



Automated 3D Printing for University Labs

Increase your labs productivity and enable high print capacity for students



Executive Summary - Element and Array in the University Lab

Although advancements in 3D Printing technology have made printers more accessible, reliable, and easy to use, a lack of scalability, and high labor component remain a pain point for educational institutions looking to incorporate additive manufacturing into their workflow. With over 65% of businesses already adopting these additive manufacturing processes, it's more important now than ever that these issues are addressed head on.

Array and Element offer core technologies that not only dramatically improve production throughput, but also provide institutions with a scalable solution that can meet the demands of a growing classroom, department or university workshop/studio/lab.

Array and Element, coupled with Canvas Edu, have the ability to greatly increase the efficiency of your printing lab or classroom, allowing instructors and TAs to spend more time managing projects, communicating with students, and organizing files. Canvas Edu also includes the slicing engine and remote management features that give technicians remote control over Array and Element, further optimizing their time.

Incorporating Element and Array into your classroom can be up to 6.26x more time efficient per project, and also effectively decreases cost for students to print by 65% when compared to conventional printers.¹ With Mosaic 3D printing solutions, you will significantly increase the productivity of your current operations, allowing for more time spent on meaningful collaboration and learning.

Traditional Laboratory Approach

~30 mins per project

in a lab that services 300 students

~2.5x more time spent, per print

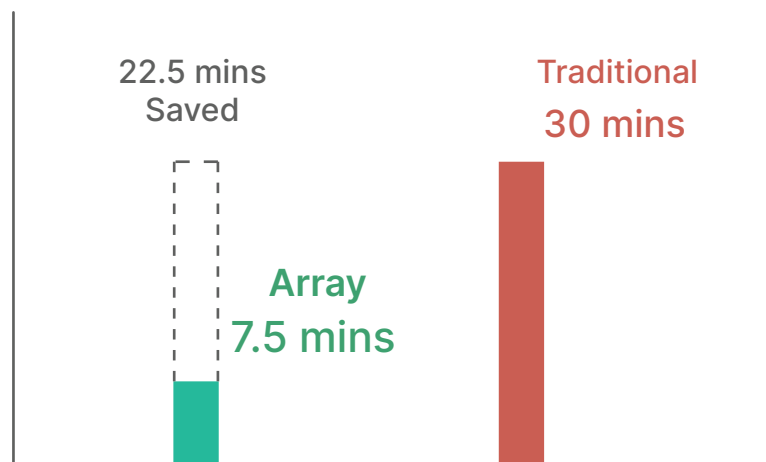
Array/Element Approach

7.5 mins per project

in a lab that services 300 students

2.5x more time saved

Lab operator time spent per project



Executive Summary - Element and Array in the University Lab

Array and Element are able to service a number of classrooms, university labs, or other on-campus production sites, regardless of what it is their students need to print. That is in large part due to Canvas Edu's unique feature set designed specifically to service classrooms:

Teams Features for Project Collaboration

Group projects allow students to group together and work collaboratively, while also giving them access to specific Element and Array machines - these features can be seen in the screenshot below. Administrator controls allow course instructors to control user profiles, form classrooms and determine what Array or Element can be accessed.

Slicing View

Offers the same slicing view and all of the features from the existing Canvas slicing view, although tweaked to lead students into the submission view. Course administrators can control what features students have access to, including print and material settings. This allows instructors to tailor the student experience to match a lesson plan or subject.

