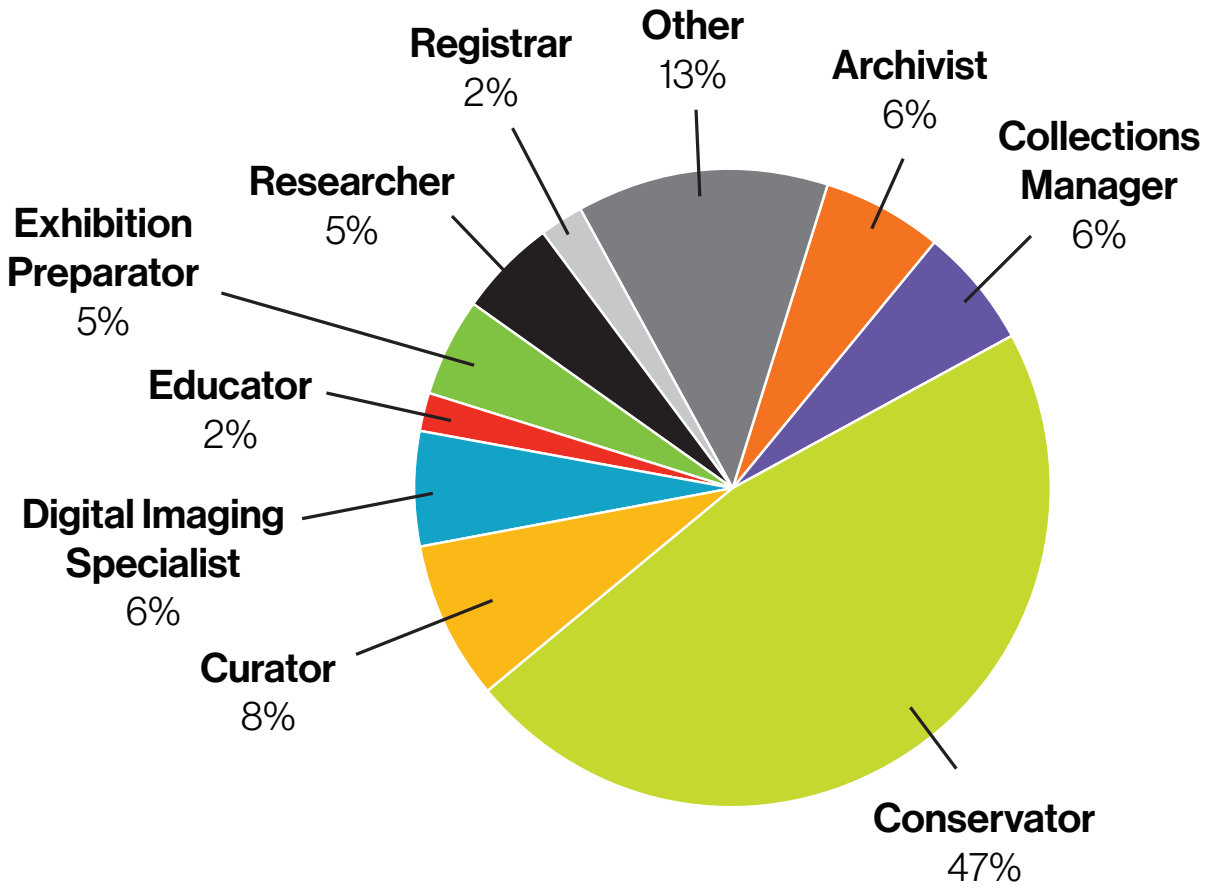


95
Respondents

3D Printed Objects in Collecting Institutions

A majority of survey respondents who chose to take the section of the survey on 3D printed objects in collections indicated that they were conservators by profession.

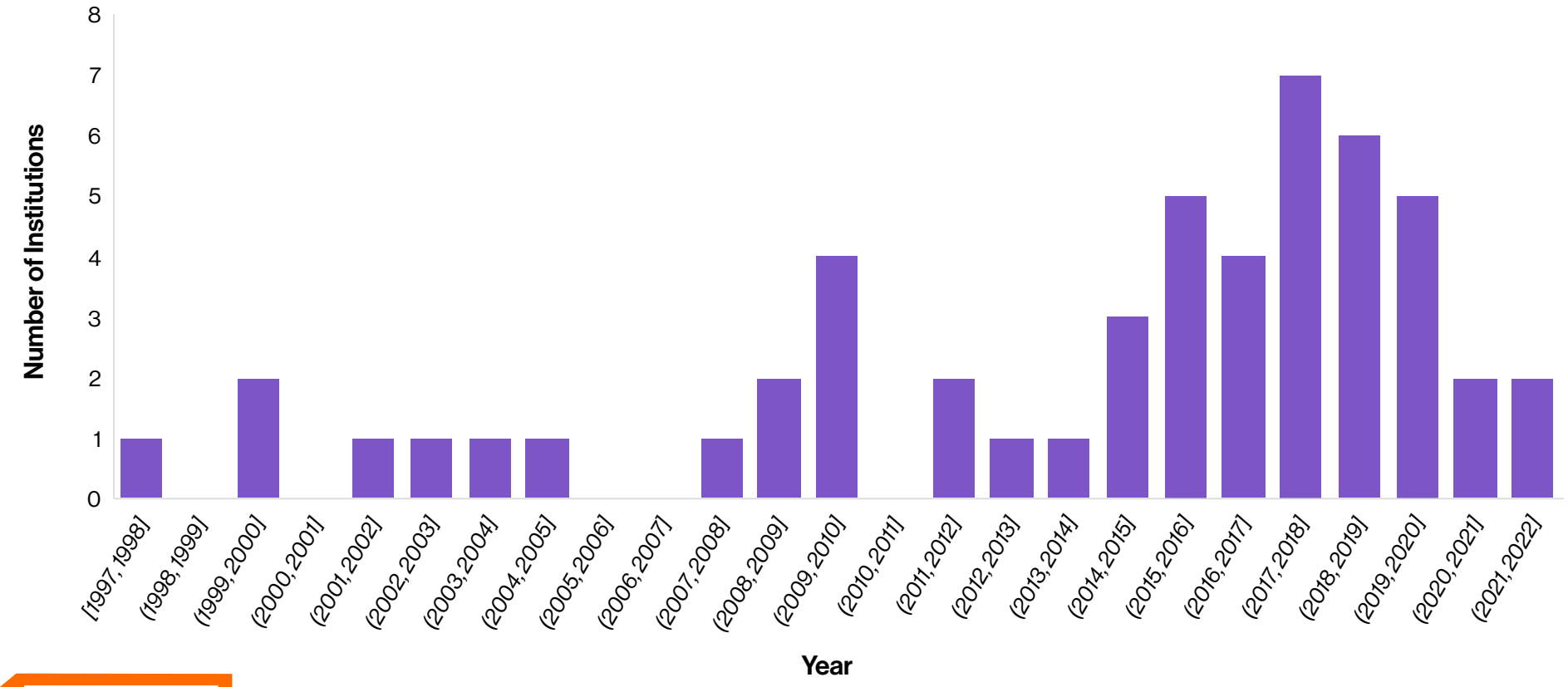
Which professional role listed below best aligns with your position?



62
Respondents

Survey respondents provided a date or a date estimate of when their institution first started acquiring 3D printed objects. Of those polled, the earliest acquisition came in the late 1990s, while >70% of respondents' institutions began acquiring 3D printed objects after 2010.

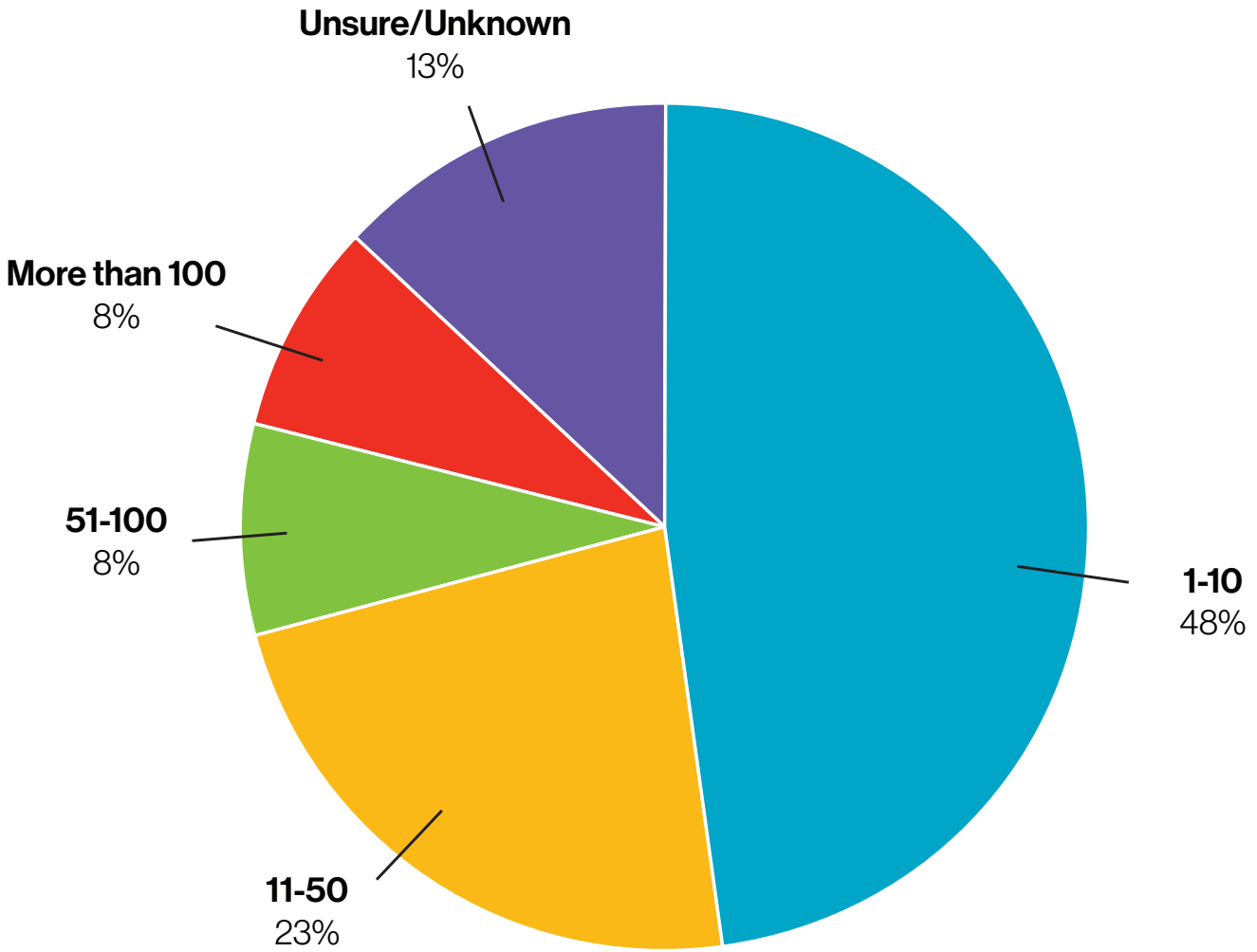
What year did your institution first start acquiring 3D printed objects?



52
Respondents

When asked about the number of 3D printed objects present in their institution's collection, almost half of respondents indicated that there were between 1 and 10 objects. Ten respondents (16%) indicated that their institution's collection held 50 or more objects.

How many 3D printed objects are in your institution's collection (best estimate)?



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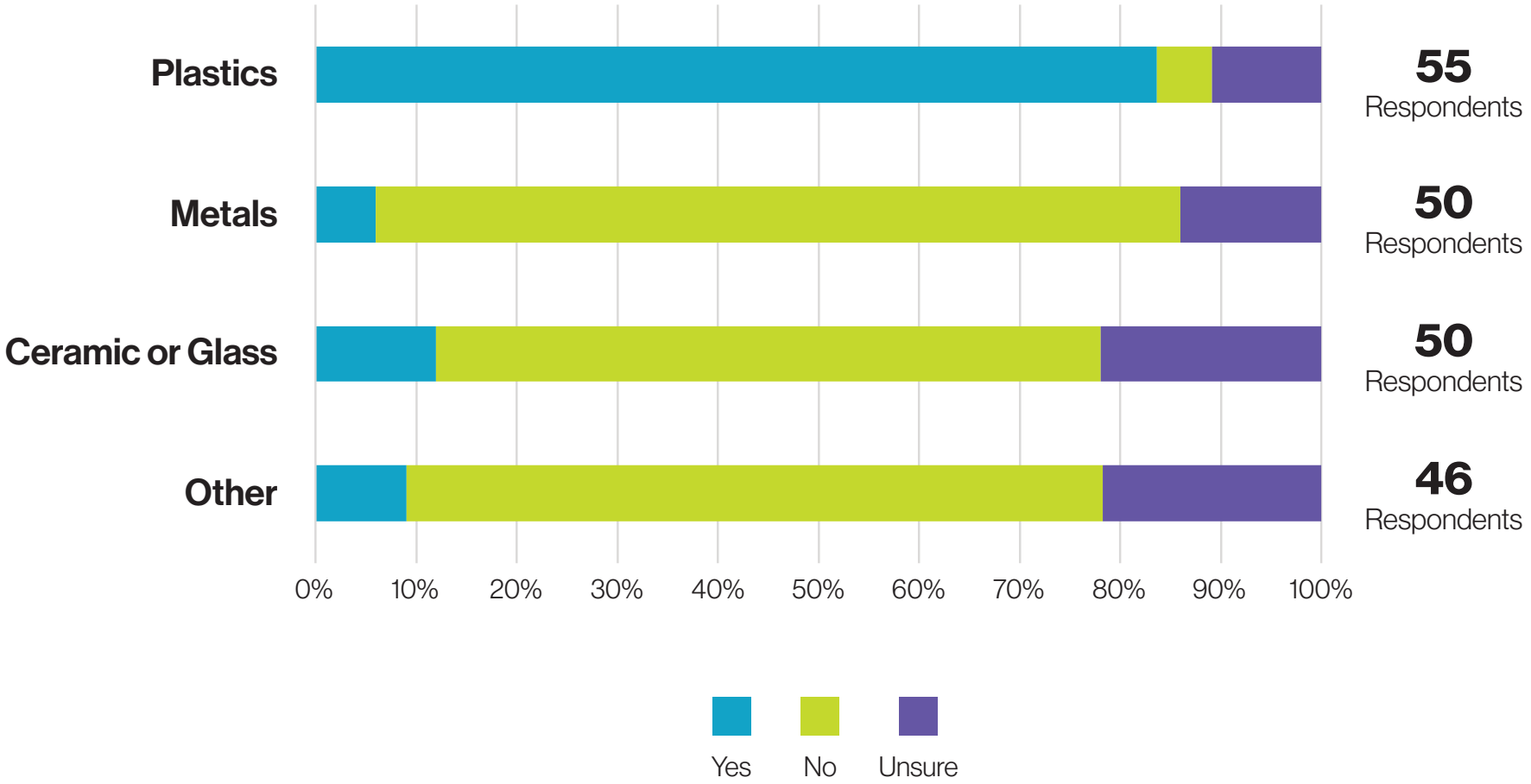
Respondents

3D Printed Objects in Collecting Institutions

Materials

Respondents who chose to take the section of the survey on 3D printed objects in collections indicated that 3D printed **plastic objects** were most commonly represented in their institution's collection.

Are the following categories of 3D printed objects represented in your institution's collection?

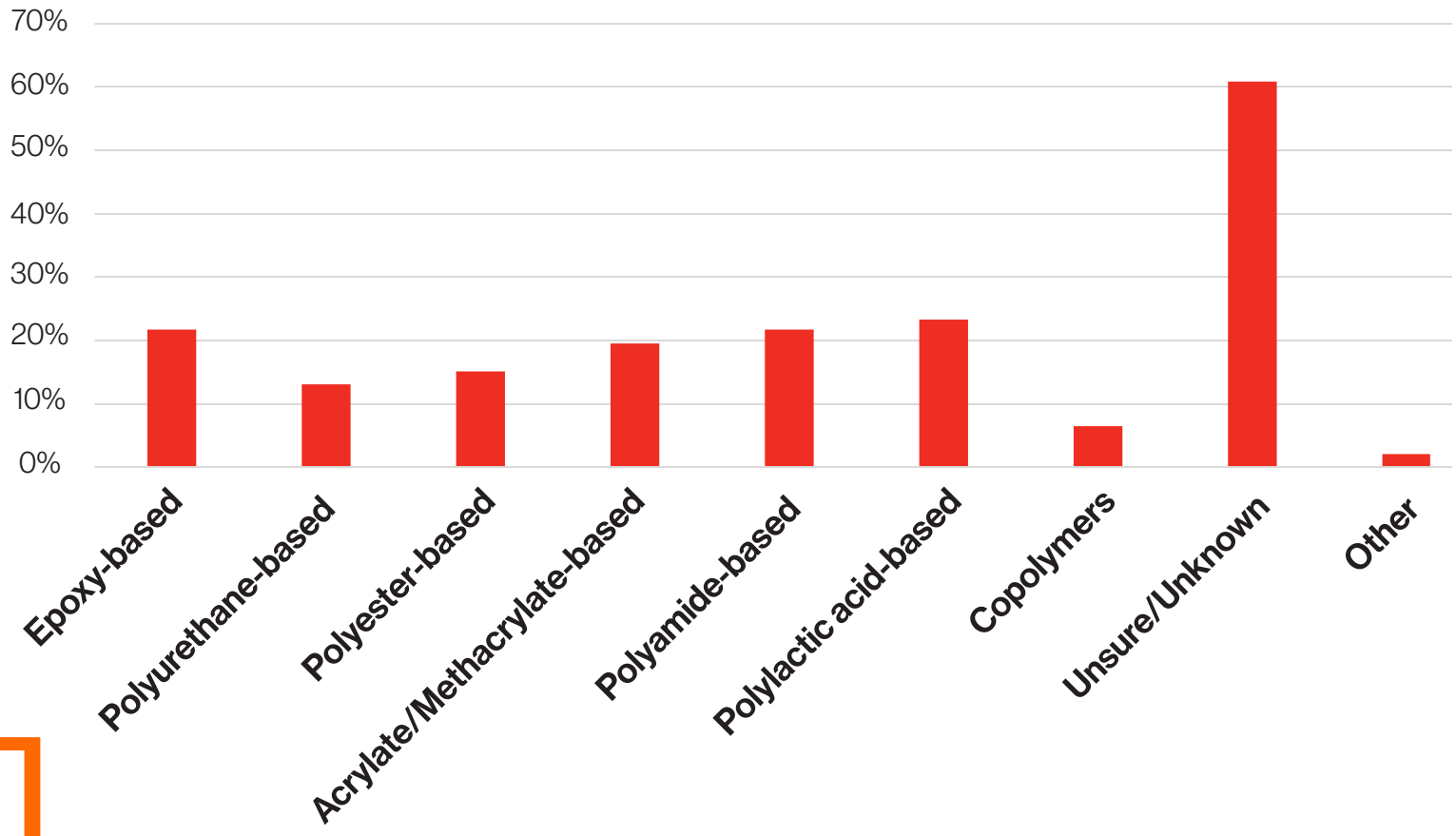


3D Printed Objects in Collecting Institutions

Plastics

Of the respondents that indicated 3D printed plastic objects were present in their institution's collection, the identity of a majority of the plastic types remains **unidentified or unknown**.

What classes of 3D printed plastics are represented in your institution's collection (select all that apply)?



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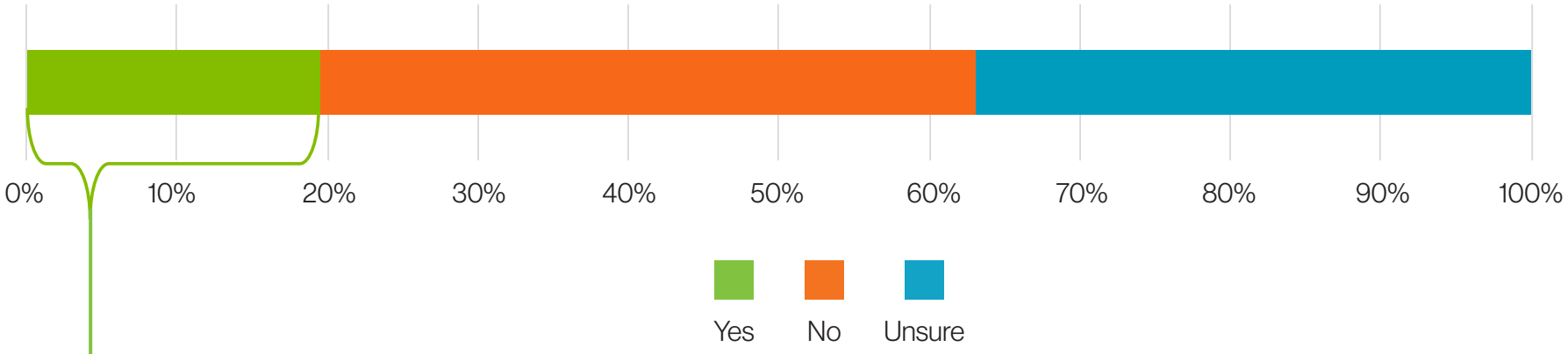
Respondents

Many plastic materials used in different types of 3D printing technologies are available reinforced or combined with other types of non-plastic materials, such as glass, metal, wood, or ceramic.

Nearly 20% of respondents indicated that these types of 3D printed plastics with composite fillers were present in their collections.

Does your institution's collection have 3D printed plastics with composite fillers (e.g. wood, glass, carbon fiber, metal, etc.)?



For those who said 'yes', composite fillers included carbon fiber, metals such as bronze and copper, wood, calcium sulphate, algae, and curry powder.

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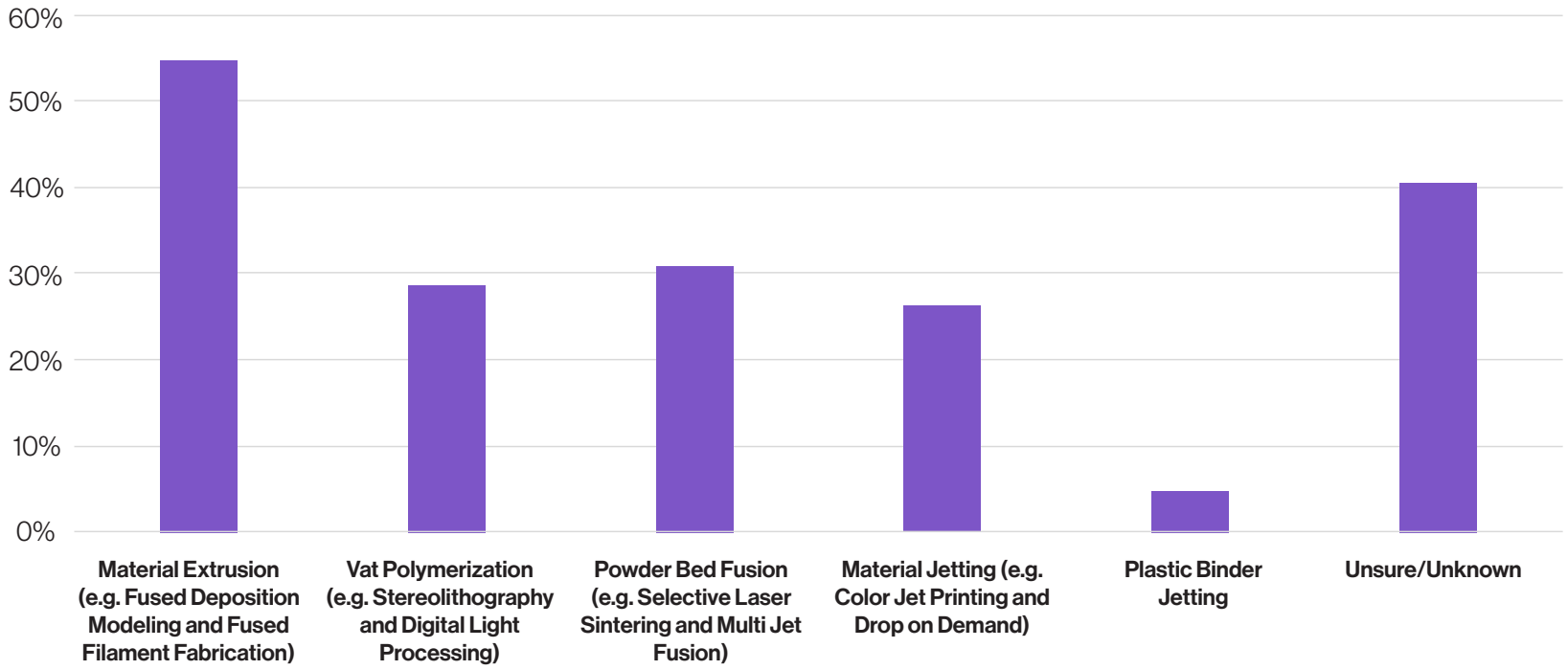
Respondents

Respondents indicated that material extrusion was the most common type of 3D printing technology used to make the 3D printed plastic objects in collections, although many respondents remained unsure of the technologies used to 3D print the plastic objects in their institution's collection.

