Makers Who Improve 3D Printers

Survey results January 2021

Source: 3D Printer | Solutions

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YOUMAGINE

3D printing accelerates innovation

In the past few decades, we have observed a trend often described as the democratization of innovation (von Hippel, 2005). This implies that individual users, also known as, Makers have, due to technological advancements, become better able to invent, design, and produce products themselves without relying on commercial organizations. The development of 3D printers has accelerated this phenomenon. An increased number of individuals across the globe develop and share designs, using online knowledge platforms like YouMagine.

Makers develop useful complements to 3D printing machines

An interesting trend is that Makers not only develop personal tools, gadgets, and fixtures. At YouMagine, we have seen that Makers also improve 3D printers and share their designs to the benefit of all. The '3D printer parts and enhancements' collection on YouMagine is impressive and growing. Ultimaker used a few of these designs as inspiration, or direct inputs, to their next generation of machines. Makers who improve producer products (e.g., the Ultimaker) are known as 'user-complementors'.

We survey characteristics of user-complementors

Our survey aims to find out the characteristics of Makers contributing to 3D printers. In the academic literature, this is yet uncharted territory!

So far, studies have shown that individual users innovate (see, for example, von Hippel [2005]) and that their innovations are more likely to add functional novelty to products than those developed by producers (Riggs and von Hippel, 1994). It is recognized that users can complement professional machines and equipment to the benefit of all (Gambardella et al., 2017). But what kind of people engage in this effort is unknown.

The question to be answered

The survey we have conducted contributes to answering the question: *What are the characteristics of Makers improving 3D printers, i.e., their motivations, experience, time investment, and skills?*

Answering this question will help those concerned with innovation to be more effective: commercial firms can learn about who is most likely to improve their offering and online platforms like YouMagine about who is making contributions from which others benefit.

Survey methods: 122 respondents – thank you! 😊

We sampled all Makers who contributed a design in the '3D printer parts and enhancements' category of YouMagine. Most of these designs were complements to the Ultimaker machine; many of these designs were downloaded and/or printed > 100 times, some even > 1000 times.

Two excellent examples of designs uploaded to YouMagine in this category are provided below:

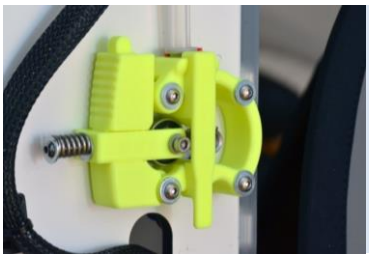


Figure 1: Alternative UM2 feeder design (youmagine.com)

Figure 2: Nozzle torque wrench (youmagine.com)

Our survey had 14 questions covering respondents' motives, time invested, experience with 3D printing, and skills. We sent out the survey on October 16th, 2020, to 376 Makers. After having sent one reminder, the survey was closed on October 30th. We received a total of 122 responses, making the response rate 33%.

Maker characteristics: well-educated and more professional than we thought

Table 1 below provides demographic information on the sample of respondents to our survey:

Table 1: Demographics of the survey sample (N = 122)

Level of education (in %)					Occupation (in %)				Work in 3D printing
High School	Bachelor's	Master's	PhD	Other	Un-employed	Student	Self-employed	Employed	Average %
16.4	32.0	28.7	5.7	17.2	6.6	0.8	32.0	60.7	40.2

Makers who improve 3D printers are well-educated—with most respondents having pursued a Bachelor's, Master's, or even Ph.D. degree. Most of the respondents having selected the 'Other' option indicate having pursued an Associate's degree.