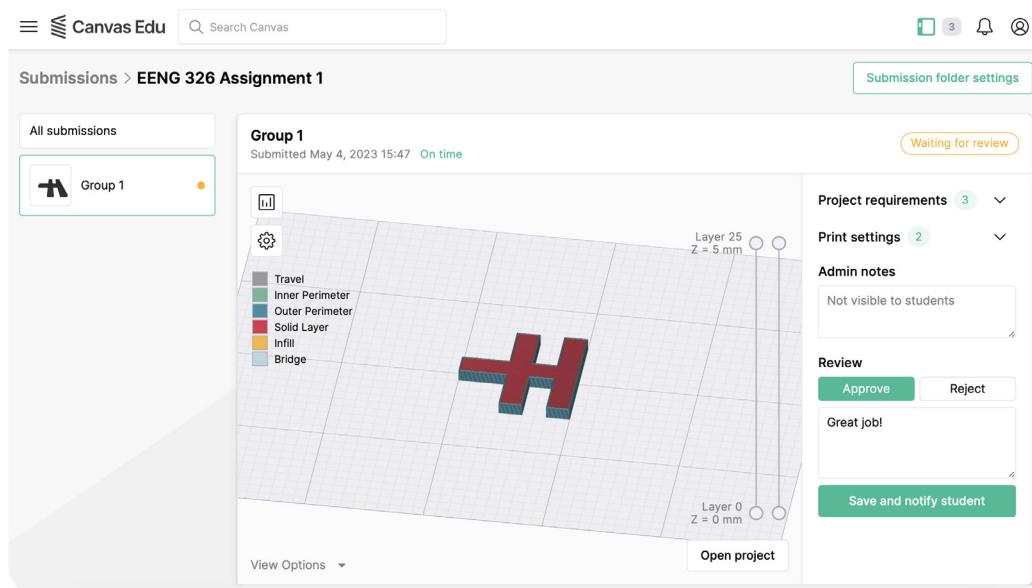
Submissions View

After project slicing, students see a special view on Canvas to submit their project to their instructor, or administrator. This special view includes deadlines, project requirements and submission criteria:

- If the sliced project does not conform to the deadline parameters set by the course administrator, students won't be able to submit their project for grading. The student will then be prompted to check the project against the parameters, and re-submit.
- If the sliced project doesn't meet specific technical requirements, students will be alerted to it prior to submission.

Grading / Review View

Integrated grading features allow course administrators to make user projects based on technical requirements already established in the submissions view. Feedback outside of those parameters can also be shared directly with the student post-submission, maintaining student-to-teacher communication and providing critique for improvement.



Breakdown of each method

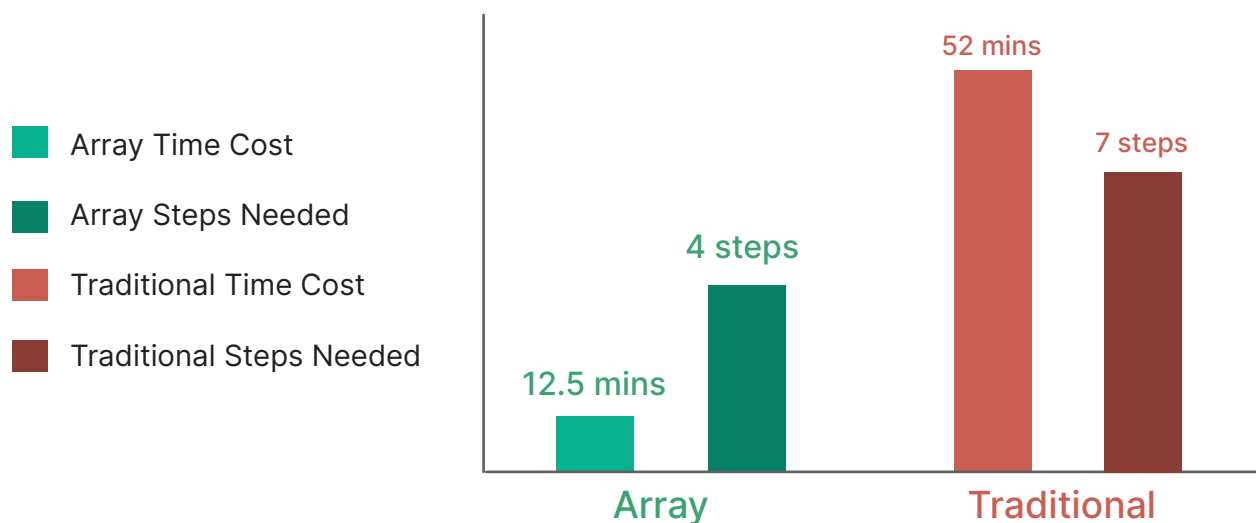
Traditional Print Lab Approach

1	Downloading student submission from email & importing into slicer	7-10 Minutes	27-52 mins of administrator time spent
2	Reviewing sliced file to ensure model fits project requirements	5 Minutes	
3	Emailing suggested changes to student	5-10 Minutes	
4	Slicing student file, transfer to print, swap material and start print	5-10 Minutes	
5	Remove completed print from printer	5-10 Minutes	
6	Emailing student about project completion	2-5 Minutes	
7	Noting completed print in tracking sheet, print review	2 Minutes	