What types of 3D printing technologies are represented by these plastic objects (select all that apply)?



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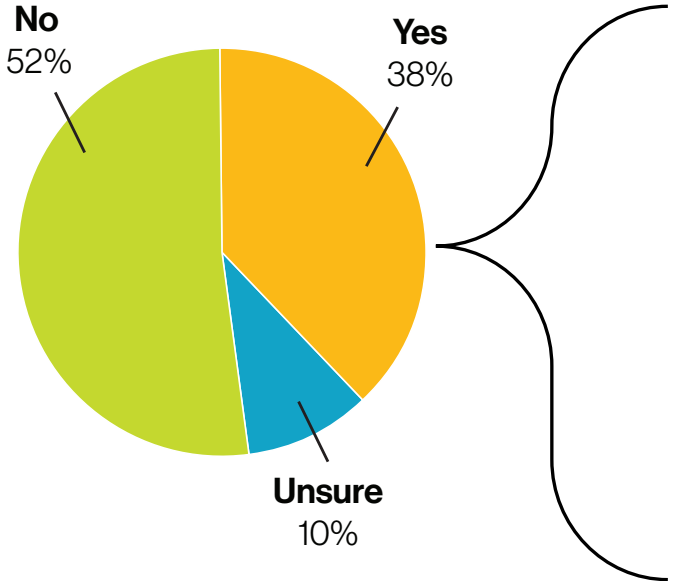
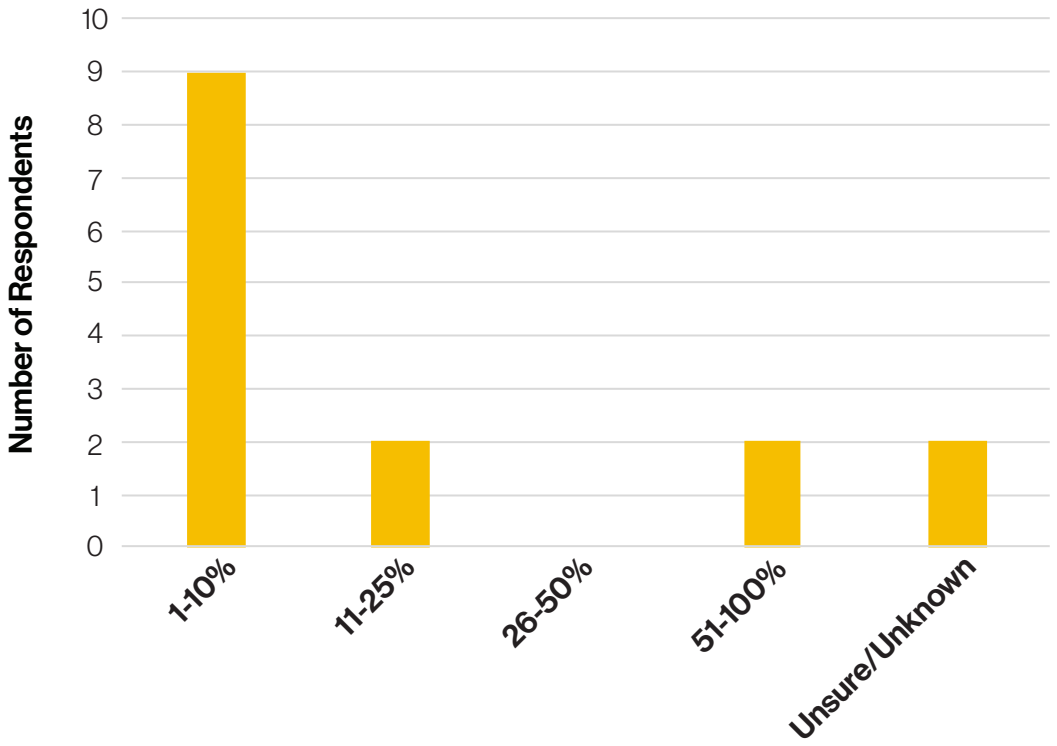
Respondents

Some respondents have noticed deterioration of the 3D printed plastic objects in their collections. In most cases, the deterioration impacted less than 10% of the collection objects.

Have you noticed any deterioration of these plastic objects?



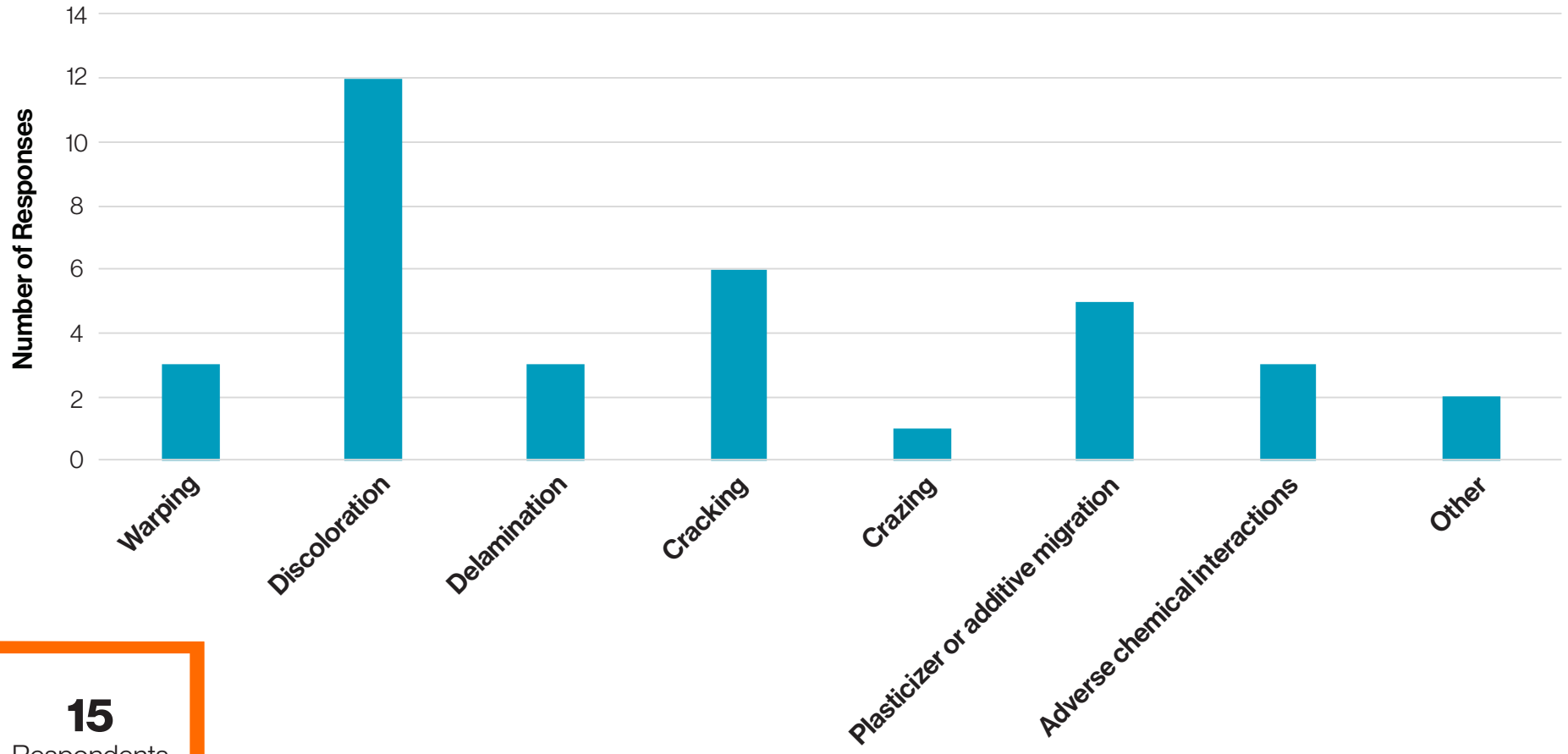
What proportion of 3D printed plastic objects in the collection have exhibited deterioration?



42
Respondents

Of respondents who noticed deterioration in their institution's collection, most (80%) noticed discoloration as the predominant form of deterioration.

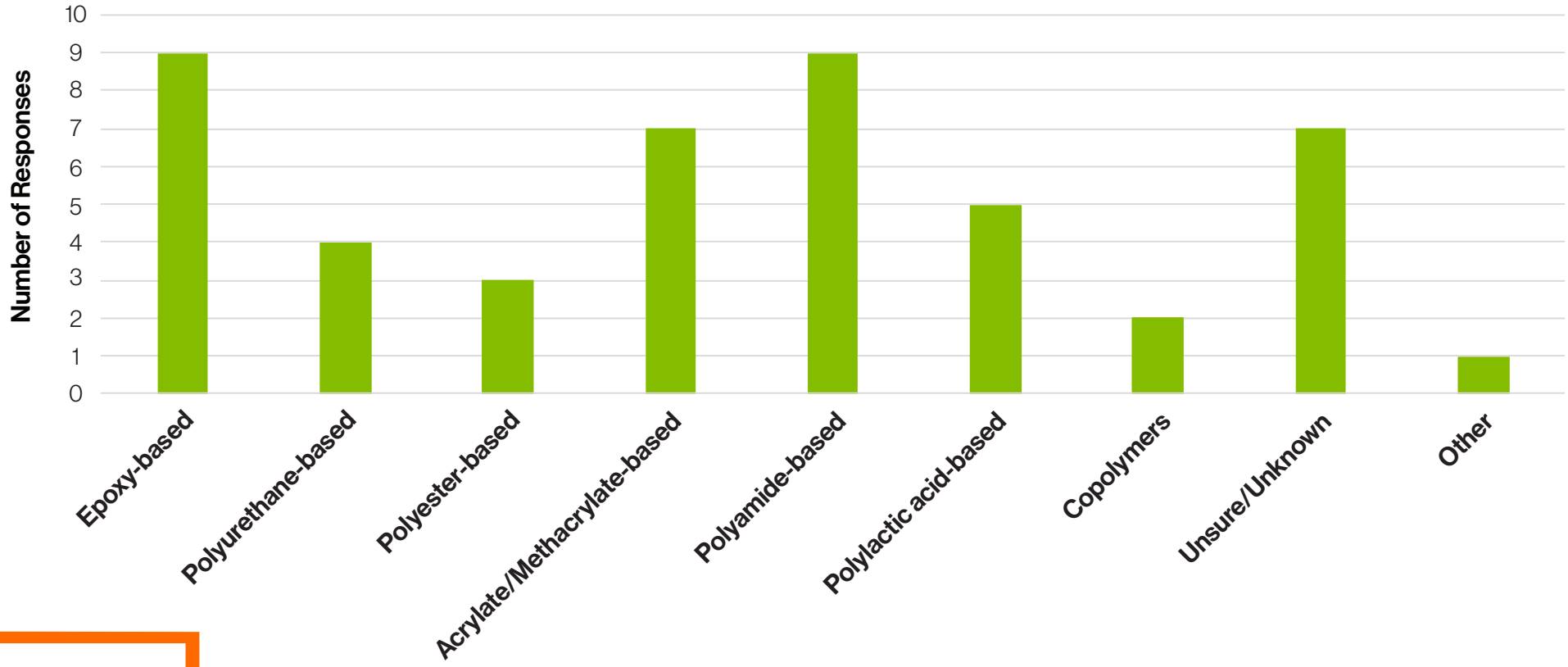
What major types of deterioration have you noticed in 3D printed plastic collection objects (select all that apply)?



15
Respondents

Of respondents who noticed deterioration in their institution's collection, the following 3D printed plastics were reported as being housed within their collections.

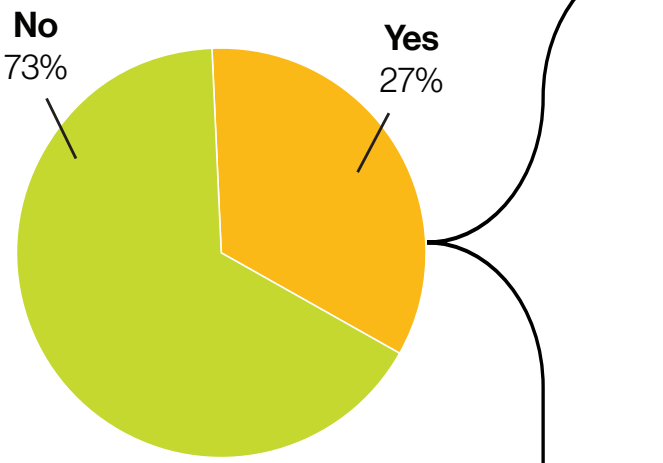
What classes of 3D printed plastics are represented in your institution's collection (select all that apply)?



15
Respondents

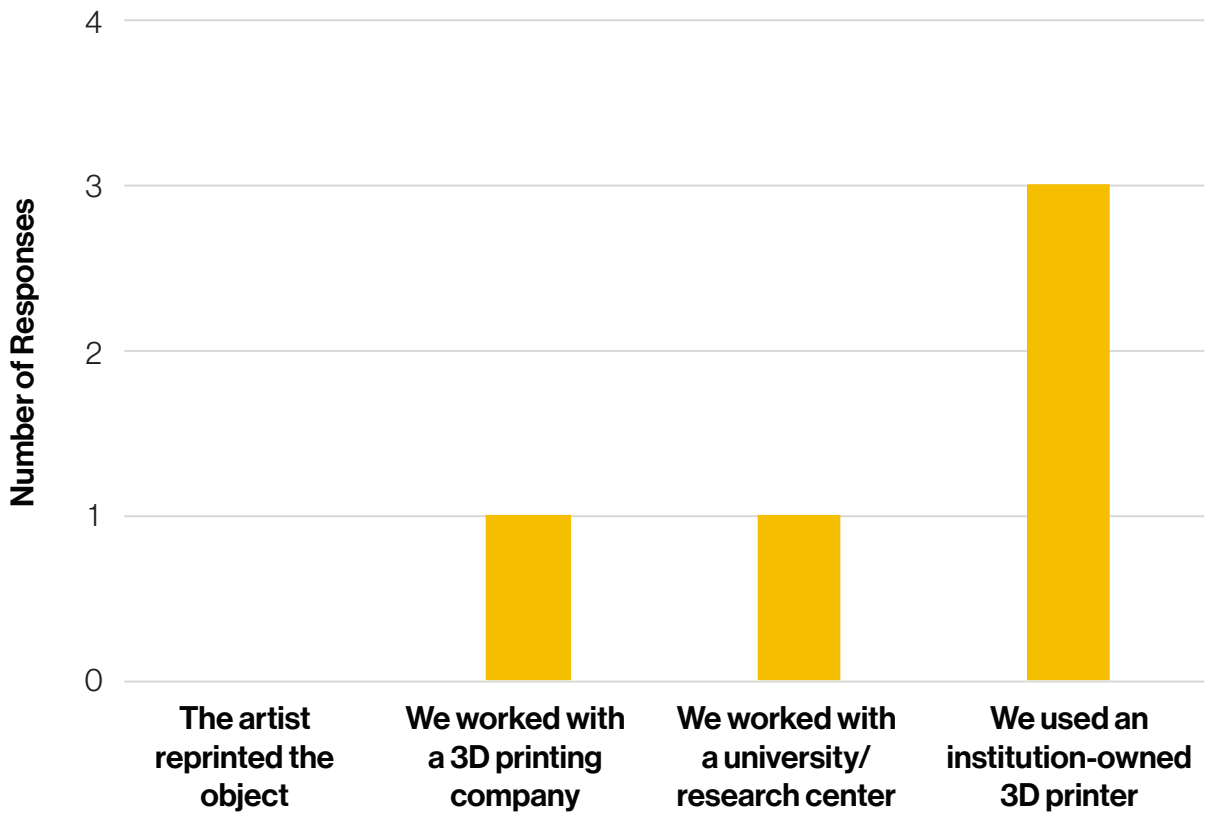
Four respondents who noticed deterioration in their institution's 3D printed plastic collection have reprinted objects in response to that deterioration. Three of the four used an institution-owned printer to do so.

Have you reprinted 3D printed plastic collection objects in response to deterioration?



15
Respondents

How were the 3D printed plastic collection objects reprinted (select all that apply)?



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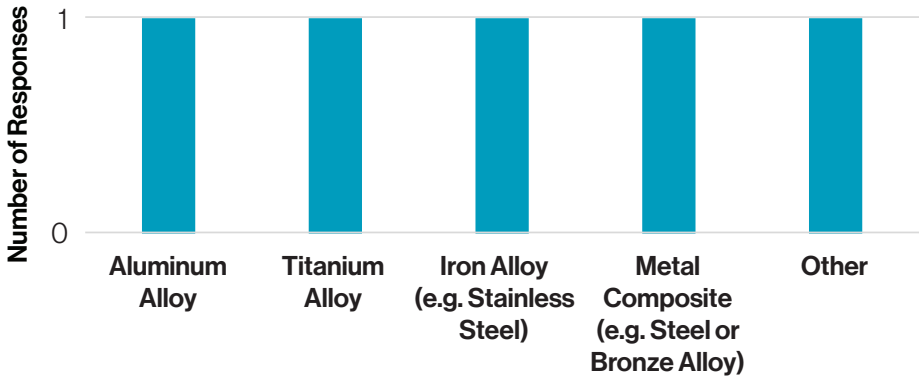
3D Printed Objects in Collecting Institutions

Metals, Ceramics, Glass, and Other

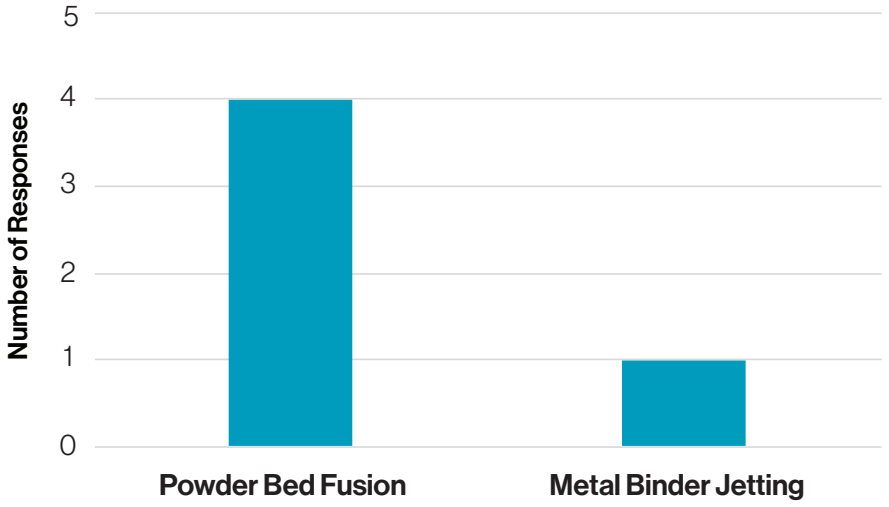
Three of 50 respondents (6%) indicated that 3D printed metal objects were present in their institution's collection. Powder bed fusion was the primary technology through which these objects were made. One respondent noticed corrosion of a metal composite object that was printed with metal binder jetting. In response to this deterioration, the artist reprinted the object.

What types of 3D printed metals are represented in your collection (select all that apply)?



Note: *Copper Alloy (e.g. Bronze)*, *Precious Metals (e.g. Gold or Sterling Silver)*, and *Unsure/Unknown* were also options but received no responses.

What types of 3D printing technologies are represented by these metal objects (select all that apply)?

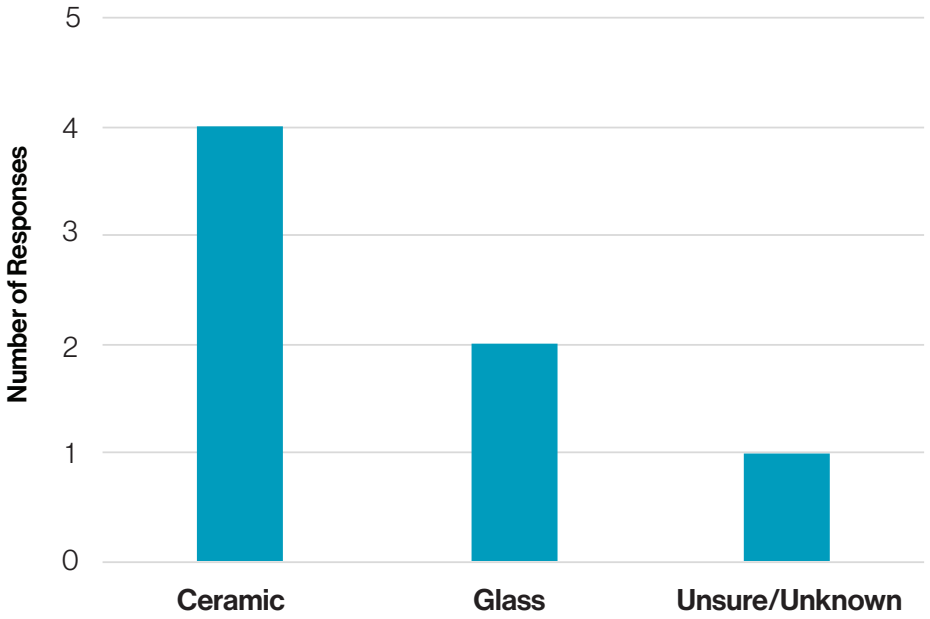


Note: *Material Extrusion*, *Direct Energy Deposition*, *Other*, and *Unsure/Unknown* were also options but received no responses.

3
Respondents

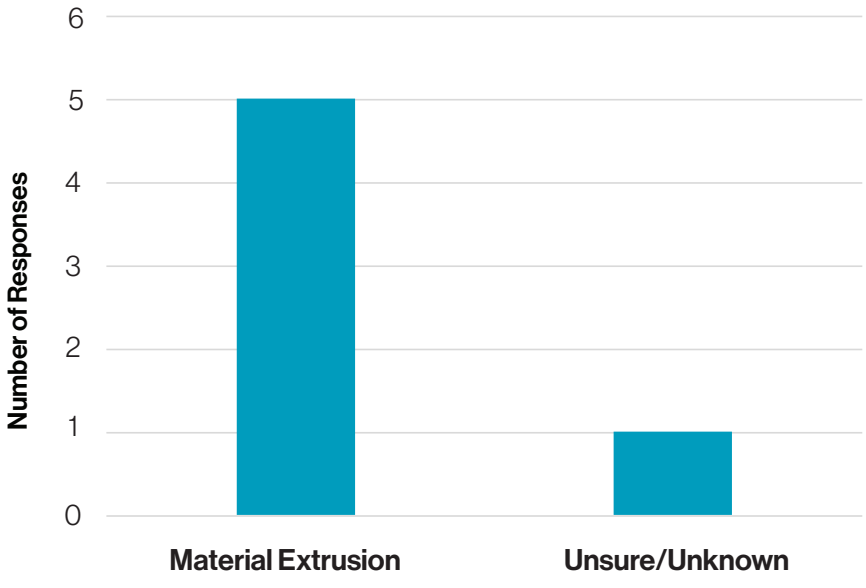
Six of 50 respondents (12%) indicated that 3D printed ceramic and/or glass objects were present in their institution's collection. A majority of these objects were created through material extrusion, and no respondents noticed deterioration of these objects.