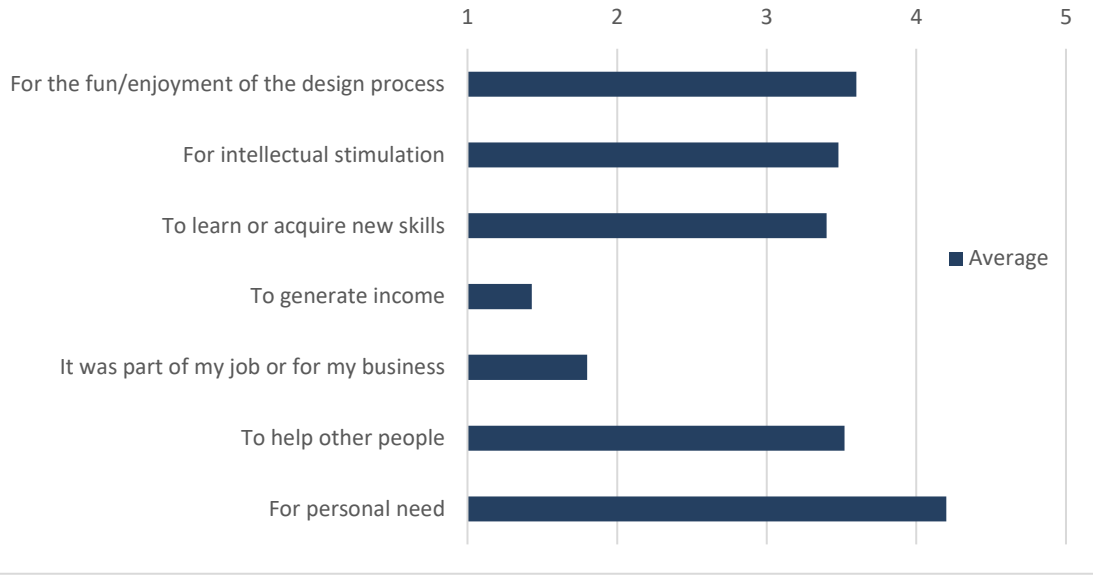
Another noteworthy statistic is the number of self-employed/entrepreneurs among our survey respondents. With 32.0% this number is high above the average in most Western countries. For example, in The Netherlands, around 20.5% of the working-age population is an entrepreneur or self-employed (CBS, 2020).

Finally, 40.2% of our survey respondents indicate to have a job or business in which they create 3D printing designs. Apparently, Makers who improve 3D printers are a lot more professional than we anticipated!

Motives to create: personal need, hedonistic, less commercial

In the first questions of our survey, we asked about the respondents' motivations to create and share 3D printing designs. For all statements, we asked the respondents to which extent they agree on a one-to-five scale (1 = totally disagree; 5 = totally agree). Figure 3 shows that commercial motives rank among the least likely reasons to create designs. Designs are rather created out of hedonic motivations (being for fun or intellectual stimulation), to satisfy a personal need, help others, or to learn. Despite that many of our survey respondents are professionals or even entrepreneurs, creating designs to improve 3D printers is not primarily motivated by commercial interests.

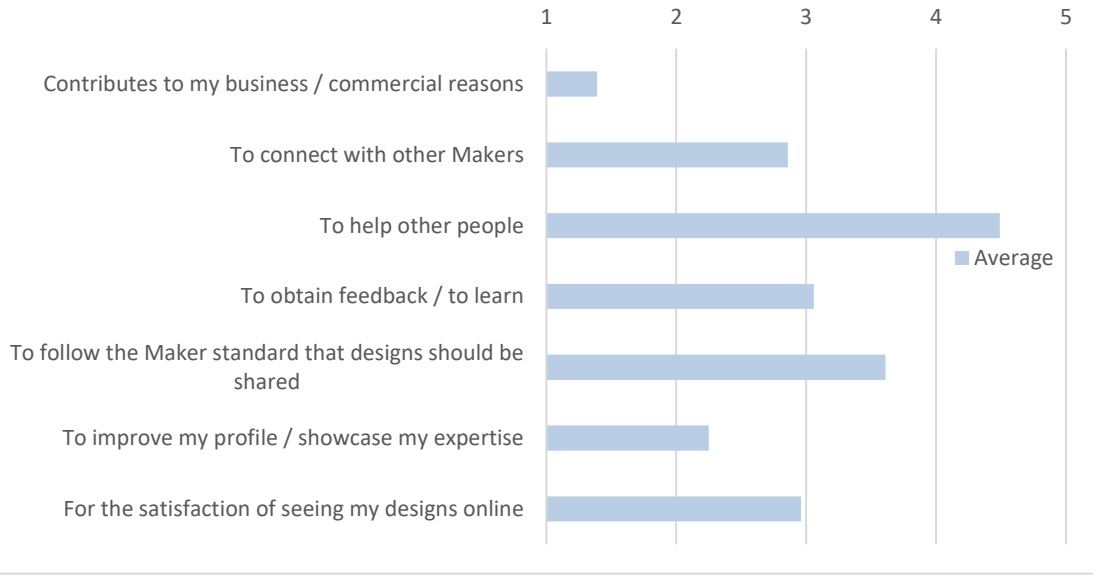
Figure 3: Motivations to create 3D printing designs (N = 122)



Motives to share: helping others

Zooming in on the motivations to share 3D printing designs (Figure 4; 1 = totally disagree; 5 = totally agree), we see that most respondents share their designs to help others, because they want to connect with other Makers and recognize the openness in the Maker movement, for the satisfaction of seeing their designs online, or to learn. It seems that Makers have consideration for other Makers. Possibly, they are also motivated by networking benefits. They care for the community on YouMagine and likeminded others, rather than expecting to gain massive financial profits.