What types of 3D printed ceramics or glasses are represented in your collection (select all that apply)?



Note: *Ceramic Composite* and *Other* were also options but received no responses.

What types of 3D printing technologies are represented by these objects (select all that apply)?

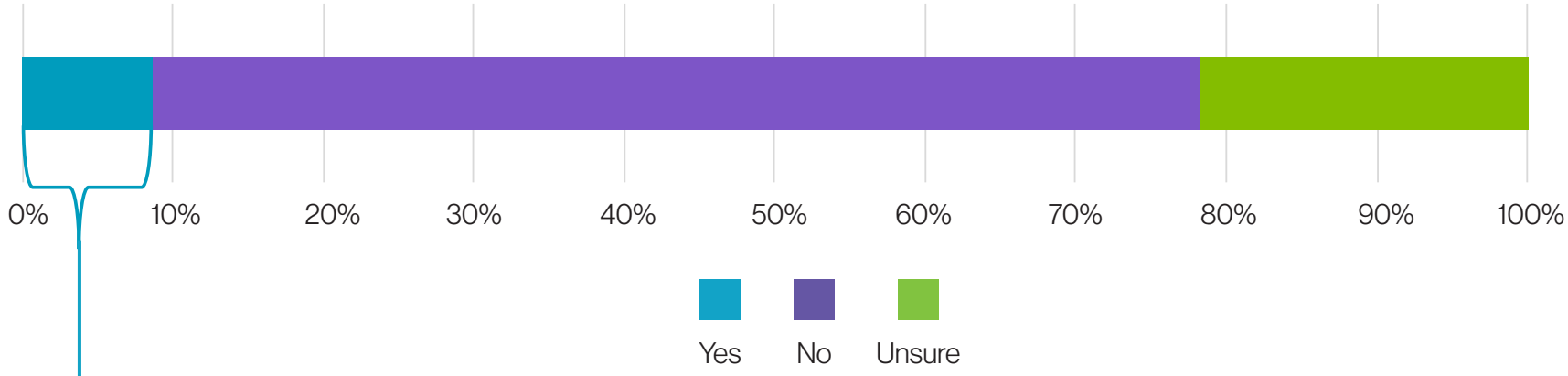


Note: *Powder Bed Fusion*, *Sand Binder Jetting*, and *Other* were also options but received no responses.

6
Respondents

Four of 46 respondents (9%) indicated that 'other' types of 3D printed materials that did not fit neatly into the categories of plastic, metal, ceramic, and glass, were present in their collections.

Are there other types of 3D printed materials in your institution's collection?



For those who said 'yes', other types of 3D printed materials included resins, an aluminum/plastic composite, and an orange peel/biopolymer.

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Respondents

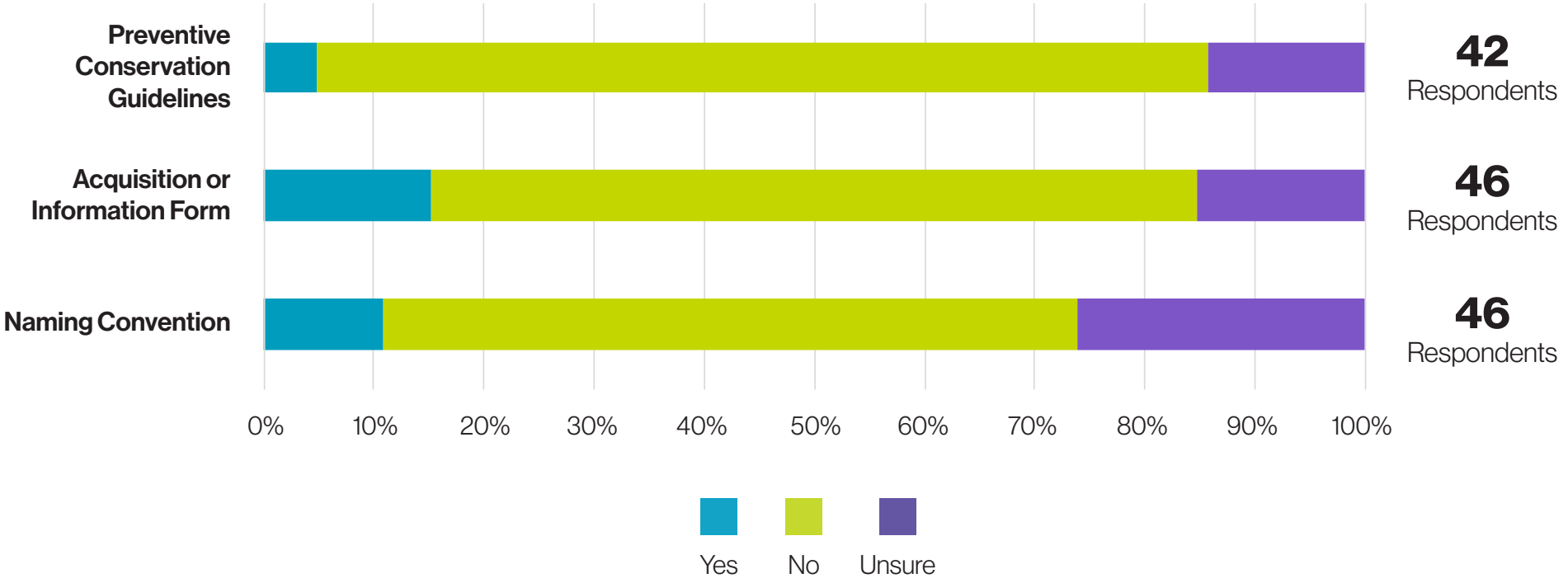
3D Printed Objects in Collecting Institutions

Guidelines, Institutional Tools, and Digital Assets

Only two respondents (5%) indicated that their institution had preventive conservation guidelines specific to 3D printed objects. These guidelines at their most specific required cool or cold storage and low UV exposure, but often fit into general guidelines for plastic objects.

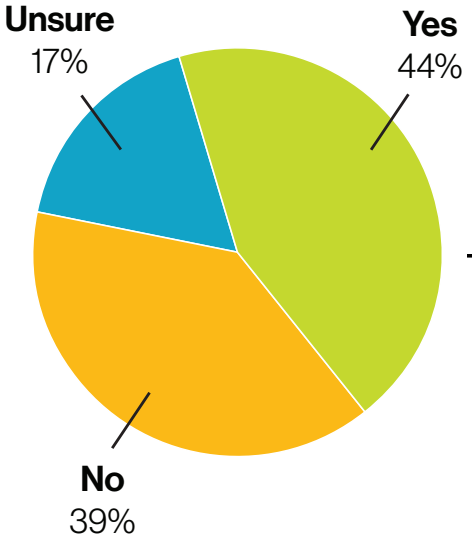
Slightly more respondents indicated that their institution had an acquisition form specific to 3D printed objects and associated media. Still, a majority of institutions did not have acquisition forms and did not have naming conventions in place for describing 3D printed objects.

Does your institution have any of the following *specific* to 3D printed objects?

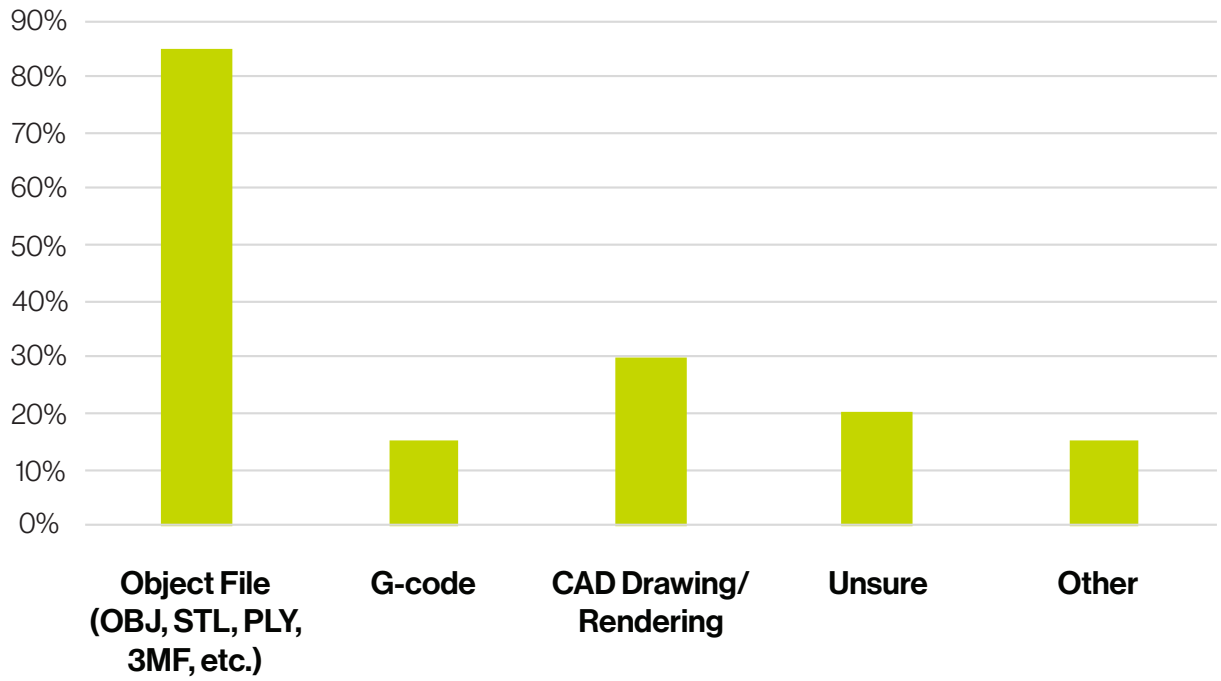


Almost half of respondents indicated that their institution has collected digital assets associated with 3D printed objects. Most often, these digital assets were the object files associated with the 3D print.

Has your institution collected digital assets (e.g. object files, g-code, etc.) associated with 3D printed objects?



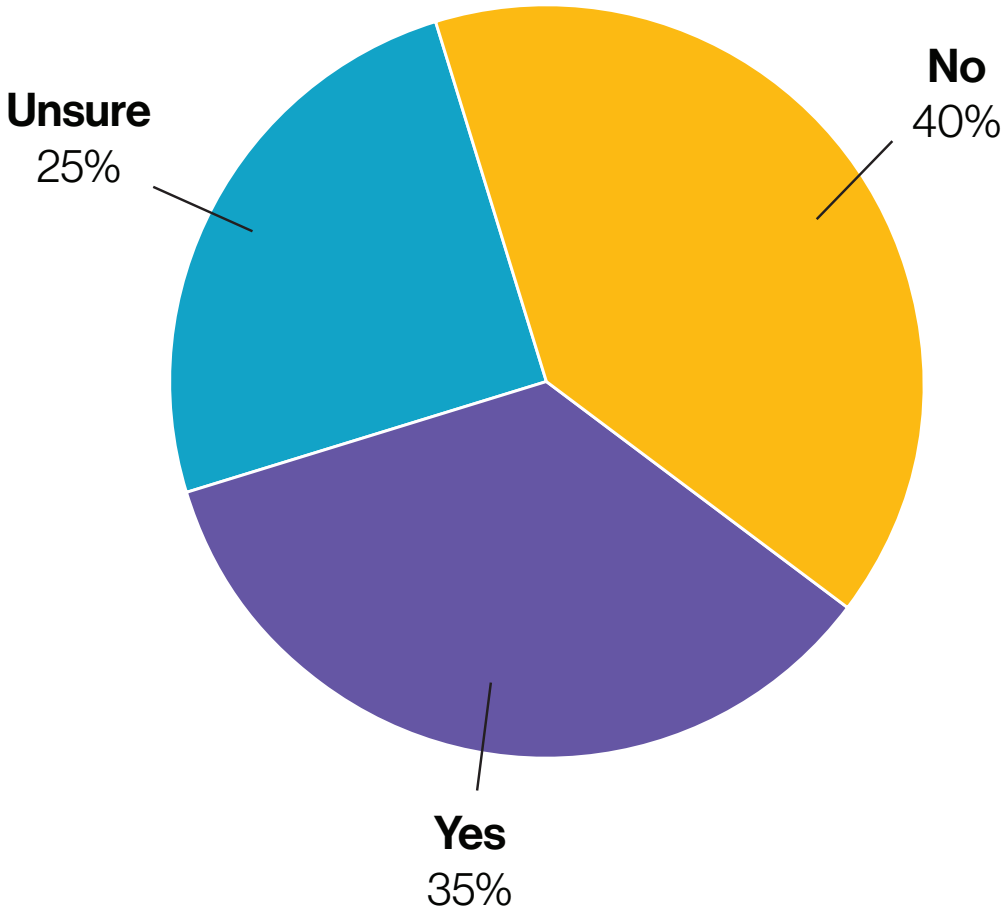
What types of digital formats has your institution acquired (select all that apply)?



46
Respondents

Of the 20 respondents whose institutions have collected digital assets, 7 indicated that their institution has collected digital assets *without* the physical 3D printed object.

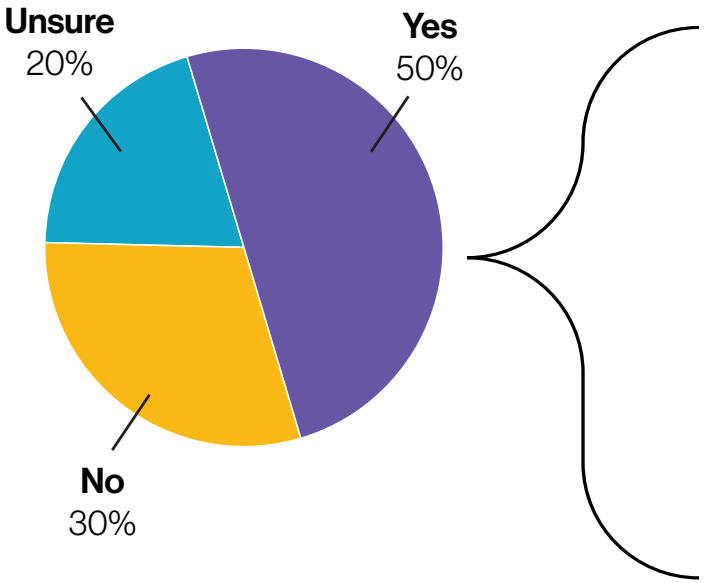
Has your institution collected digital assets (e.g. object files, g-code, etc.) *without* the associated 3D printed object?



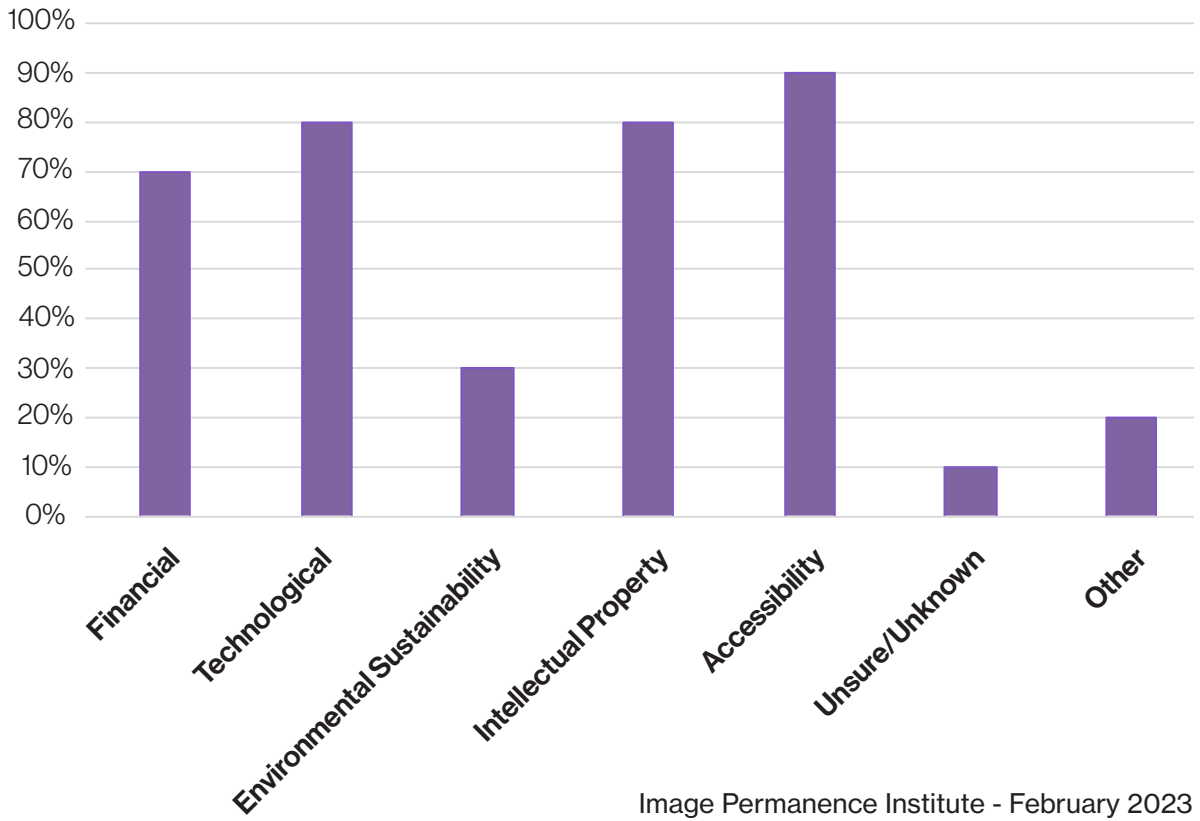
20
Respondents

10 respondents whose institutions have collected digital assets indicated their institution had a data management plan (DMP) in place for long-term data management. Factors considered in the DMP were primarily accessibility, intellectual property, and technological, followed by financial.

Does your institution have a data management plan (DMP) for long-term management of this data?



What factors are considered in your institution's DMP (select all that apply)?



20
Respondents

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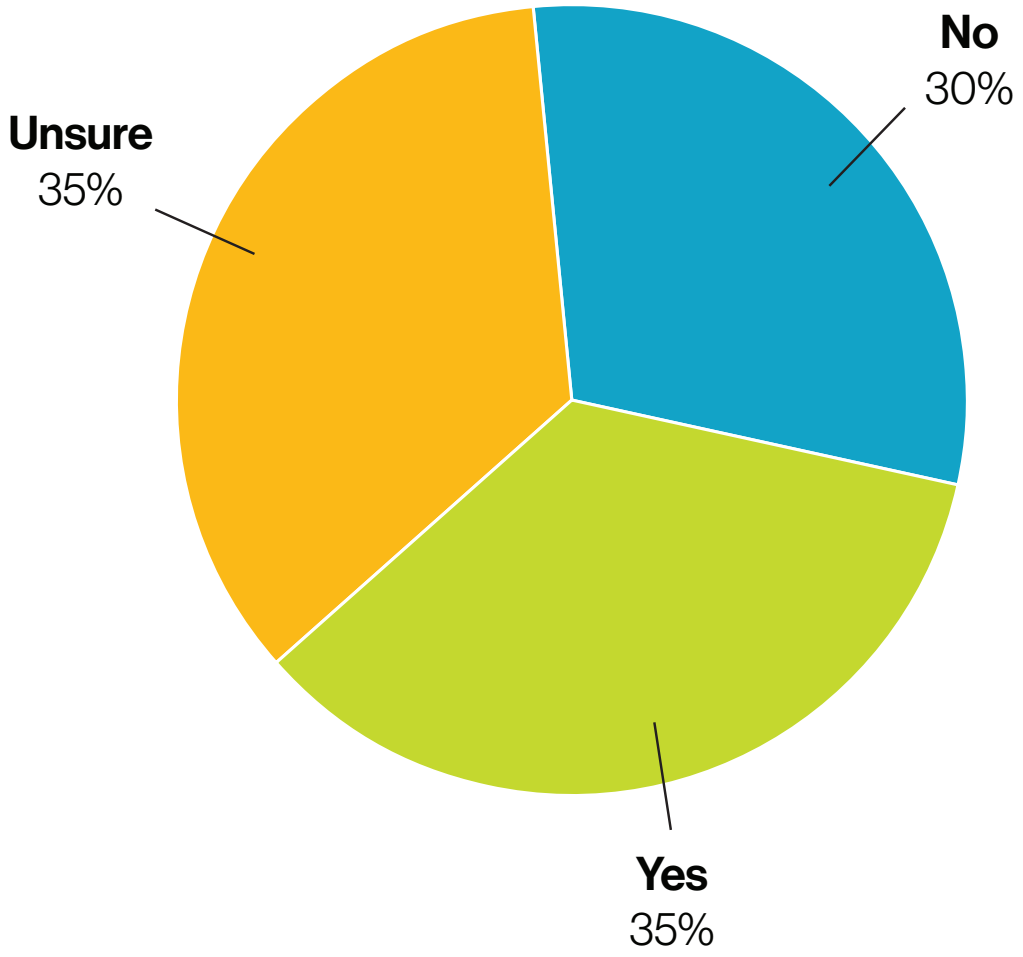
Seven respondents whose institutions have collected digital assets indicated their institution had a protocol with which to manage metadata associated with digital assets. These protocols most often required storage or upload of metadata into collections management databases.

Does your institution have a protocol for managing metadata associated with digital assets for 3D printed objects?



20
Respondents

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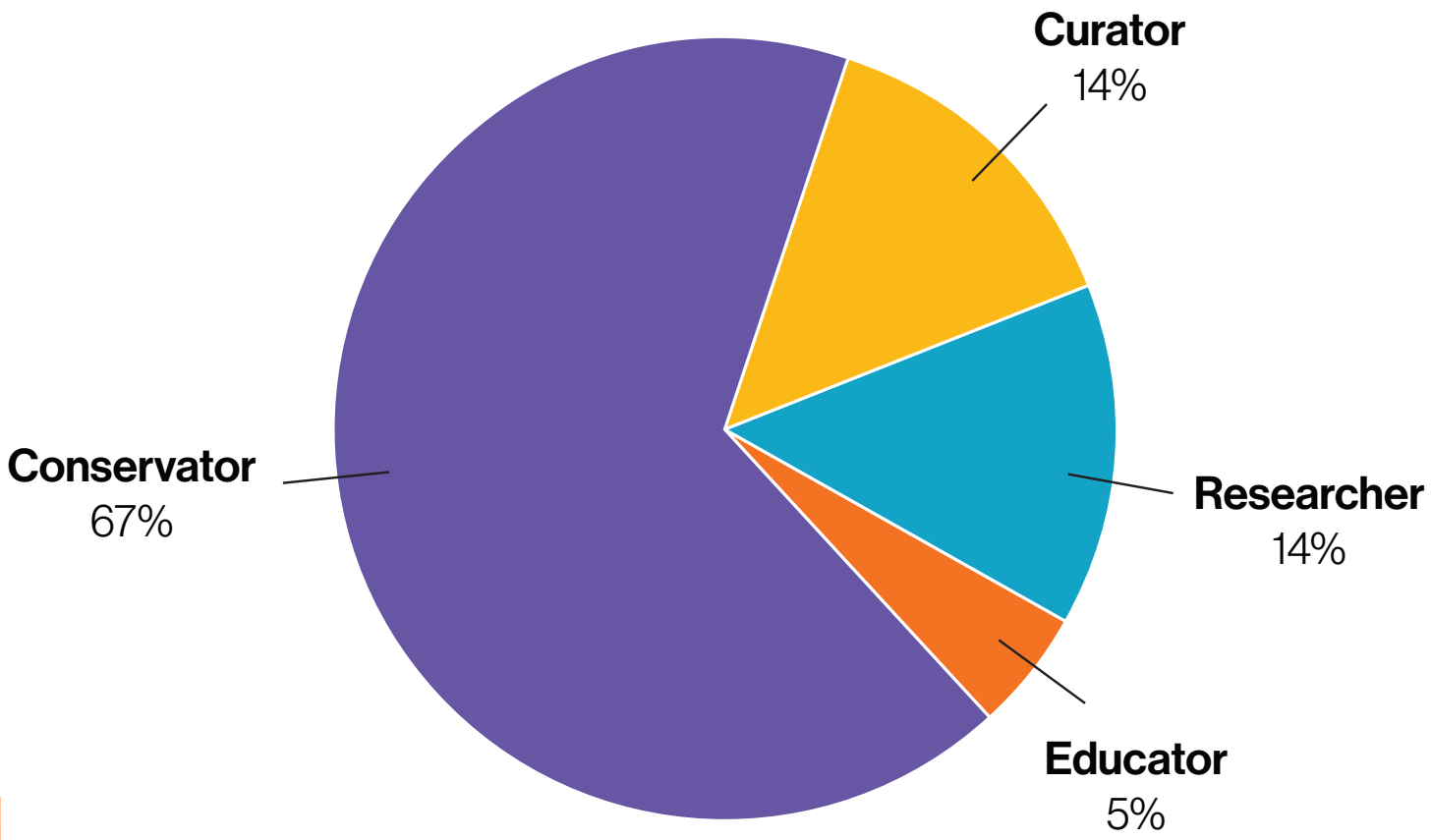
Conservation Treatments of 3D Printed Objects

A majority of the survey respondents who chose to take the section of the survey on conservation treatments of 3D printed objects indicated their professional role is conservator.

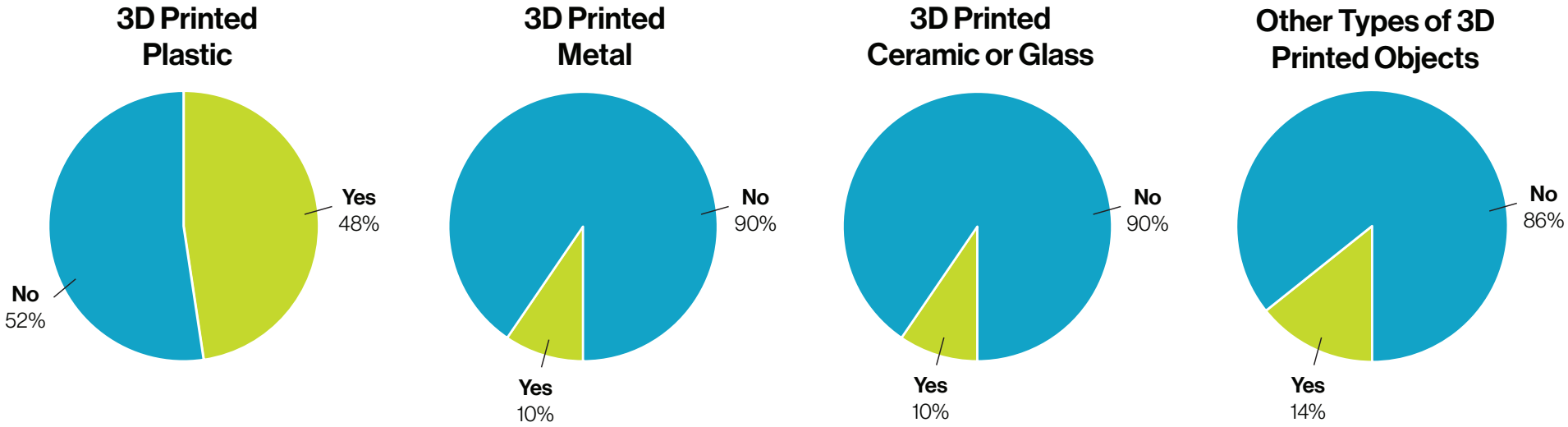
Which professional role listed below best aligns with your position?



21
Respondents

Respondents who chose to take the section of the survey on conservation treatments of 3D printed objects were most likely to have performed a conservation treatment on a 3D printed plastic object.

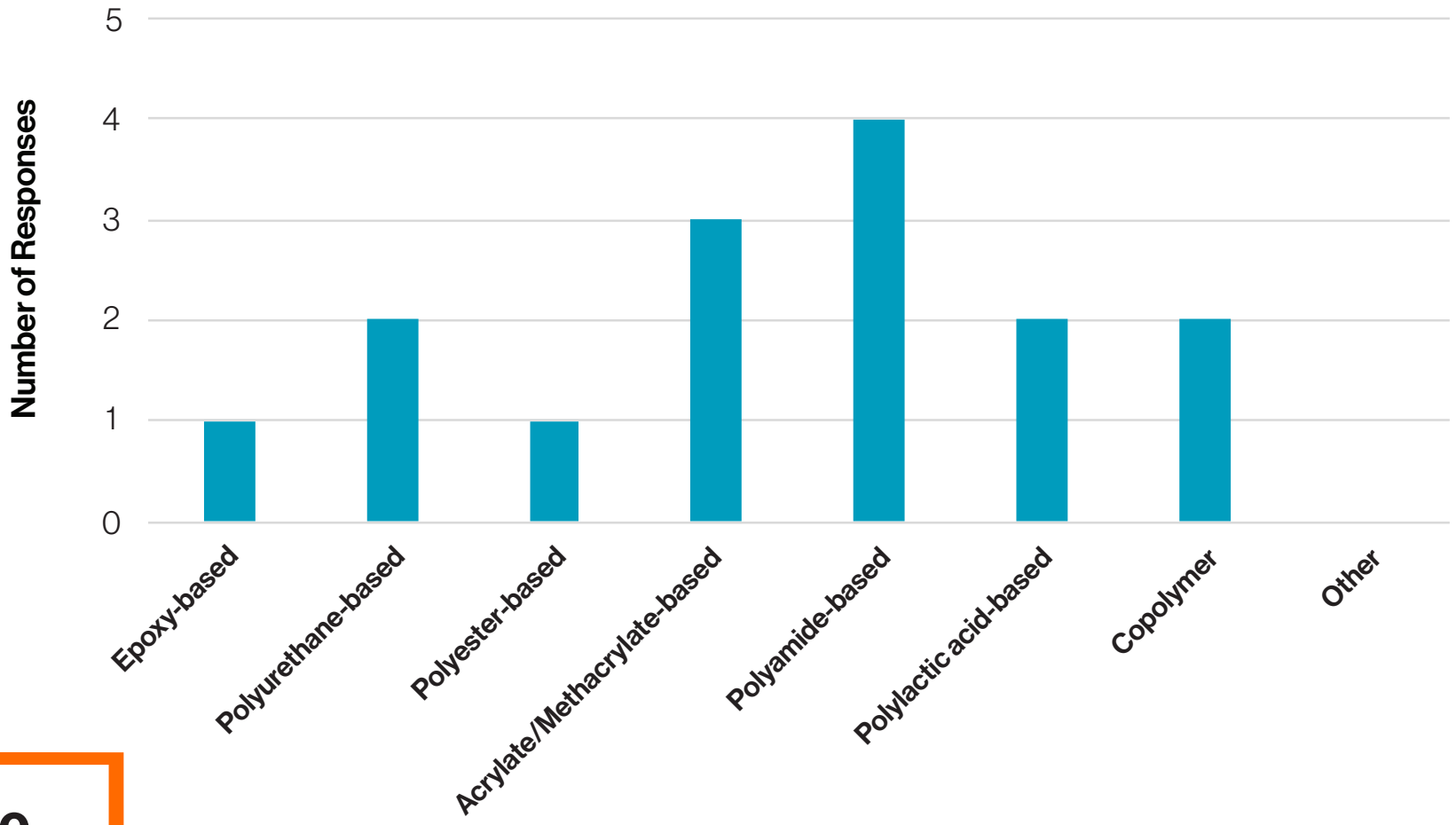
Have you performed a conservation treatment on the following types of 3D printed objects?



21
Respondents

Ten respondents indicated they have treated 3D printed plastic objects. The types of plastics treated by these respondents represented a range of materials.

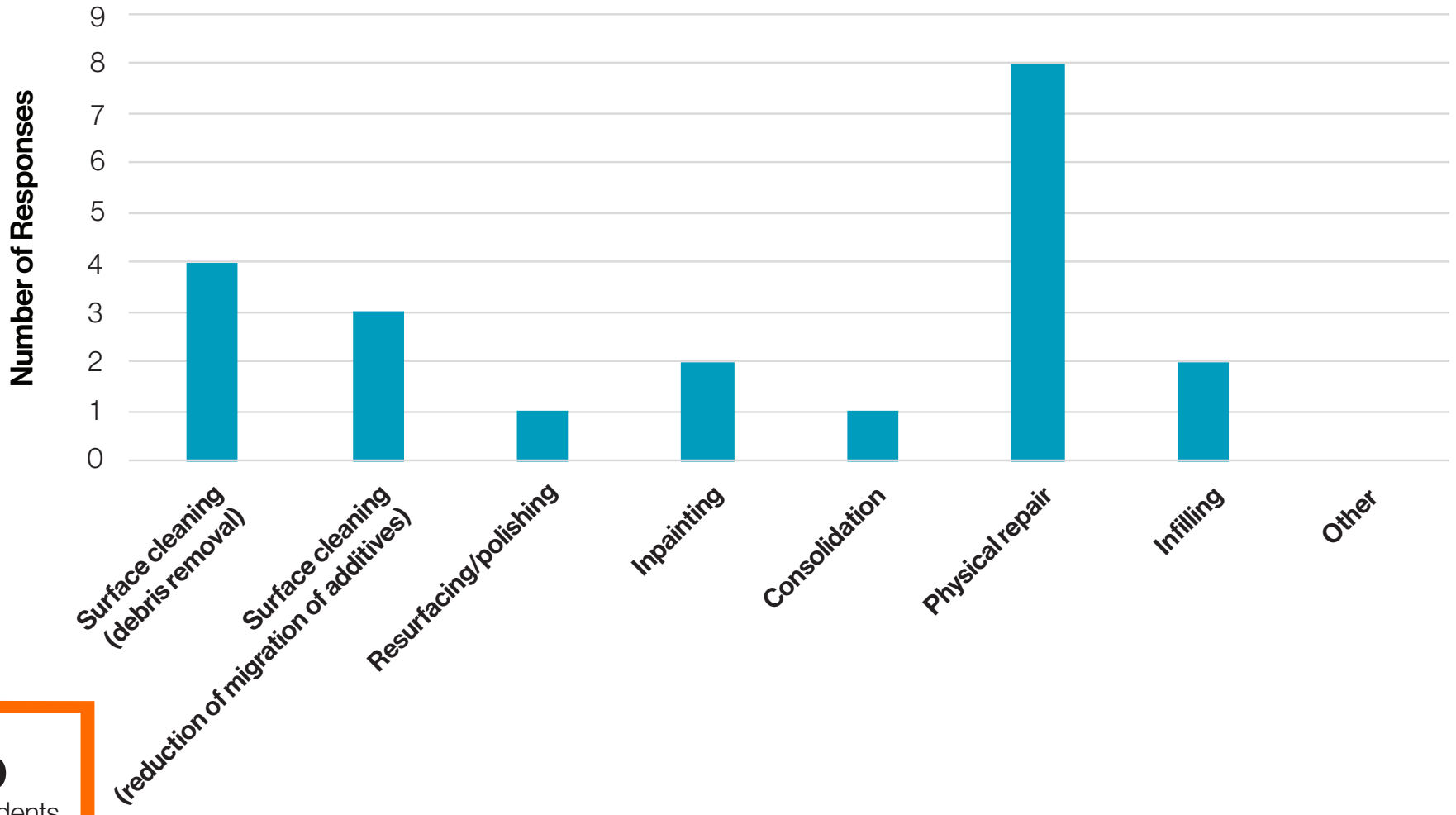
What types of 3D printed plastics have you treated (select all that apply)?



10
Respondents

Respondents were most likely to perform a physical repair on a 3D printed plastic object. Surface cleaning was also a commonly cited treatment, for different reasons.

What types of treatments did you provide on 3D printed plastics (select all that apply)?



10
Respondents

Specific information about which types of 3D printed plastic objects required which treatments are given in the table below:

3D Printed Plastic Type	Type of Treatment	Materials Used to Treat the Object
Polylactic acid-based	Physical repair	Cyanoacrylate adhesive
Polylactic acid-based; Polyamide-based	Surface cleaning-debris removal; Physical repair	Brushes, dust cloths, PVAc emulsion adhesives
Polyamide-based	Surface cleaning-debris removal; Inpainting; Physical repair; Infilling	Epoxy putty, watercolors
Polyamide-based	Resurfacing/polishing; Physical repair	Emulsion, cyanoacrylate
Polyamide-based; Acrylate/Methacrylate-based	Surface cleaning-debris removal; surface cleaning-reduction of migration of additives; Physical repair	Swabs coated with Lascaux dried to remove surface debris; Plexigum PQ611 in Shellsol T
Acrylate/Methacrylate-based	Inpainting; Physical repair; Infilling	Epoxy resin, carbonate mineral fillers
Acrylate/Methacrylate-based; Epoxy-based; Copolymer	Consolidation; Physical repair	Gesso and shellac
Copolymer; Polyester-based	Surface cleaning-debris removal; surface cleaning-reduction of migration of additives	
Polyurethane-based	Surface cleaning-reduction of migration of additives	
Polyurethane-based	Physical repair	

One respondent provided information on the type of treatment they performed on a 3D printed metal object:

Metal Type	Treatment Type	Materials Used to Treat
Precious Metals (e.g. Gold or Sterling Silver)	Resurfacing/Polishing	

Two respondents provided information on the type of treatment they performed on 3D printed glass or ceramic objects:

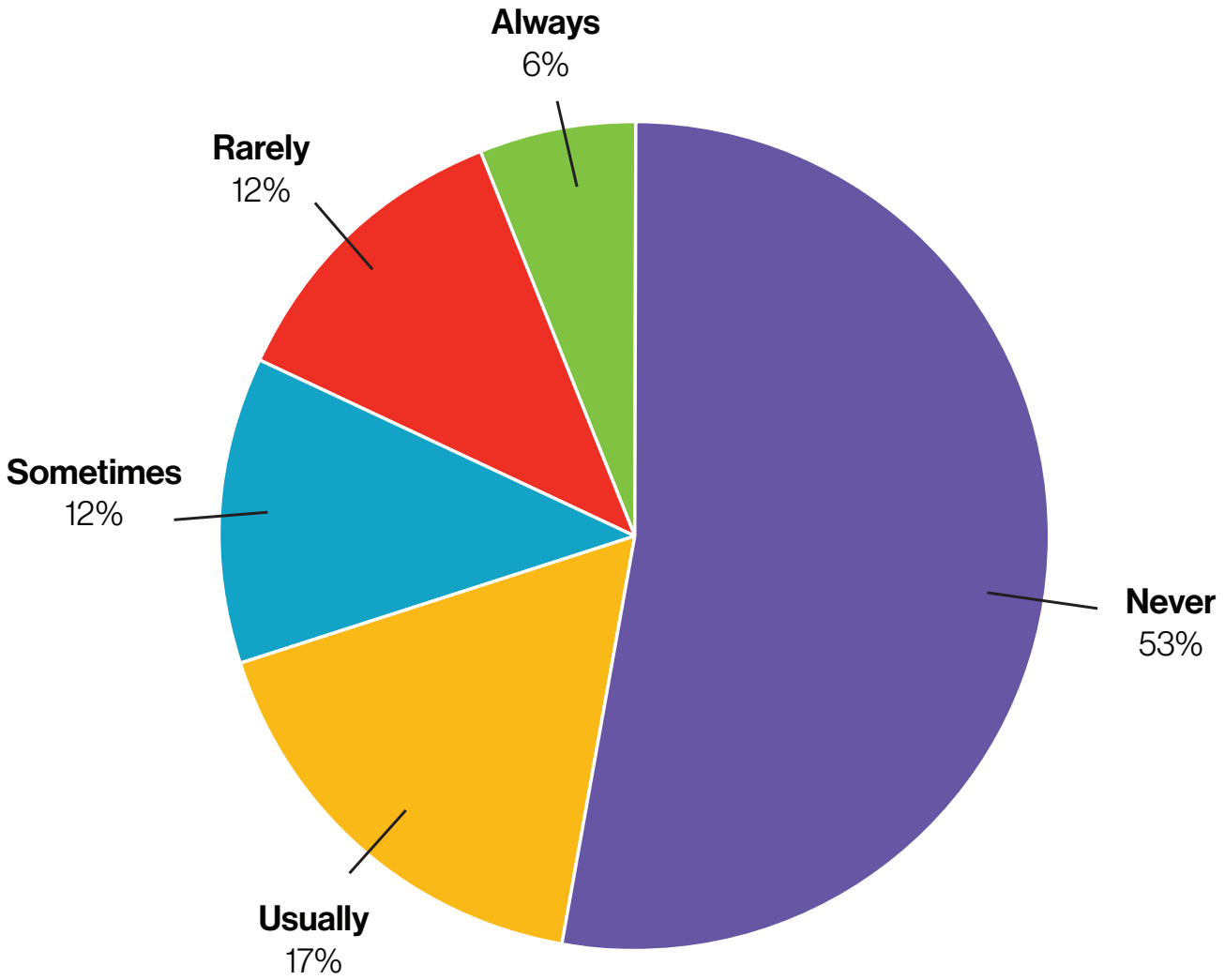
Ceramic or Glass Type	Treatment Type	Materials Used to Treat
Powder-based Ceramic	Physical repair; Inpainting	Lacquer, wax, cyanoacrylates
Extruded Glass	Consolidation	

One respondent provided information on the type of treatment they performed on 'other' 3D printed objects:

Material Type	Treatment Type	Materials Used to Treat
Concrete	Consolidation, Physical Repair, and Coating	

The frequency with which respondents collaborate with the artist and/or designer on the preservation of their 3D printed work varied, with almost half having pursued collaboration on some level.

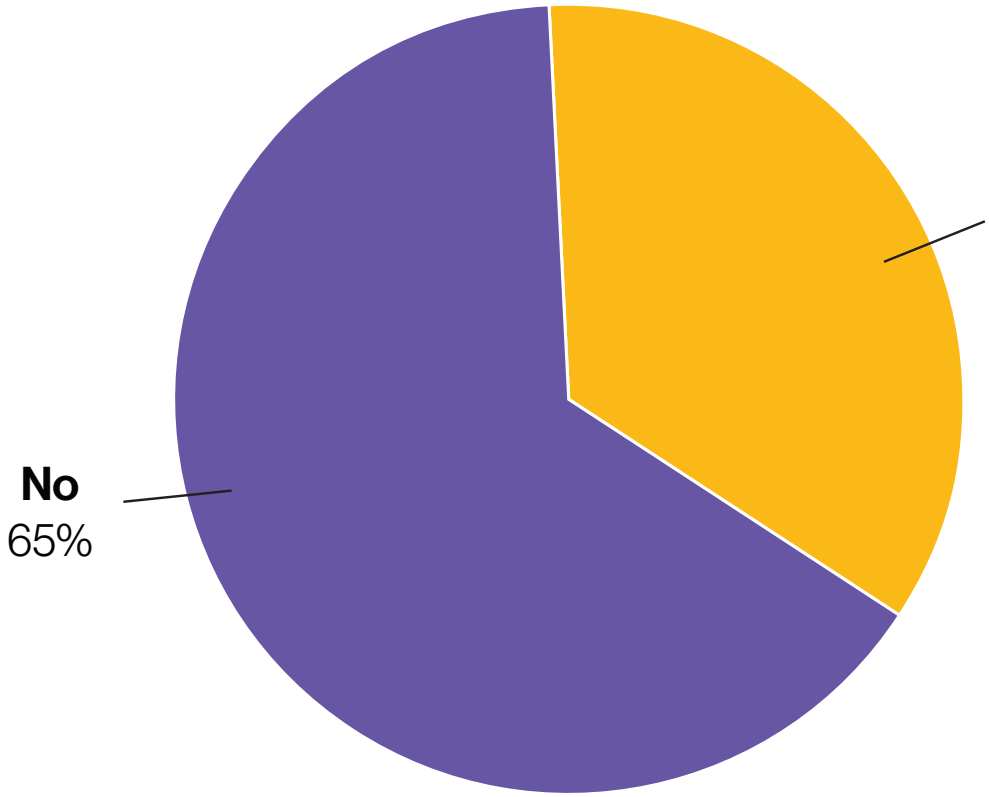
How frequently do you collaborate with artists and/or designers on the preservation of their 3D printed work?



17
Respondents

For 3D printed objects that were unable to be treated, over a third of respondents indicated that they have pursued reprinting.

Have you reprinted 3D printed objects that could not be treated?



The six respondents who pursued reprinting objects did not always work with the artist and/or designer of the object. Three indicated they 'usually' worked with the artist and/or designer, and three indicated they 'never' or 'rarely' worked with the artist and/or designer.

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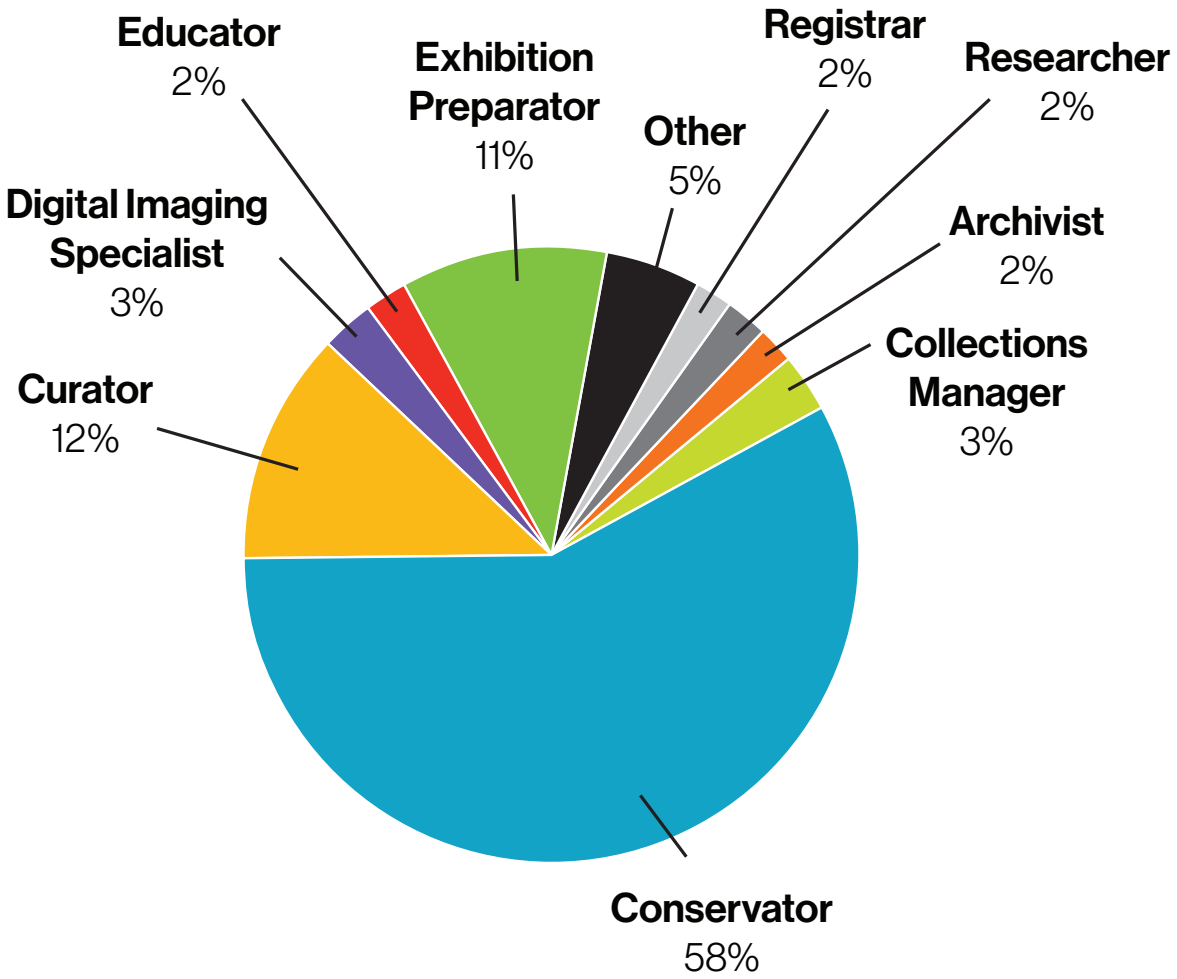
Respondents

3D Printing in Preservation and Access Activities

A majority of the survey respondents who chose to take the section of the survey on 3D printing in preservation and access activities indicated their professional role is conservator.