Figure 4: Motivations to share 3D printing designs (N = 122)



Substantial experience and time invested

Makers who improve 3D printers are not just random users quickly stopping by to post their designs to YouMagine. Instead, it is seasoned designers making the most

important contributions. Figure 5 shows that, on average, Makers improving 3D printers spend 10 hours per week. A considerable share does so in both their leisure time as well as at work—usually with the permission of their employers. Makers have lots of experience and work on a range of different platforms. Again, many of those improving 3D printers are also engaged with 3D printing on a professional basis.

Figure 5. Infographic about time invested and experience

On average, the survey respondents spend **10 hours per week** on 3D printing.

42% spend only leisure time; 1% only work time; **57% spend both leisure as work time**.

On average, the survey respondents have **7 years of experience** in 3D printing.

They use **5 different printers**.

Share their designs on **2 platforms**.

Of those who spend work time, 92% have consent from their employer and **70% have a job or business in creating 3D printing designs**.

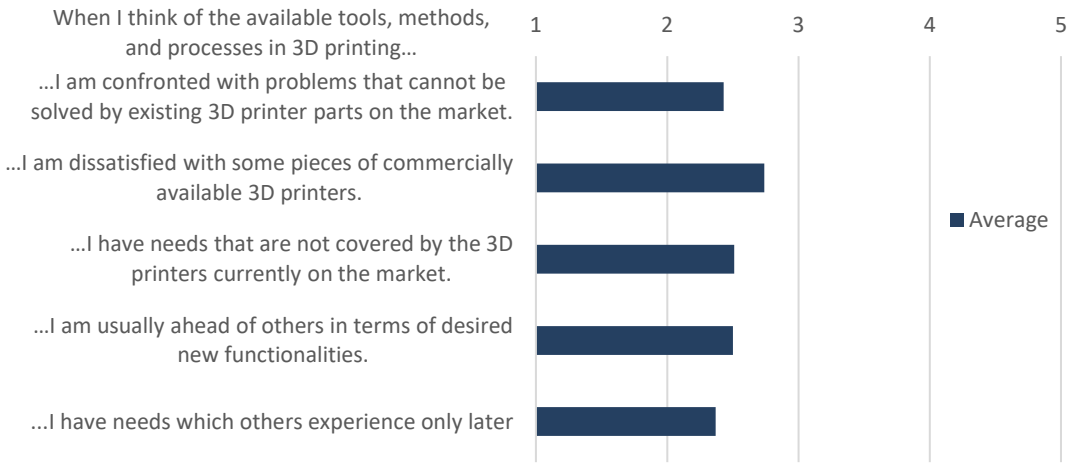
And **57% considers him/herself part of an open-source community** in 3D printing.

Makers improving 3D printers are not necessarily lead-users

Previous academic studies reveal that *lead-users* are important bearers of new product development and improvements to existing equipment (von Hippel, 2005). Lead-users are members of a community who (1) anticipate receiving relatively high benefits from obtaining a solution to their needs and (2) are currently experiencing needs that will only later be experienced by most others.

To our surprise, lead-userness seems not so important for Makers improving 3D printers. Figure 6 reveals that many survey respondents do not consider themselves lead users (1 = totally disagree, 5 = totally agree).

Figure 6: Lead-user characteristics of the survey respondents (N = 122)