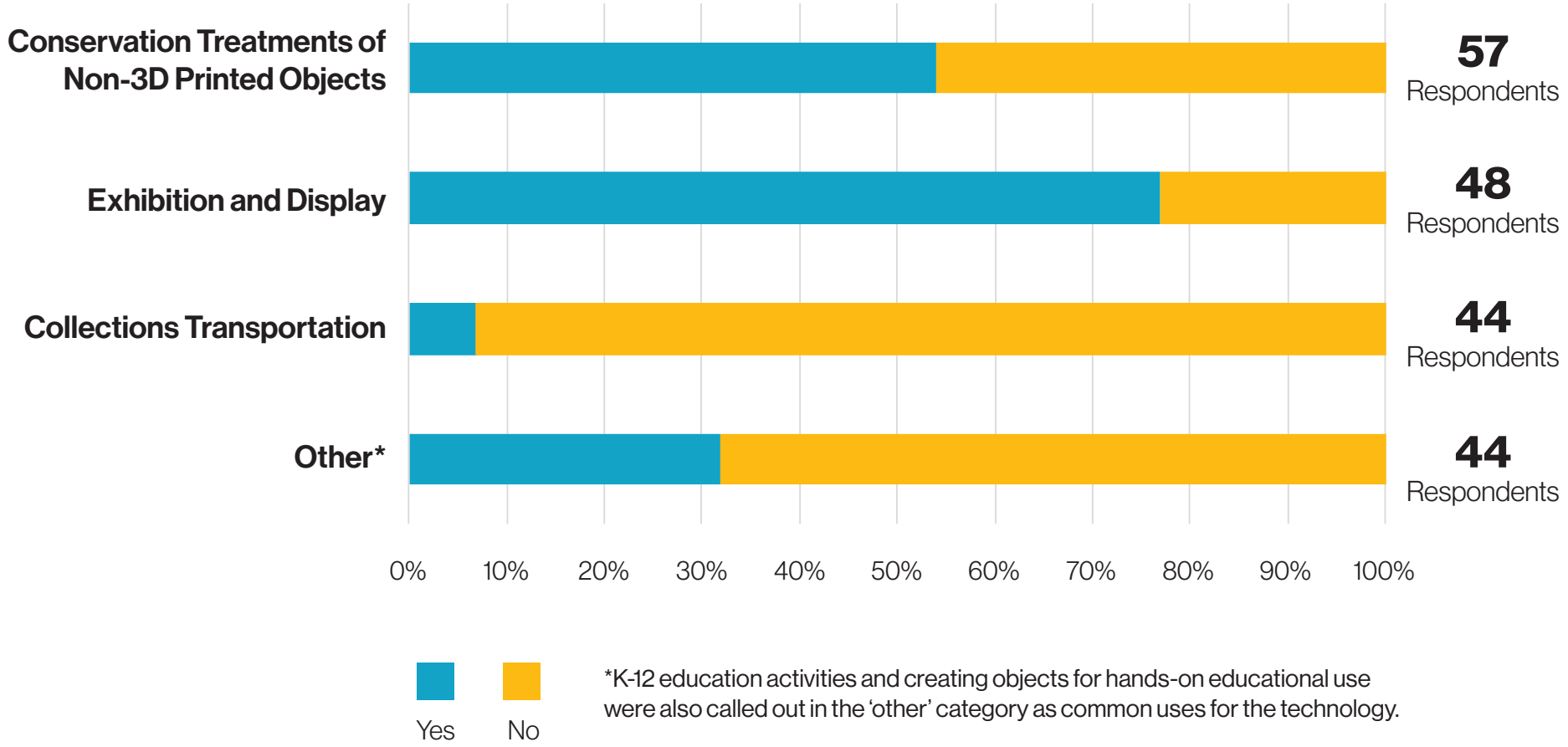
Which professional role listed below best aligns with your position?



57
Respondents

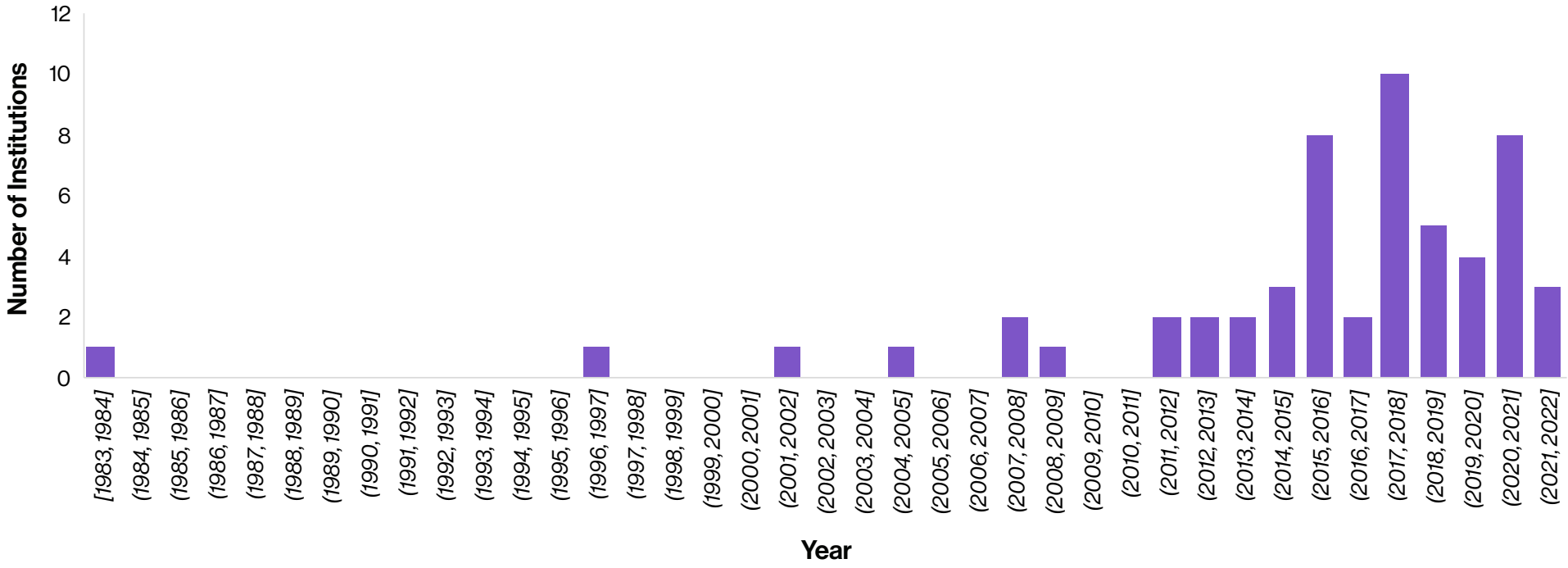
Respondents who chose to take the section of the survey on preservation and access activities indicated using 3D printing primarily to support exhibition and display activities, followed by conservation treatments of non-3D printed objects.

Have you used 3D printing to support the following preservation and access activities?



Survey respondents provided a date or a date estimate of when they first started using 3D printing in preservation and access activities. Most began using the technology in the mid- to late-2010s, while the earliest initial use dated back to the 1980s. One respondent indicated that they were not currently using the technology, but planned to use it in the future.

What year did you first start using 3D printing in preservation and access activities (if unsure please indicate best approximation)?

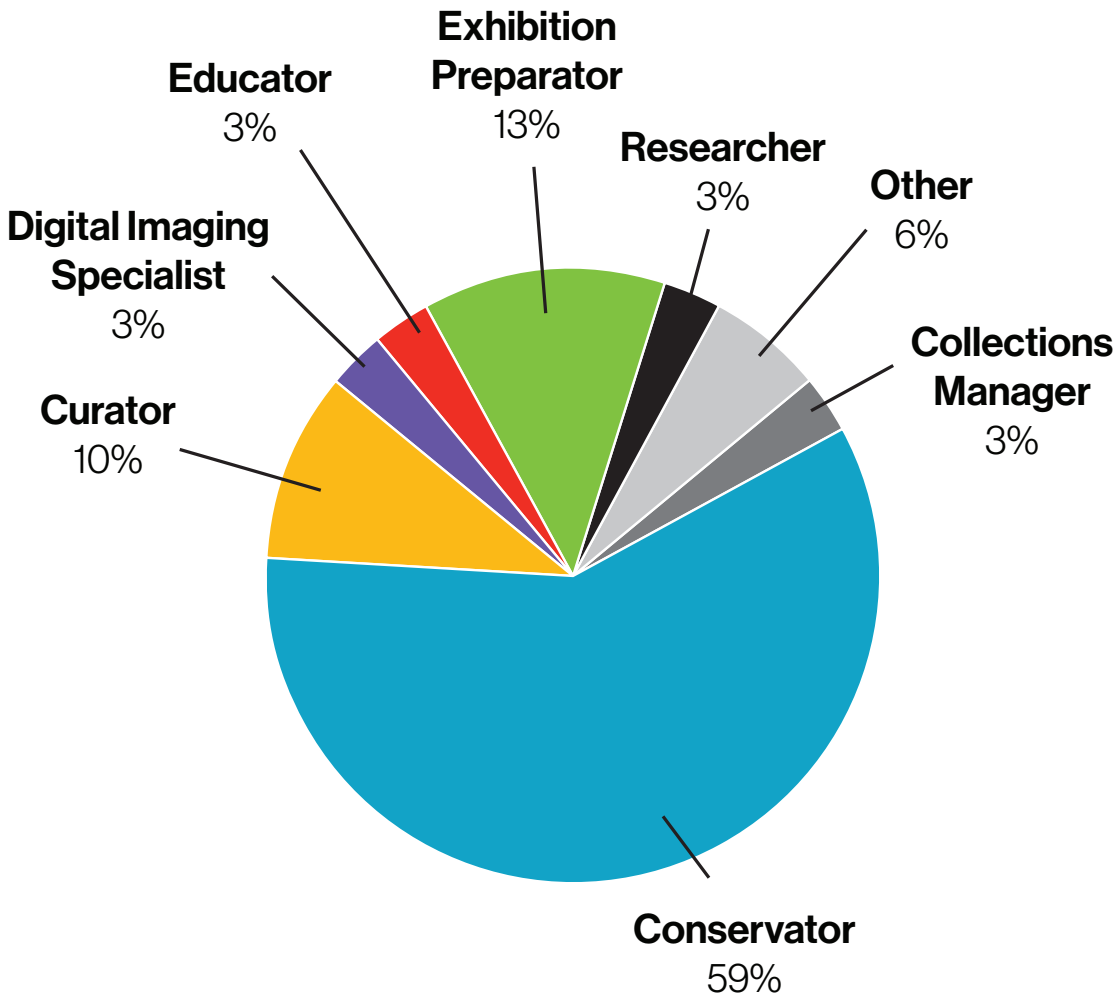


56
Respondents

3D Printing in Preservation and Access Activities: Conservation Treatments

A majority of the survey respondents who chose to take the section of the survey on the use of 3D printing to support conservation treatments of *non*-3D printed objects indicated their professional role is conservator.

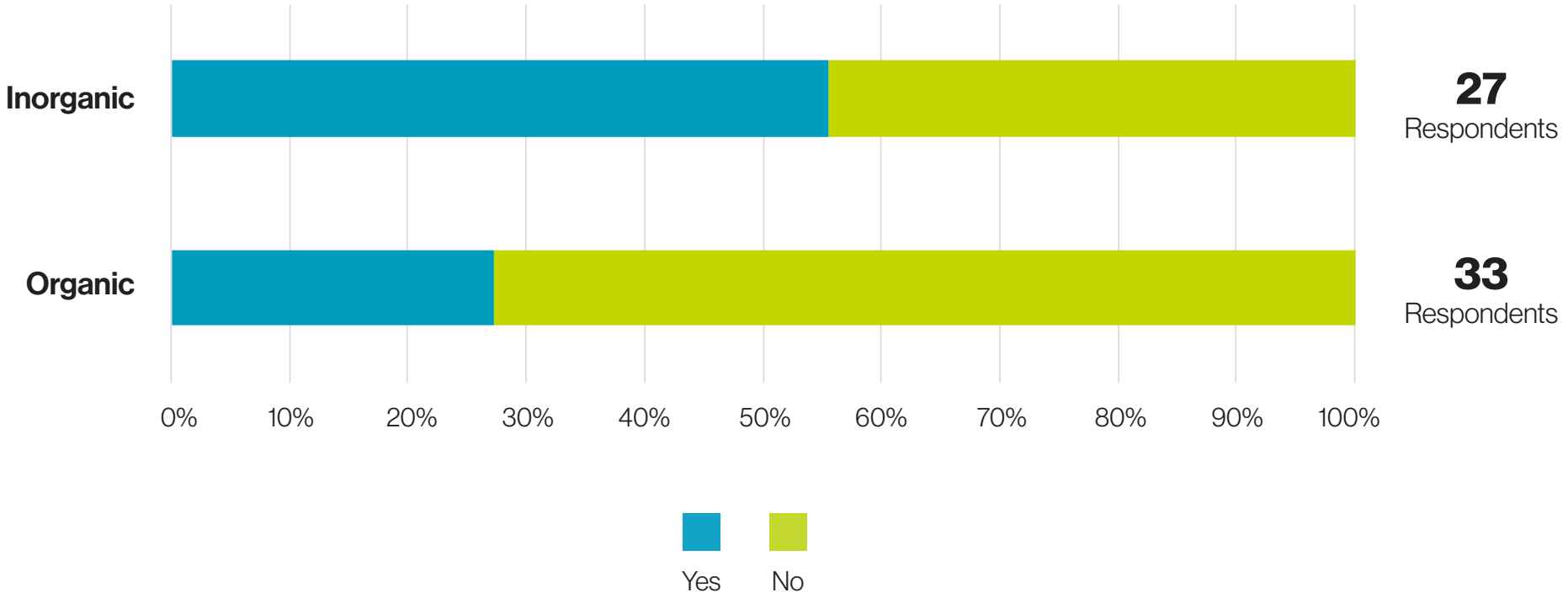
Which professional role listed below best aligns with your position?



33
Respondents

More survey respondents used 3D printing as a tool to treat *inorganic* objects as opposed to *organic* objects.

Have you treated the following types of objects using 3D printing as a tool?



Twelve respondents who used 3D printing to support the conservation treatment of inorganic objects provided information about the type of object that was treated and the 3D printed material used during the treatment process.

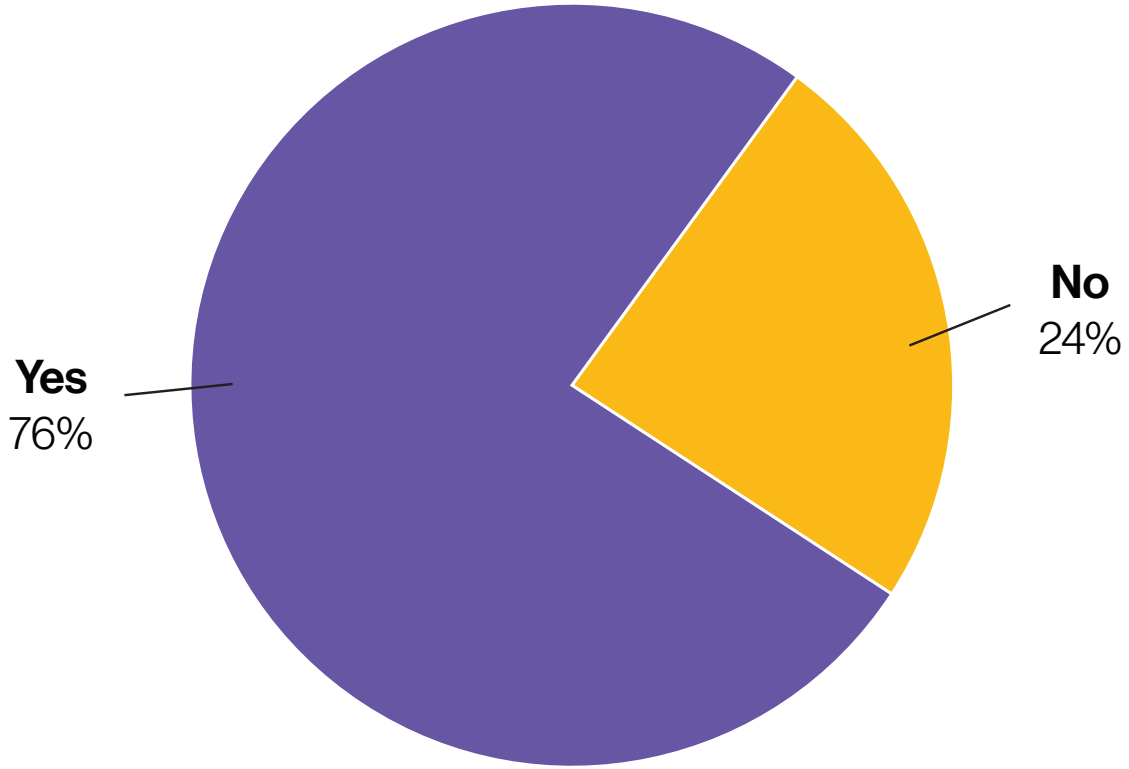
Object Description	How 3D Printing Was Used	3D Printed Materials and/or Technologies Used
Plastic and Metal Object	3D printed replacement parts on objects that have visitor interaction. Fragile or difficult to locate parts are replicated through 3D printing for "preservation by replacement"	Polyester-based
Metal Sculpture	3D printed replica	
Stone	3D printed replica of a sculpture that was otherwise obscured	
No description of object		Nylon 12/carbon fiber
Fossil	3D print of object used for casting a replica in a more traditional material	Unsure/Unknown
No description of object	3D printed replica	Ceramic powder from a powder bed fusion printing technology
Porcelain	3D print of object used for casting replacement parts	Polyester-based
Ceramic/Porcelain	3D print of object used for casting a replica in a more traditional material	Polylactic acid-based
Steel Sculpture	3D printed replica from a 3D model	Polyester-based
Salt Cores		
Ceramic and Metal	Used to generate different design options for loss compensation. 3D print of object used for casting replacement parts	Acrylate/Methacrylate-based; Polylactic acid-based; Copper Alloy (e.g. Bronze)
Porcelain		Powder-based ceramic; Pure porcelain and, in another case, a composite material used in medical applications

Eight respondents who used 3D printing to support the conservation treatment of organic objects provided information about the type of object that was treated and the 3D printed material used during the treatment process.

Object Description	How 3D Printing Was Used	3D Printed Materials and/or Technologies Used
Paper Fan	Creation of a custom mount to better support the object	Unsure/Unknown
Unsaturated Polyester Objects	3D print of object used for casting a replica in a more traditional material	Styrene-Acrylic; Polyurethane
Wooden Object		Unsure/Unknown
Plaster and Wooden Object	3D print of missing elements	Polylactic acid-based
Natural Objects	Scan and 3D print of missing elements	Epoxy-based; Polyurethane-based; Possibly copolymer
Tile artifacts made from an undocumented mix of clay and ceramics reinforced with horse hair		Polyamide-based
Mummies, coffins		Polyester-based; Acrylate/Methacrylate-based; Polyamide-based; Polylactic acid-based; Polyethylene
Wooden model threshing machine	3D printed replacement parts	Polylactic acid-based wood composite

In many cases, digital scanning technology was utilized during the treatment process. Based on written responses, 3D printing is often used to create a surrogate or replica of an object from a 3D scan. These prints are often used for casting to create molds for replacement parts on objects in more traditional materials.

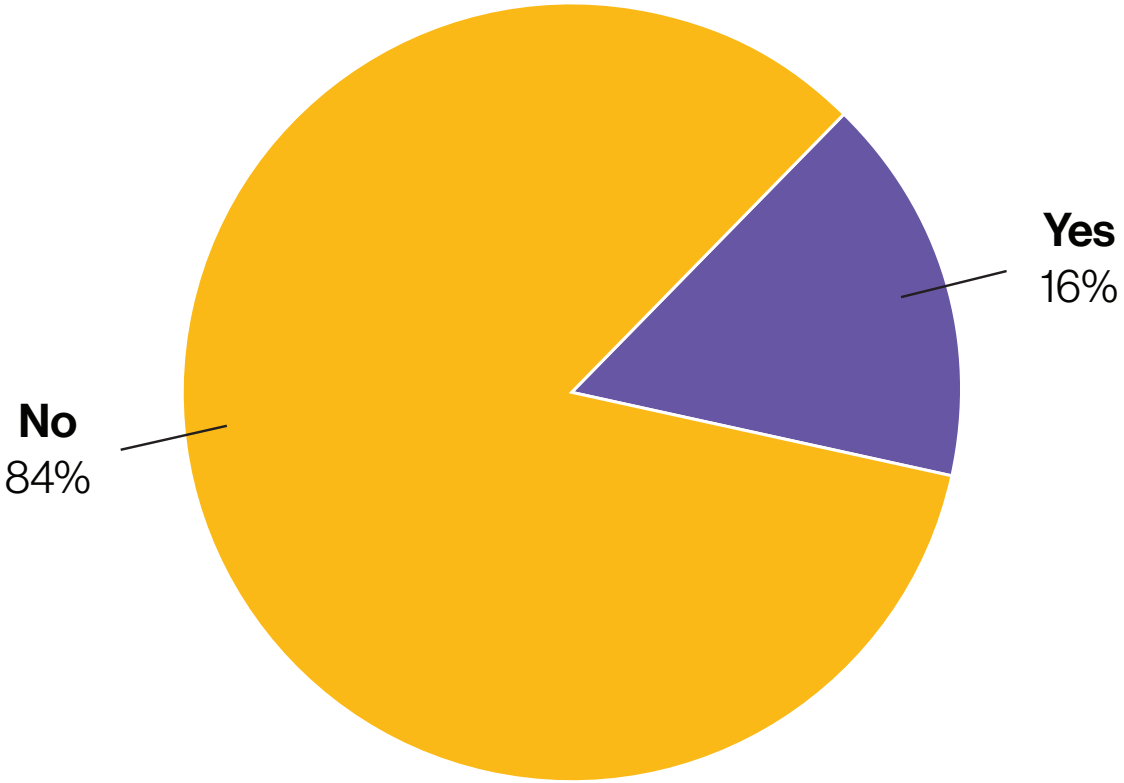
Was digital scanning technology used in the treatment process?



25
Respondents

Only 16% of respondents used 3D printed materials for integrations such as infills during a treatment project. The length of time the integration remained in contact with the object varied. In some cases, the integration was only in contact with the object for seconds, while others were in contact for the duration of an exhibit or until the next treatment of the object.