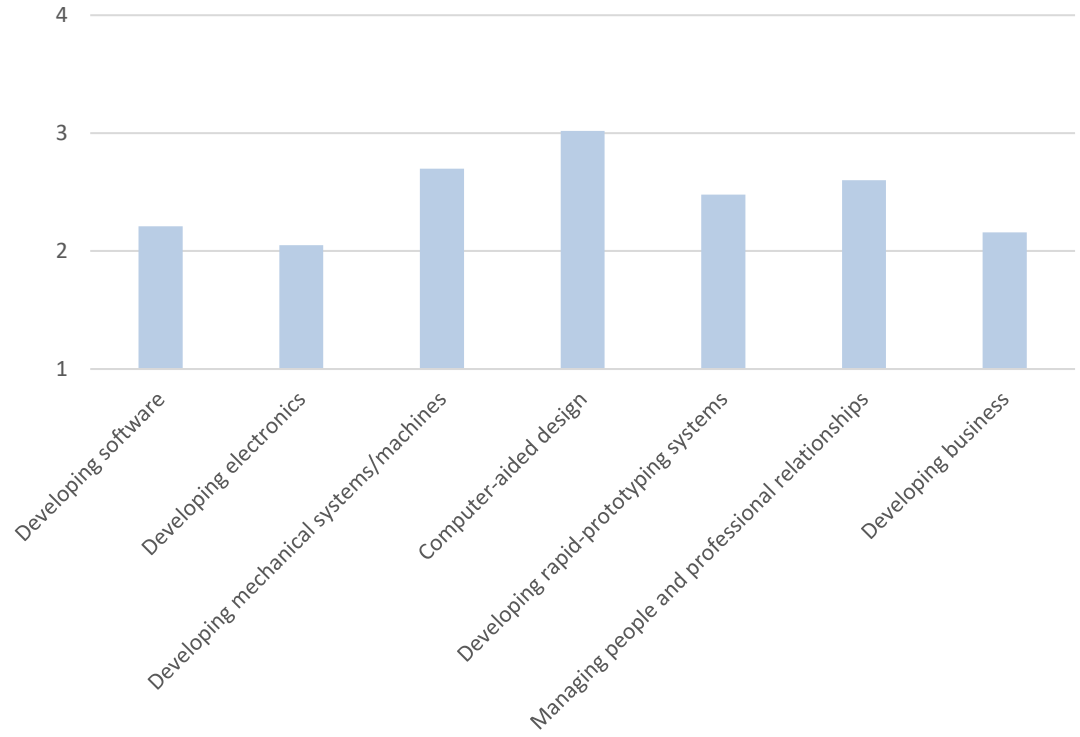


Our impression is that Makers do create designs to fix personal problems (see Figure 3), but this is not a general pattern that applies to ALL designs posted to YouMagine. Rather, contributions to 3D printer parts and enhancements are amongst contributions to other categories on the platform like miniatures or home accessories.

Skills: obviously computer-aided design, but also business-related

In the final question of our survey, we asked our respondents about their skills in technical as well as business-related dimensions. Though the differences are subtle, from Figure 7 below, we see that our respondents are most skilled in computer-aided design, developing mechanical systems or machines, and managing people and professional relationships. Recalling that 24% of our respondents indicate to be self-employed or run a business, this echoes that many Makers improving 3D printers are professionals and not the stereotypical lone wolf hobbyist.

Figure 7: Technical and business-related skills



Who sees their designs adopted the most?

Using the YouMagine database, we calculated an index proxying the adoption of designs improving 3D printers based on the number of CAD file downloads, downloads of instruction files, and the number of times a design got favorited by other YouMagine users. Table 2 below shows significant correlates of adoption by others.

What matters is the very motive to create a design. When it is for a personal need, more adoption is observed, while less adoption is seen for designs developed for fun, intellectual stimulation, or to learn. Naturally, what also matters is time invested and 3D printing experience.

Table 2: Correlates of adoption

Survey question	*Correlation with adoption*
Motivations to create 3D printing designs	
For the fun/enjoyment of the design process	-.08
For intellectual stimulation	-.14
To learn or acquire new skills	-.17
For personal need / to solve problems	**.08**
Motivations to share 3D printing designs	
To help / others may benefit from my designs	-.10
To obtain feedback / learn	-.09
To follow the Maker standard that designs should be shared	-.14
Time and experience in 3D printing	
Number of different 3D printers the respondent worked with	**.11**
The amount of time spent per week on 3D printing	**.10**
Technical and business-related skills	
Developing software	-.08
Demographic variables	
Occupation: respondent is retired or not working	-.13

Wrapping up

Our survey helped us making the first step in unraveling the motivations, time investments, experience, and skills of Makers who improve 3D printers.

In answering our research question, we see that—though a significant share of our respondents is also occupied with 3D printing in a business environment—few are actually driven by commercial motives. Furthermore, they are experienced Makers who make significant time investments—spending 10 hours per week on average. Finally and unsurprisingly, we see that they are highly skilled in computer-aided design.

Even more interesting from an academic perspective, are the characteristics of Makers in relation to their outcome variables. Such as the adoption of their designs. Table 2 above provides a first insight into this matter and shows us that designs created to overcome a certain problem (i.e., user innovation) show a higher score of adoption. The other positive correlates of adoption are experience and effort metrics. In this case, the respondents' time investment and experience with different 3D printers are positively correlated with design adoption.

Our future study of this survey data and the YouMagine platform will dive deeper into the question of what factors determine the success of Makers. For now, thank all the survey respondents for their valuable contribution to our study!

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