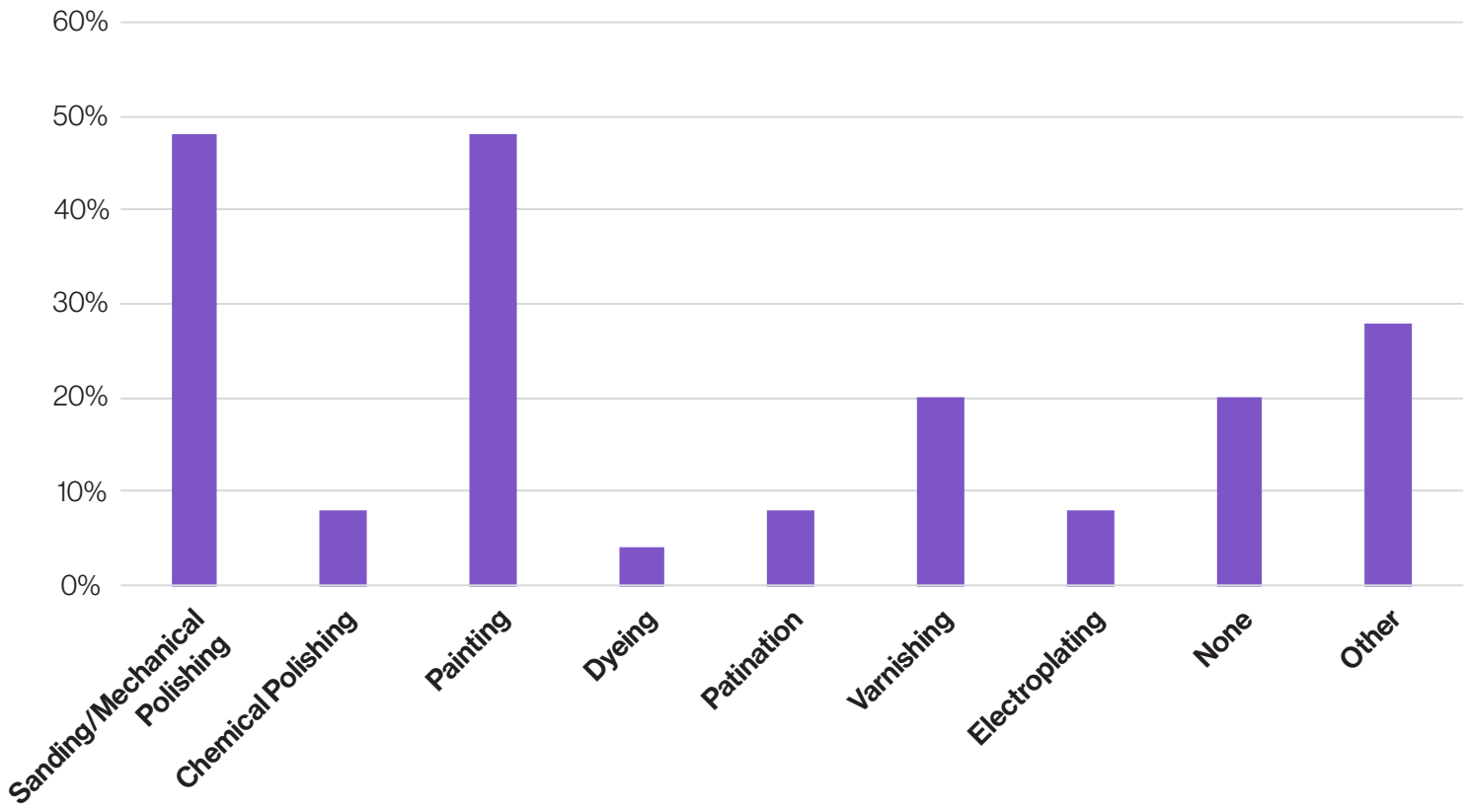
Have you used 3D printed materials for integrations in treatment projects (e.g. infills)?



25
Respondents

Respondents indicated that sanding or mechanical polishing and painting were the two most frequently used finishing techniques that they have applied to 3D printed materials used in conservation treatments. Other finishing techniques included coating and consolidating with epoxy for a replica, applying a sueded polyethylene finish (in the case of a supportive mount), and gilding to match the original object.

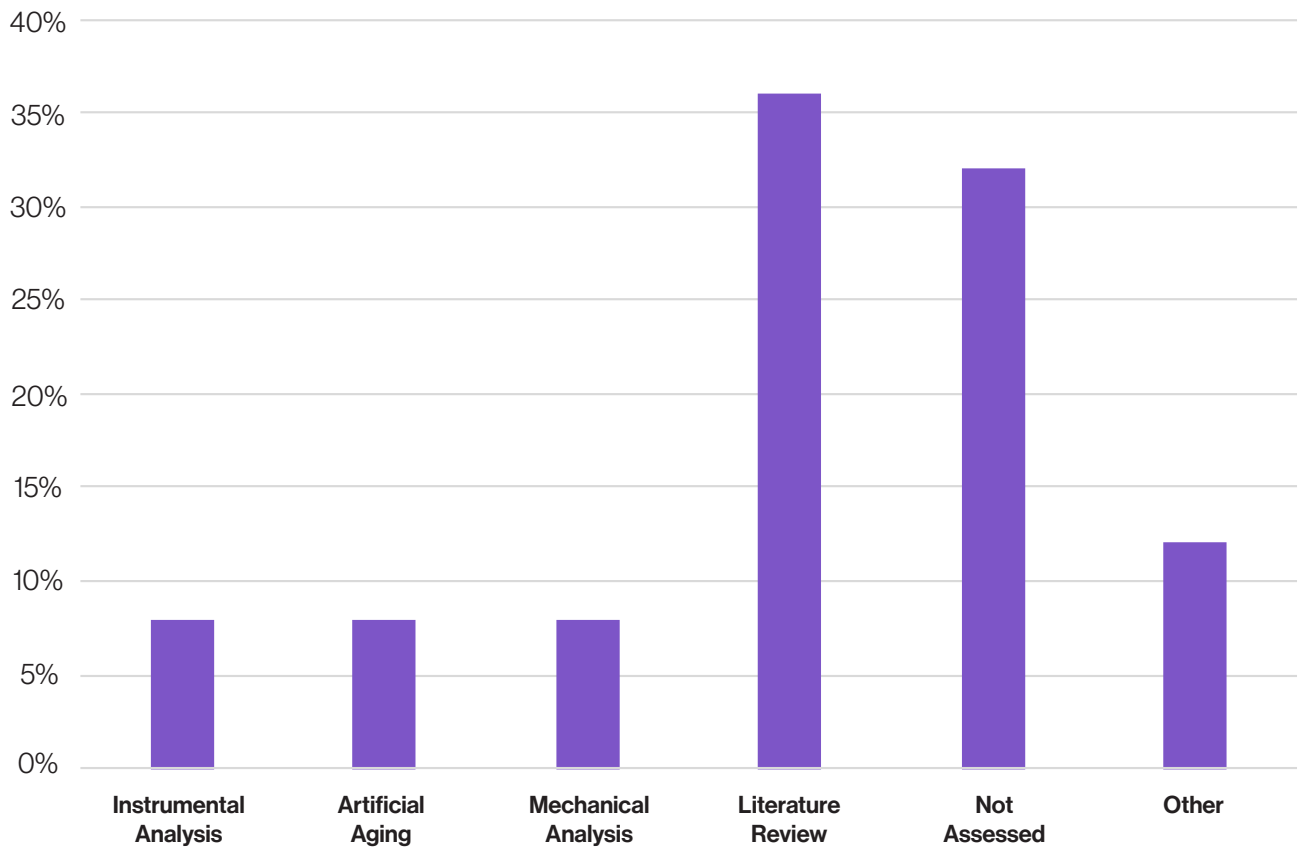
What types of finishing techniques have you applied to 3D printed materials used in conservation treatments (select all that apply)?



25
Respondents

Literature reviews were most commonly cited as the method through which 3D printed materials were assessed for longevity and safety, followed by no assessment. Some comments indicated that longevity and safety were not assessed because the 3D printed material was not used in long term contact with the object, or was used to cast a more traditional material that would then be used with the object.

How was the longevity and safety of the 3D printed materials used in conservation treatments assessed (select all that apply)?

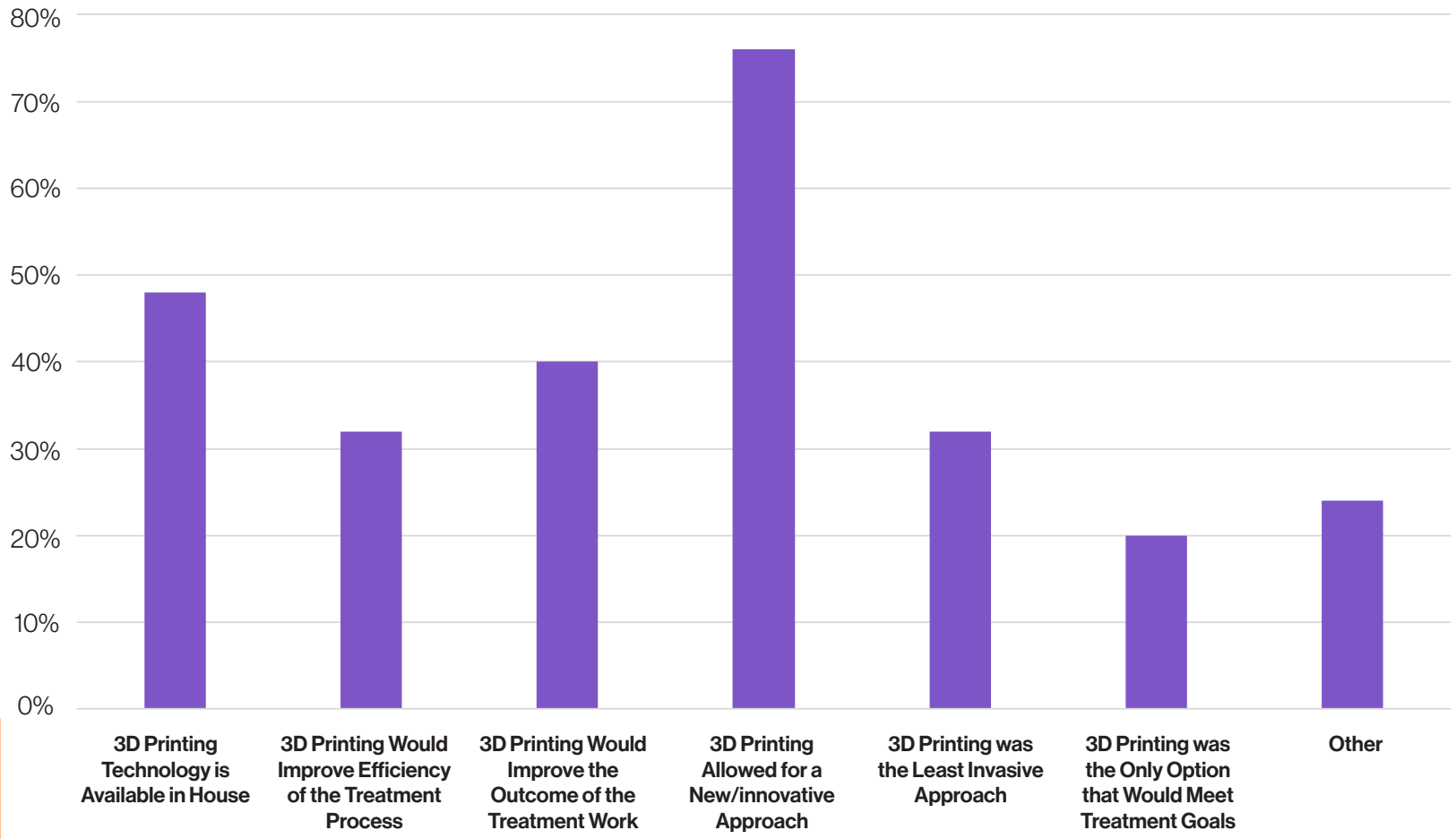


25
Respondents

Image Permanence Institute - February 2023

3D printing as a new and innovative approach was cited most commonly as a reason for its use during the treatment process. In written responses, 3D printing was used because the technology aided in visualization (3 responses), it was investigated as part of a research project (1 response), or it enabled educational opportunities for students (1 response).

Why was 3D printing considered a viable treatment option (select all that apply)?

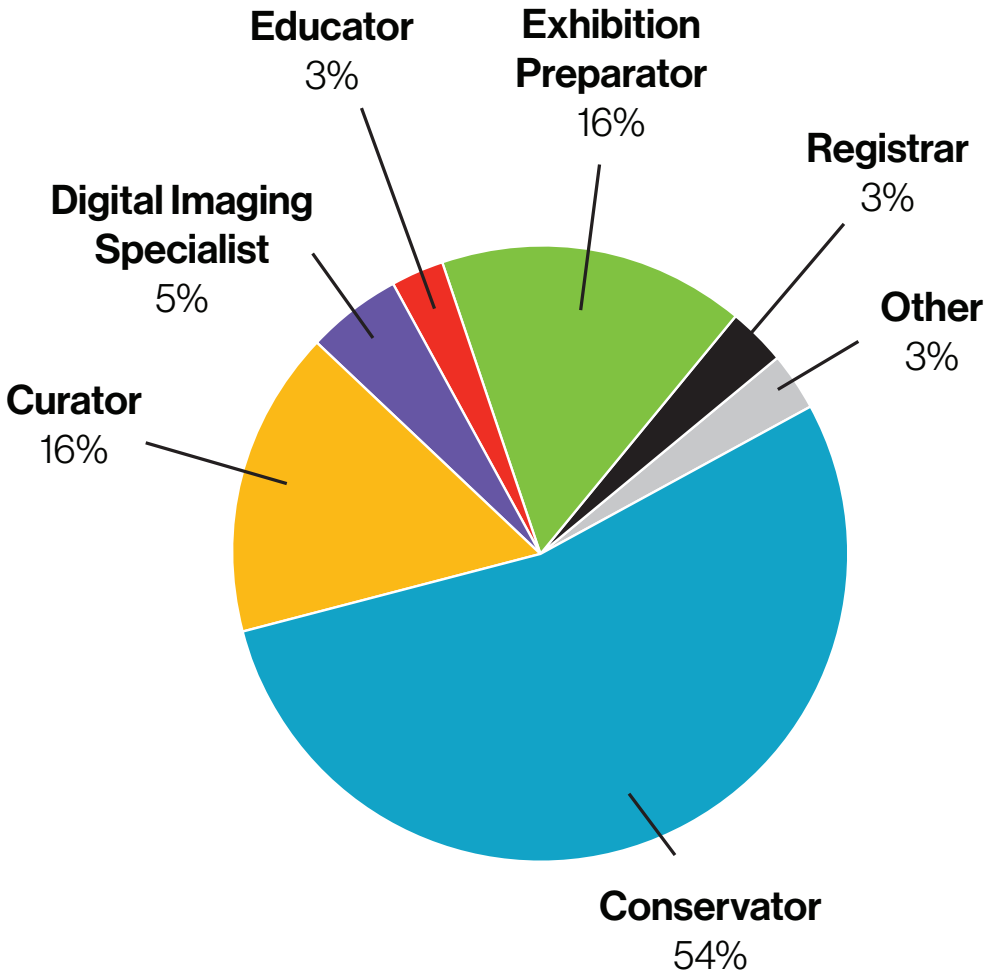


25
Respondents

3D Printing in Preservation and Access Activities: Exhibition and Display

Just over half of the survey respondents who chose to take the section of the survey on the use of 3D printing to support exhibition and display activities indicated that their professional role is conservator. Exhibition preparators and curators together constituted about a third of survey respondents for this section.

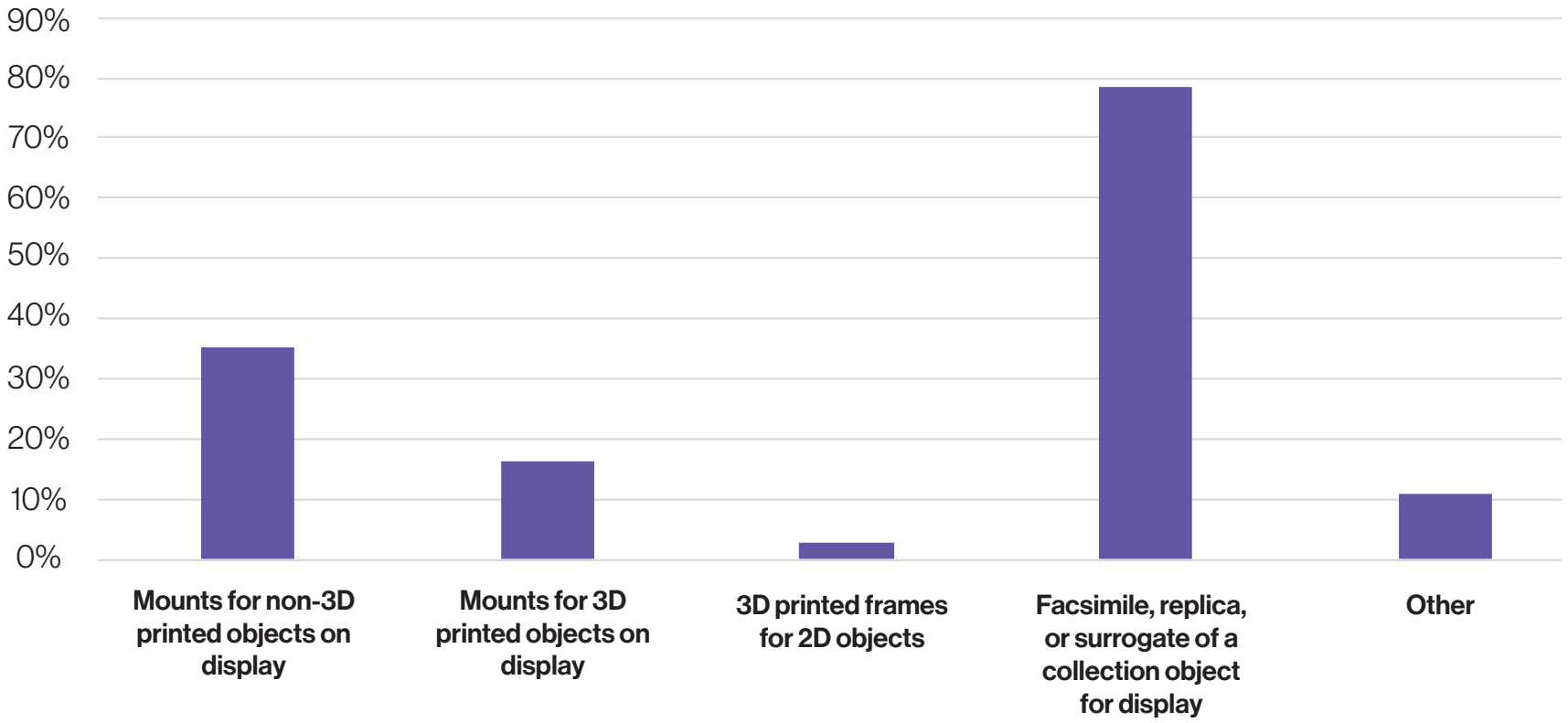
Which professional role listed below best aligns with your position?



37
Respondents

Of the respondents who use 3D printing for exhibition and display activities, the majority have used the technology to create a **facsimile, replica, or surrogate** of a collection object for display purposes.

What type of exhibition display needs have you used 3D printing to support?

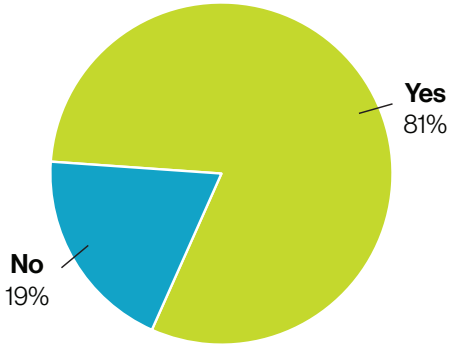


37
Respondents

A majority of respondents indicated using 3D printed plastic materials for exhibition display needs. 3D printed plastics remain the most common type of material used for preservation and access activities.

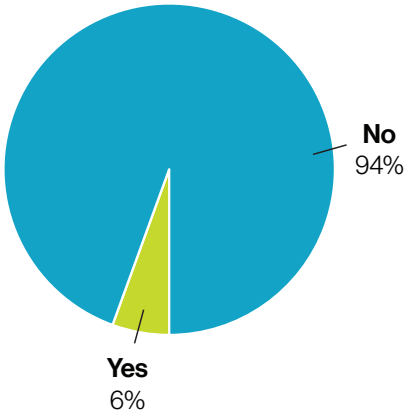
Have you used the following types of 3D printed materials for exhibition display needs?

3D Printed Plastic



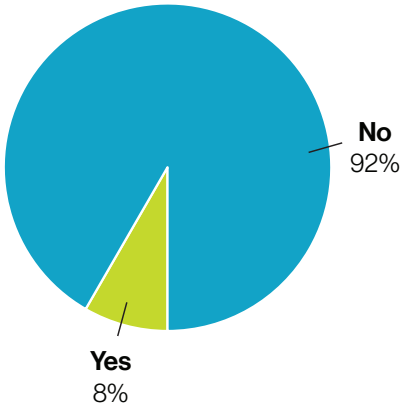
36
Respondents

3D Printed Metal



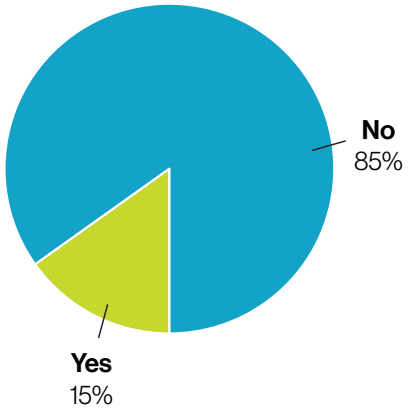
36
Respondents

3D Printed Ceramic or Glass



36
Respondents

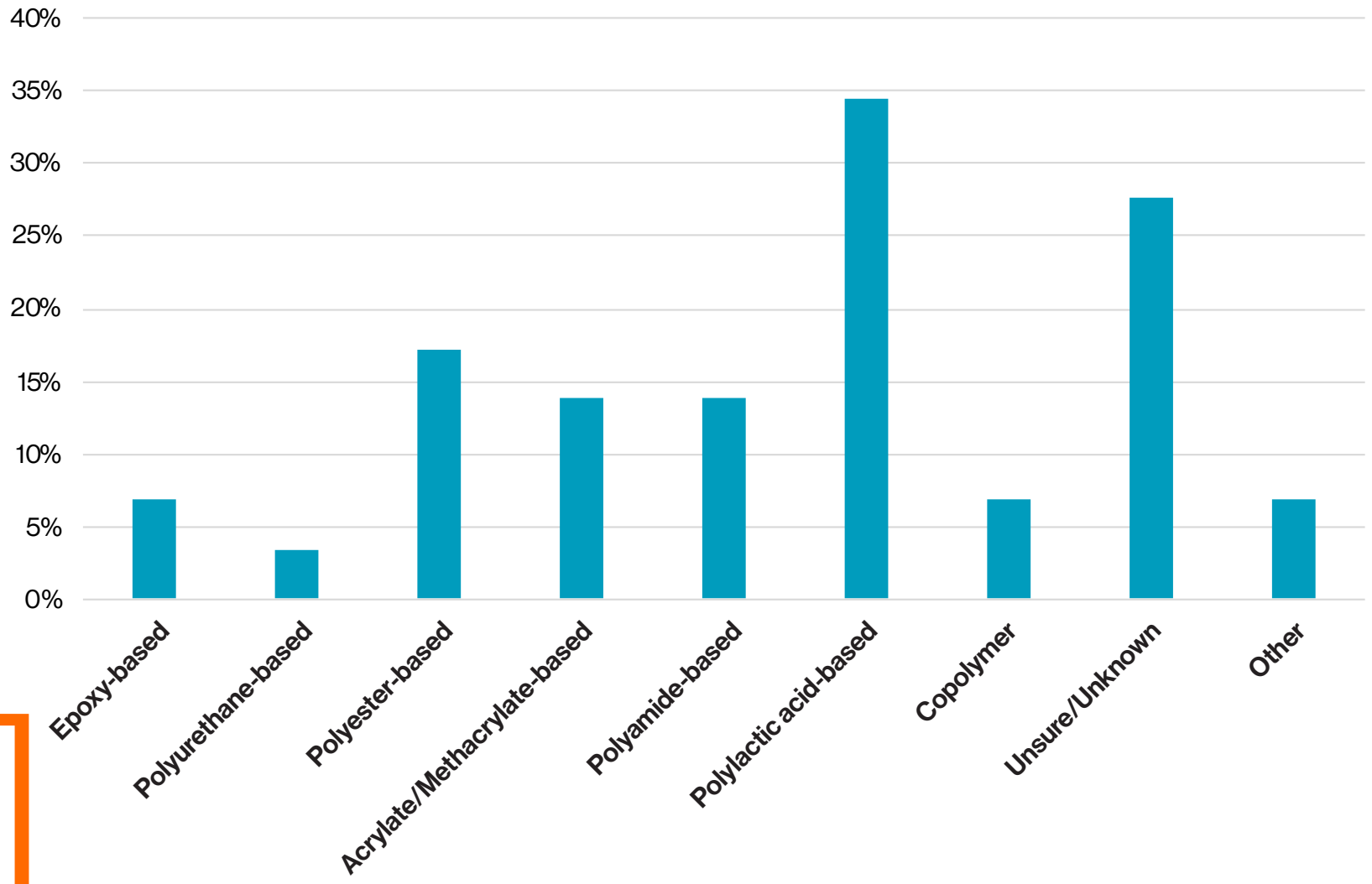
Other Types of 3D Printed Materials



33
Respondents

Of respondents who have used 3D printed plastics for exhibition display needs, over a third indicated that polylactic acid-based plastic(s) were used. In many instances, however, the type of plastic used was unknown. Many respondents indicated this was because they were not directly involved in choosing or 3D printing the material.

What types of 3D printed plastics have you used for exhibition display needs (select all that apply)?



29
Respondents

Fewer respondents used 3D printed non-plastic materials for exhibition and display activities. The number of responses and materials used are shown below:

3D Printed Metals
(2 respondents)

- Aluminum Alloy
- Titanium Alloy
- Brass

3D Printed Ceramic or Glass
(3 respondents)

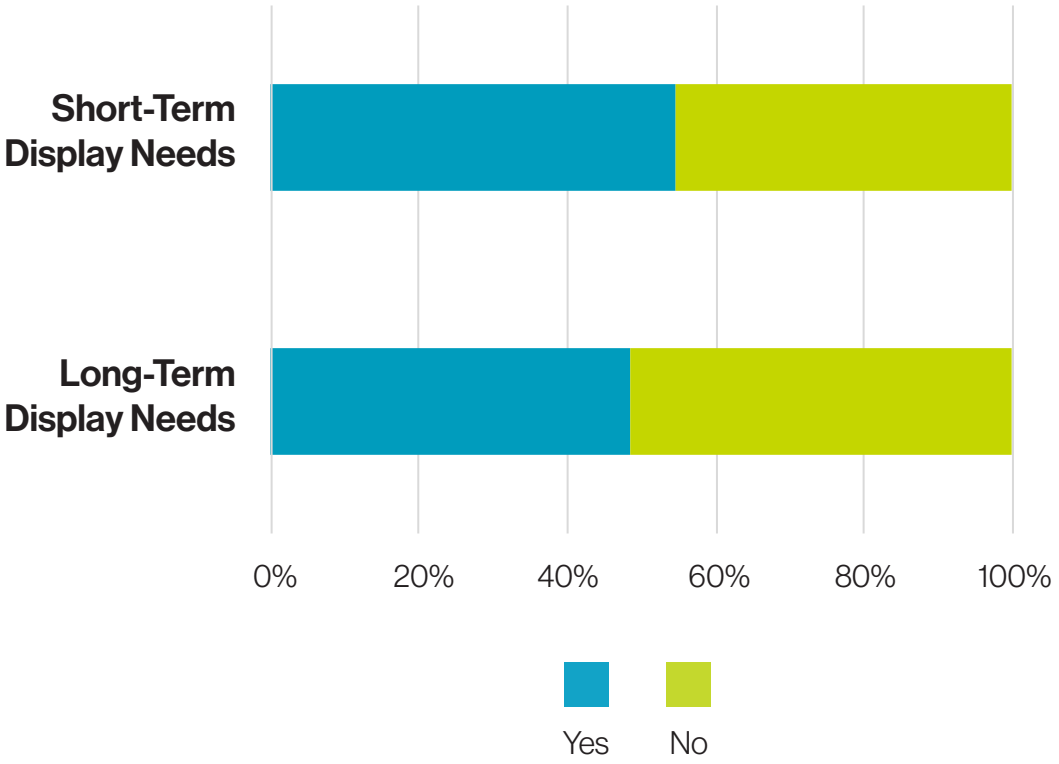
- Powder-based ceramic

Other 3D Printed Materials
(5 respondents)

- Resin
- Paper
- Wood
- Gypsum

About the same number of respondents have used 3D printed materials to support both short-term and long-term display needs. These varied and included 3D printing for tactile aspects of exhibits as well as 3D printed replicas for display of objects that are considered too fragile for exhibition.

Have you used 3D printed materials to support the following?



33
Respondents

Top 5
Short-Term Display Needs

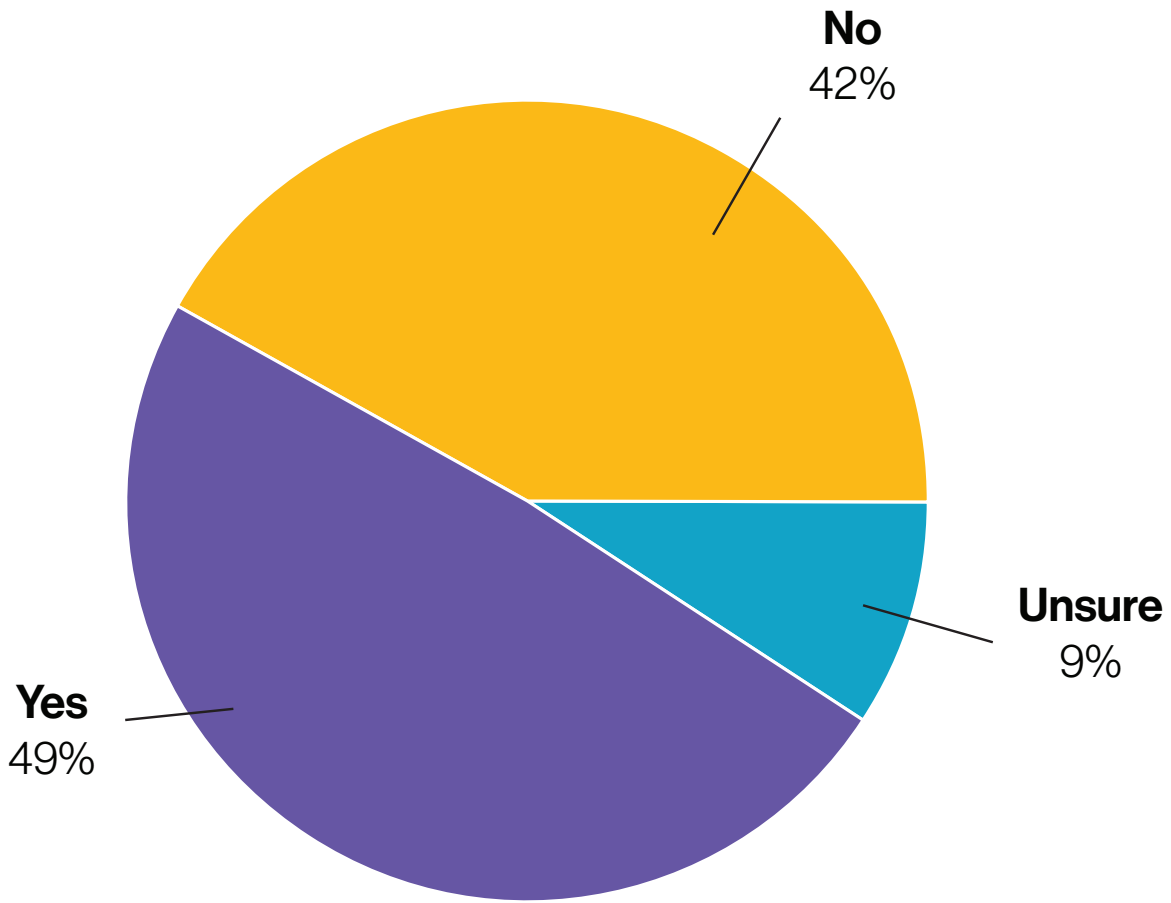
1. Replicas or objects for tactile interaction
2. Replicas for display in non-permanent exhibitions
3. Short-term display mounts/frames
4. Visual aids for exhibits
5. Objects in a temporary exhibit

Top 5
Long-Term Display Needs

1. Replicas for long-term display of fragile objects
2. Replicas or objects for tactile interaction
3. Props/models for display
4. Printed piece on display with object to show missing parts
5. Used for a long-term touring exhibition

Almost 50% of respondents indicated that digital scanning technology was used to support exhibition and display needs.

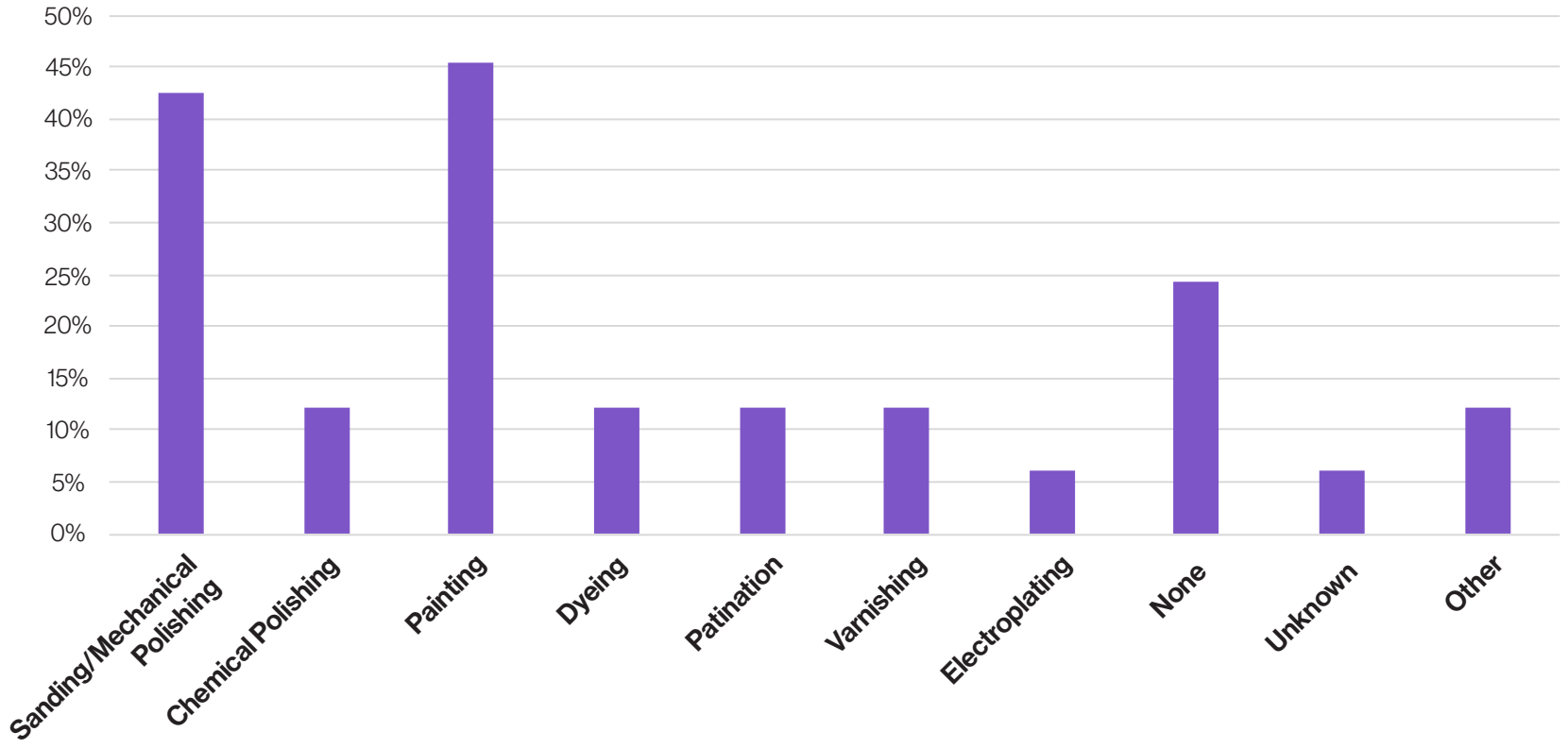
Was digital scanning technology used to support exhibition display needs?



33
Respondents

Sanding/mechanical polishing and painting are most frequently used to finish 3D printed materials for exhibition and display. In a few cases, respondents indicated applying different types of coatings, such as calcite, to provide a particular look to the 3D print for exhibition.

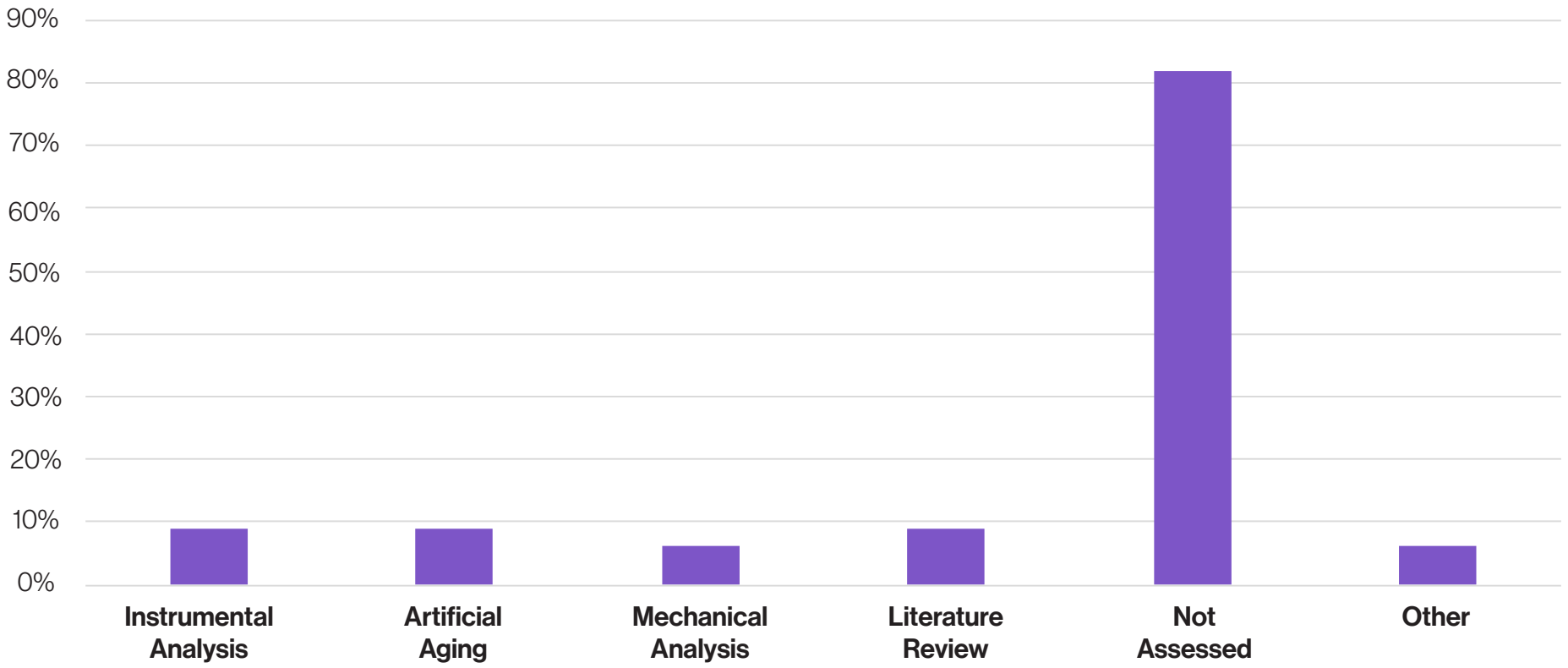
What type of finishing techniques were applied to the 3D printed materials used for exhibition display (select all that apply)?



33
Respondents

The longevity and safety of the 3D printed materials used for exhibition and display were often not assessed. Written responses indicated that this was because the pieces were meant for visitor engagement or because they were not in contact with an original object.

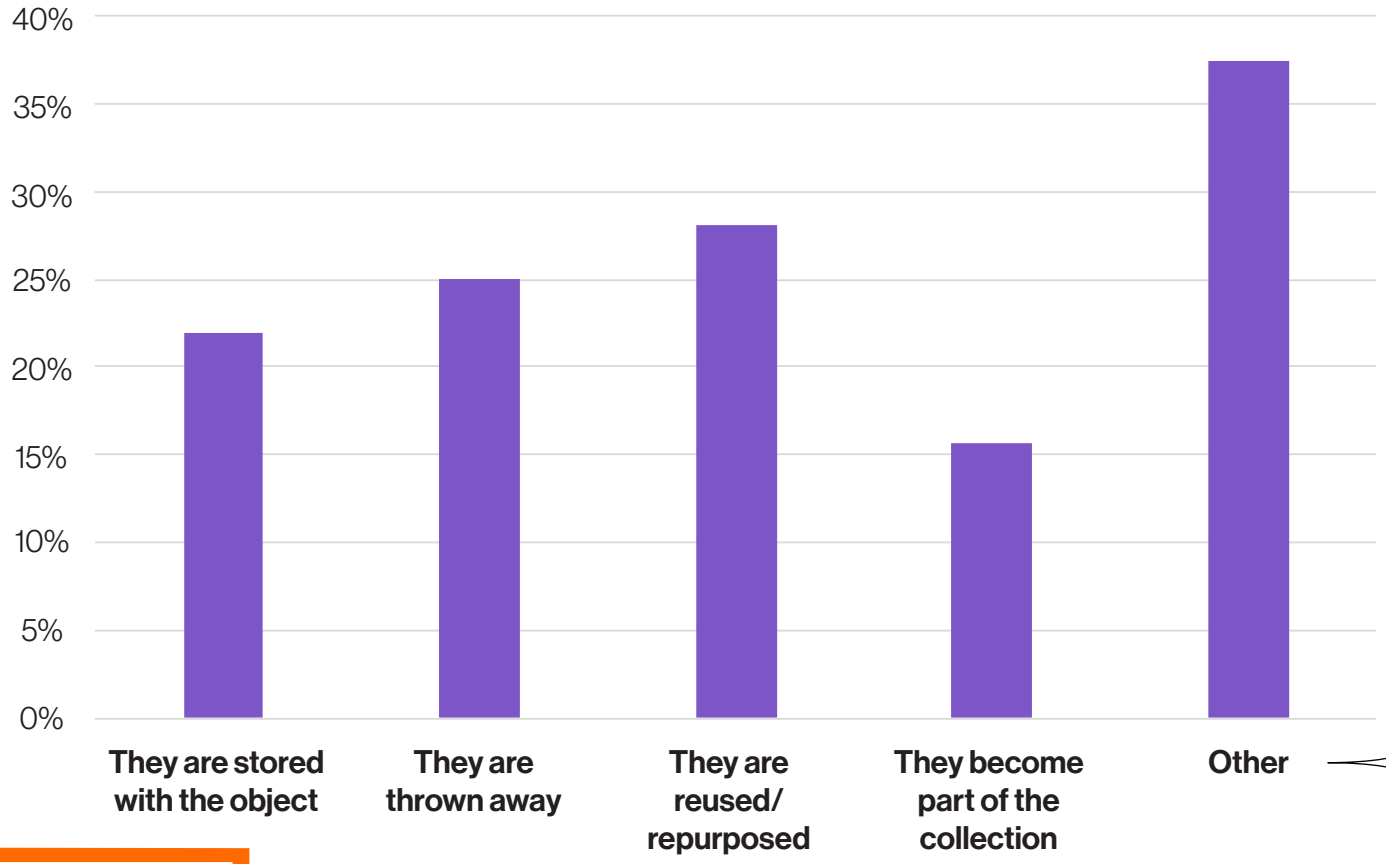
How was the longevity and safety of the 3D printed materials used for exhibition display assessed (select all that apply)?



33
Respondents

When asked about what happens to the 3D printed elements after display, respondents often chose a number of different possibilities. Many 3D printed elements are retained after the exhibition ends.

What happens to the 3D printed exhibition display elements once the exhibition ends (select all that apply)?

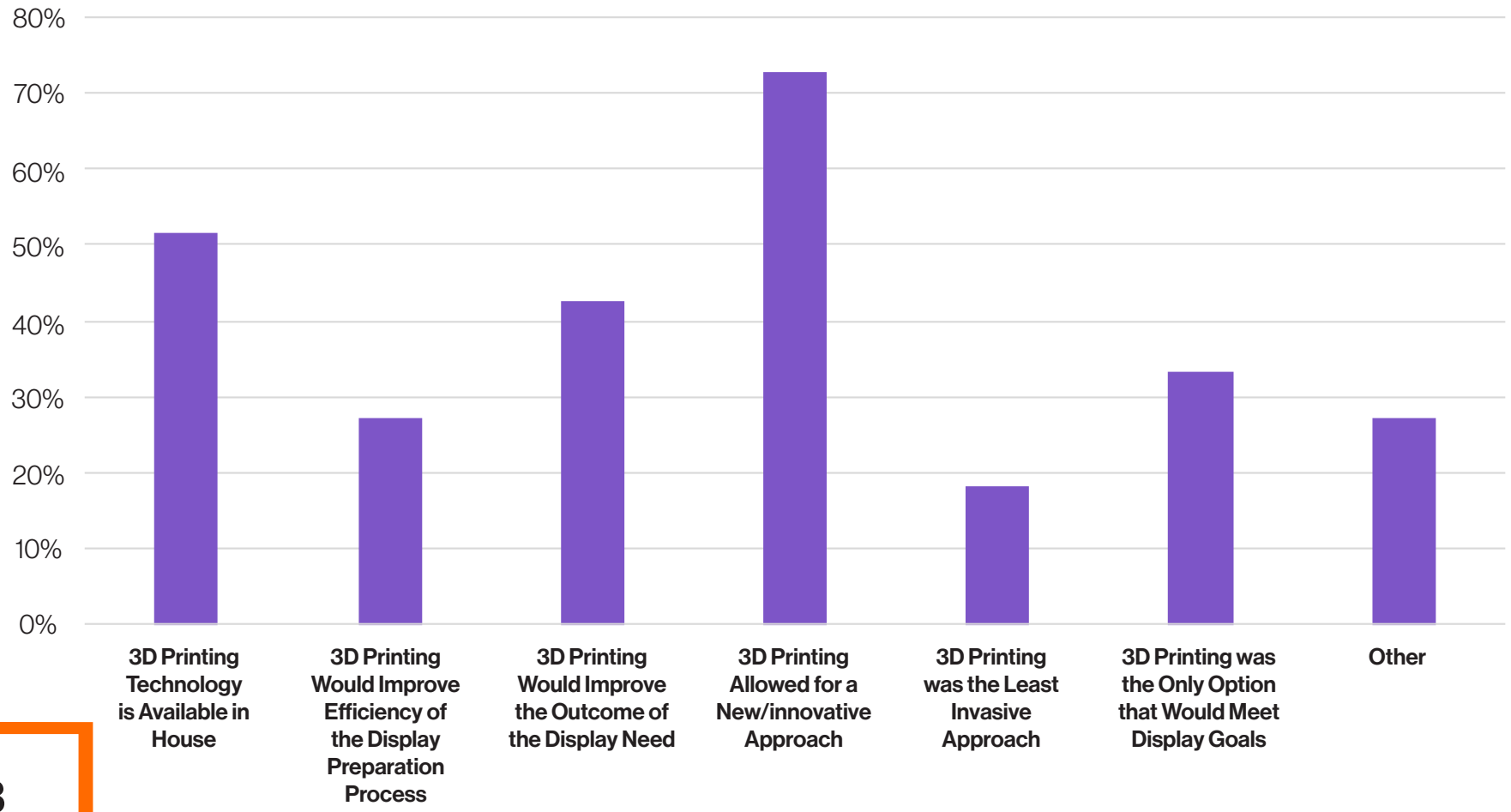


The most common responses in the 'other' category were that the objects were either put into storage for future reference or educational use, or that respondents' institutions had no policy and end-of-use was never discussed.

32
Respondents

As in other sections, 3D printing as a new/innovative approach was the most common response when indicating why the technology was considered viable for this use case.

Why was 3D printing considered a viable exhibition display option (select all that apply)?



33
Respondents

3D Printing in Preservation and Access Activities: Collections Transportation

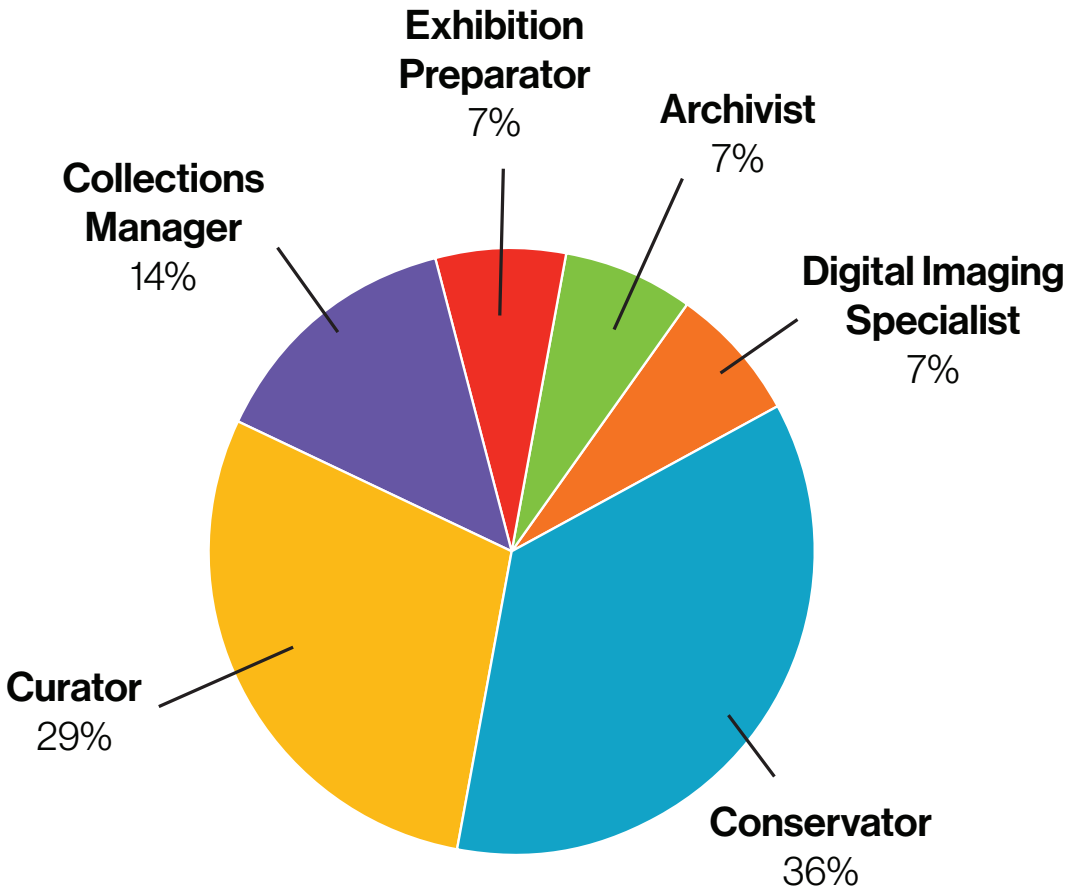
Only three out of 44 respondents indicated using 3D printing for collections transportation. Their information is summarized in the table below. In all three cases, 3D printing was utilized in a different way. Digital scanning was integral in each instance, and the safety of the 3D printed material was not assessed.

Purpose of the 3D Print	Material Used	How 3D Printing Was Used	Why Was 3D Printing Considered a Viable Option?	Other Notes
Padding or support for a non-3D printed object	Polylactic acid-based	The 3D print was created from a digital scan and used to make a mold, which was then used to create the support using a more traditional material	3D printing allowed for a new/ innovative approach	Digital scanning was used Safety of 3D printed material not assessed
Padding or support for a non-3D printed object	Polyamide-based	3D print directly used to support an object	3D printing would improve the outcome of the transportation need	Digital scanning was used Safety of 3D printed material not assessed No finishing techniques applied
Printed replica	N/A	Replica used to assess best approach for the movement of a delicate object	3D printing technology is available in-house 3D printing allowed for a new/ innovative approach	Digital scanning was used Safety of 3D printed material not assessed No finishing techniques applied

3D Printing in Preservation and Access Activities: Other Uses

Fourteen respondents indicated using 3D printing for 'other' preservation and access related activities. These respondents were primarily conservators, curators, or collections managers.

Which professional role listed below best aligns with your position?



14
Respondents

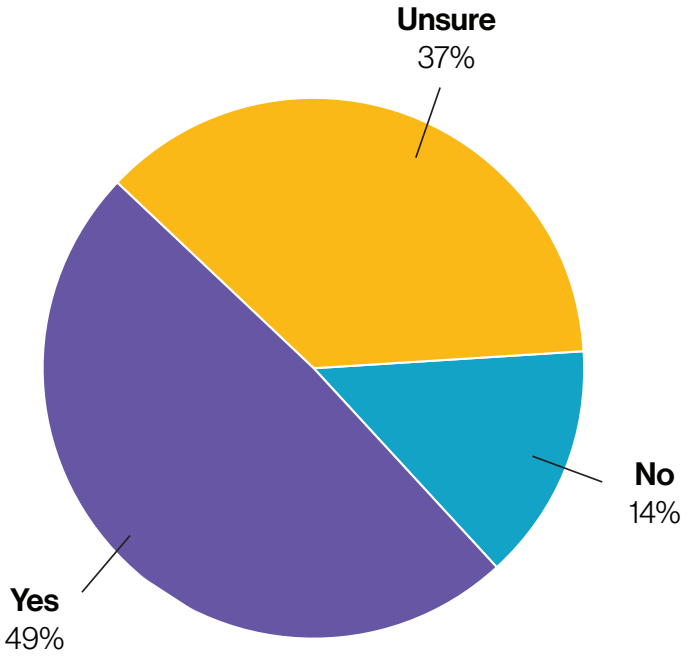
Eleven respondents gave descriptions of how they have used 3D printing. In most cases, the technology was used in educational contexts but was also used to create specialized tools, like clamping components, storage cases, or custom measuring devices. One respondent had not yet used 3D printing, but their institution was discussing its utility as an education and access tool.

Primary Use	Description
Education	3D printing used to create small scale models of a large sculpture. Models used as visual aids to present conservation plans to board members and for hands-on educational programming.
	3D printed replicas created to make 'handling kits', allowing visitors to understand how an object works or is held.
	3D printed objects intended for handling. These aided education and discussion around collection ownership, cultural artifacts, and how replicas can be used in museum collections.
	Replicas for touch and handling, associated with exhibition and commissioned for outreach work.
	3D printed miniature models of objects for tactile tours.
	3D printing used for K-12 and public outreach.
Tool Creation	3D printed clamping components made for a camera and slides. These components aided digitization of petrological thin section slides.
	3D printed a custom measuring device for large format books, including various brackets and components. Jigs were also printed to support other practical activities.
Mountmaking	3D printed replicas of objects that were too delicate to handle. Replicas then used to make mounts for the original object.
Storage	3D printed case for floppy drives used to reformat floppy disks for digital preservation. Cases are no longer made, 3D printing offered an alternative.
Religious	3D printed replica of a sculpture created for religious use outside a church.

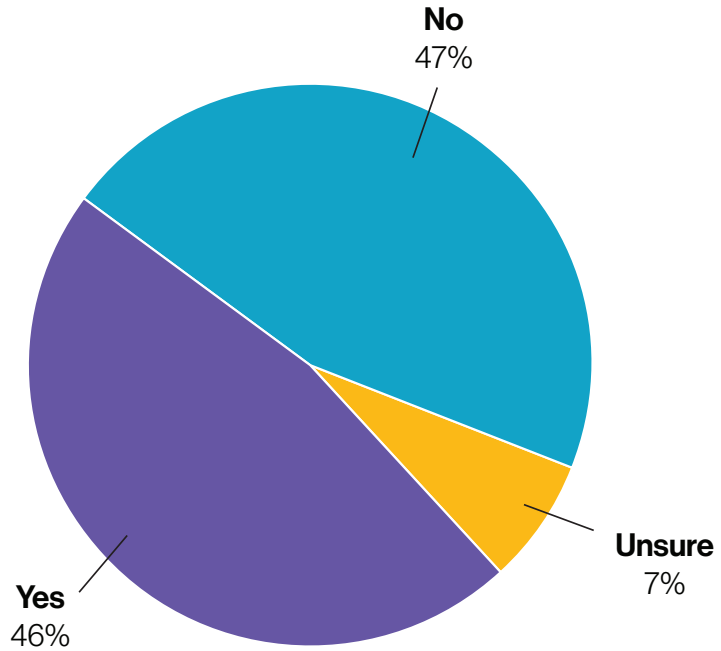
3D Printing in Preservation and Access Activities: Technology and Digital Data

Almost half of respondents know that their institution has a 3D printer onsite. Nearly the same amount of respondents (46%) have worked with a third party 3D printing company to print elements for preservation and access activities.

Do the institutions you have worked with or for have 3D printing technologies (i.e. 3D printers) available that are used for preservation and access activities?



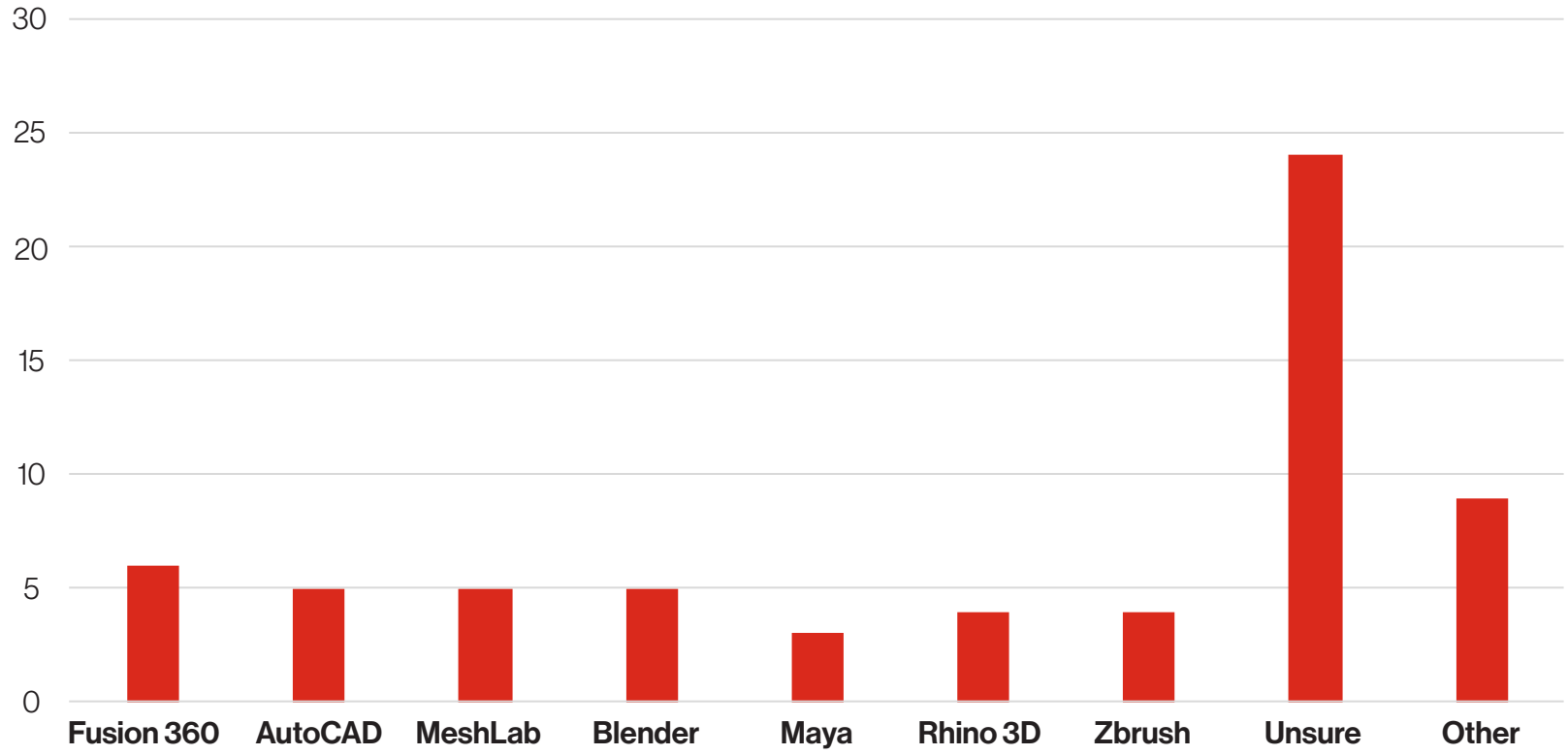
In your professional career, have you worked with any 3D printing companies to print elements for preservation and access activities?



43
Respondents

A variety of software types are used to digitally model 3D printed elements for preservation and access activities. Many respondents did not know what kind of software was used because their institution either worked with a third party or digital modeling was not their job responsibility. Of those who did use software to digitally model 3D printed elements, 73% indicated using more than one type of program.

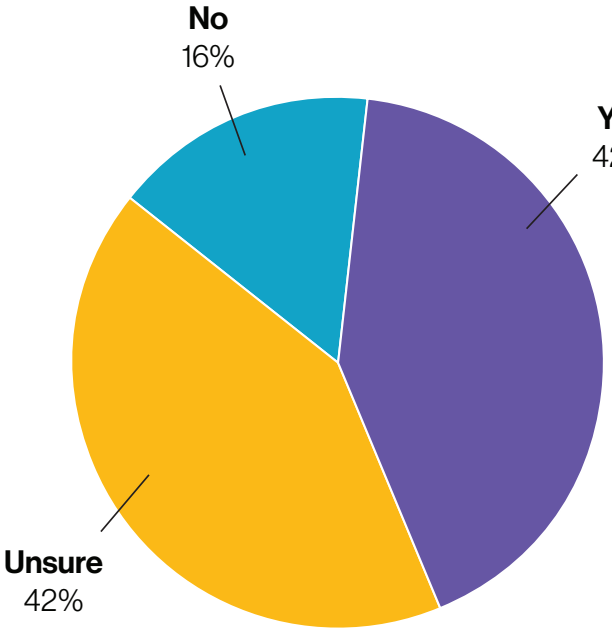
What software have you used to digitally model 3D printed elements for preservation and access activities (select all that apply)?



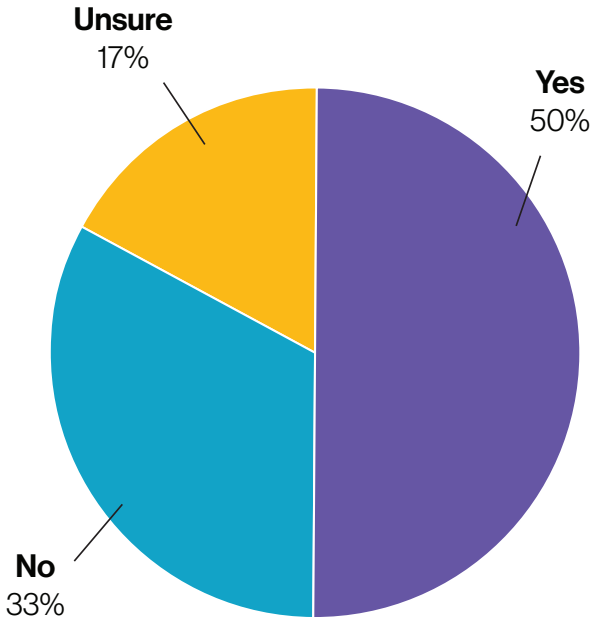
43
Respondents

18 respondents indicated their institution keeps digital assets associated with the 3D prints that the institution creates for preservation and access activities. Of these respondents, half indicated that their institution's DMP informed the management of this digital data.

Do the institutions you have worked with or for keep digital assets (CAD rendering, object file, g-code, etc.) associated with 3D printing for preservation and access activities?



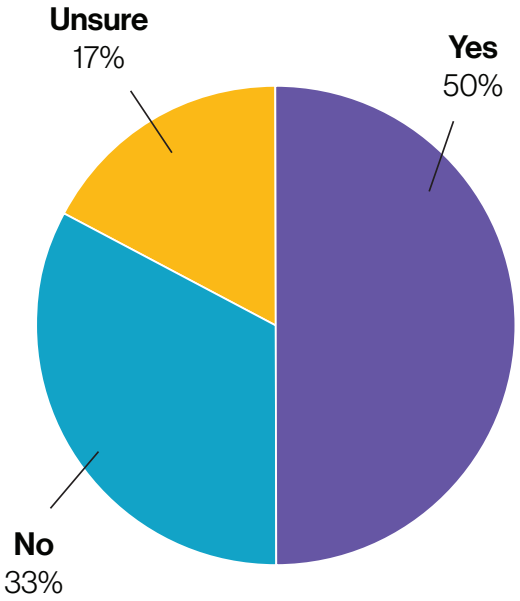
Does your institution have a data management plan (DMP) for long-term management of this data?



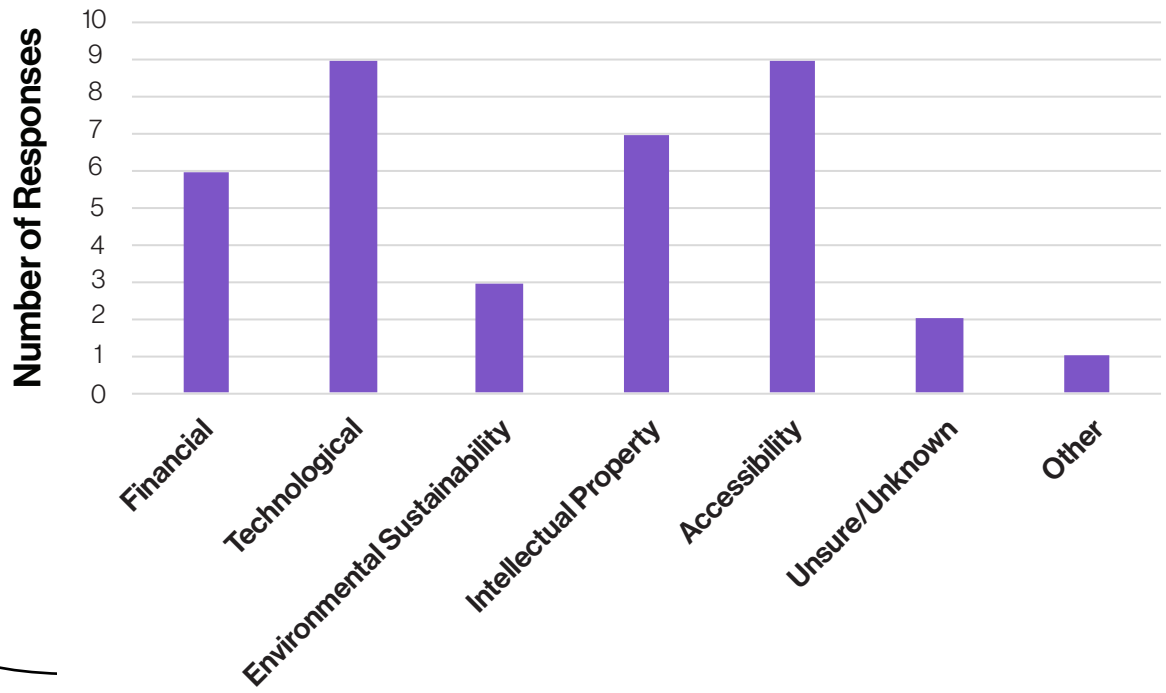
43
Respondents

The factors considered in these institutions' DMPs were primarily technological and accessibility, followed by intellectual property.

Does your institution have a data management plan (DMP) for long-term management of this data?



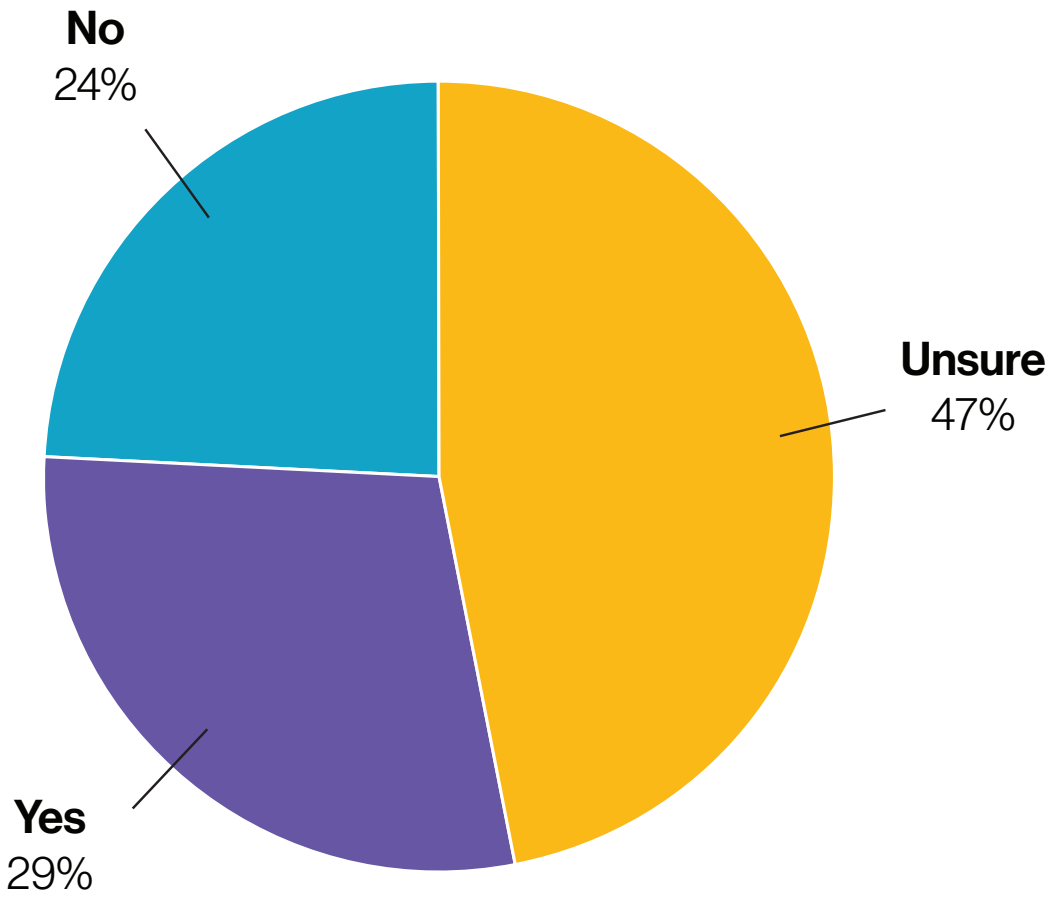
What factors are considered in your institution's DMP (select all that apply)?



18
Respondents

Five respondents indicated their institution had a protocol for managing metadata. These included storing data in collections databases or other library systems for digital data.

Do you have a protocol for managing metadata?



17
Respondents

Next Steps

The data from this survey will be used to create a number of different resources specific to 3D printing for the cultural heritage field, including a web-based resource that will be made available for free from IPI's website and a 3D printed study collection consisting of the most commonly identified materials and technologies found in museums. Six copies of the collection will be created. Two will remain at IPI while the other four will be sent to preservation research labs and educational programs, including the Winterthur/University of Delaware Program in Art Conservation and the Institute for the Preservation of Cultural Heritage at Yale. Each will serve as an educational resource and source for future material studies.

In addition to the questions presented in this report, respondents had the option of providing written feedback about their personal experiences with 3D printing technology. These questions elicited more detailed feedback about challenges with the technology, current research, and research questions. These responses, in combination with the other data collected, a literature review, and site visits to both institutional collections and 3D printing companies, will be used to inform preservation research agendas specific to 3D printed materials and technologies. These research agendas, once complete, will be shared widely with the cultural heritage field.

Together, these resources will support continued research and education for professionals responsible for preserving objects created by these emerging technologies.

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