Array/Element Approach

1	Reviewing file submission on Canvas Edu	5 Minutes	7.5 mins of administrator time spent
2	Commenting on suggestions on project file	5 Minutes	
3	Import into Canvas and send to Element/Array	2 Minutes	
4	Remove completed print from storage cart	0.5 Minutes	

Labor Cost (as Time) Spent on Student Projects



An Introduction to Element and Array

Element is an accessibly priced, industrial 3D printer. It has been designed with reliability and user experience in mind. Array is an automated 3D printing system, consisting of four Element 3D printers. Array helps companies scale their output, while decreasing their total cost per part. Array and Element offer a number of benefits over existing approaches to help incorporate 3D printing into your library, lab, school or university.

Plug and Play

We have curated an end to end workflow that is easy to use. We provide training and support to help you get up and running quickly and to ensure long term success.

Reliability and Repeatability

Element and Array were designed to produce parts at scale. This means Element and Array have the highest quality components to ensure repeatability across parts, and reliability for years to come.

Autonomous Printing

Array's automation systems and part storage cart allow it to run for a minimum of 72 hours with no operator intervention. 24/7 operation increases printer uptime by over 50%, leading to significant cost and throughput benefits.

Scalability

With Array, one operator can run the equivalent of 250 3D printers. Multiple Arrays can work in parallel with each other, giving you a scalable approach to streamline your process at any required throughput level. This means one operator can manage the systems to print over 10,000 custom small prints / month.



Modular Design

Element and Array were designed with serviceability in mind. This means Element and Array can be operated by non-technical users. With an easily swappable extruder, and the ability to remove and replace an Element print head you can be sure your Array spends its hours printing productively.

Accessible, High Quality Materials

Mosaic Materials were designed to be a long term solution, with a focus on automation, accessibility and quality. You can learn more about these materials via the material data sheets attached to the end of this report.

Simple, Straightforward Software

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Measuring ROI - Reducing Administrative Leadtime

When thinking about your return on investment and equipment payback period, it's important to note a few different aspects:

1. Simplifying the process for students
2. Closing the loop between machine, assignment criteria and review
3. Remote print management and high capacity printing with Array

The following series of tables can help breakdown what this operator time savings looks like in various education-focused scenarios:

Traditional Print Lab, University Faculty use, highest demand

Print Volume (per month)	500 prints
Minimum Operator Time Cost (per print)	27 mins
Total Labor Cost (monthly)	225 hours

ARRAY - University Faculty use, highest demand

Print Volume (per month)	500 prints
Minimum Operator Time Cost (per print)	7.5 mins
Total Labor Cost (monthly)	62.5 hours

Array and Element provide the greatest amount of time savings in an environment that necessitates high demand printing (500+ parts per month).” In the instance of a university classroom, for example, Array is able to save **at least 19.5 minutes of administrator time** on each student submitted project, in comparison to a traditional print lab set up. Array is **at least 3.6 times more efficient by comparison**, and by not using an Array you effectively turn your lab tech’s 5 day work week into a 6 day work week in order to meet student demand.

Measuring ROI - Reducing Administrative Leadtime (Cont.)

ARRAY or Multiple ELEMENTS - University Lab Environment (moderate demand)

Traditional	Print Volume (per month)	300 parts
	Minimum Operator Time Cost (per print)	27 mins
	Total Labor Cost (monthly)	125 hours
Element	Print Volume (per month)	300 parts
	Minimum Operator Time Cost (per print)	14 mins
	Total Labor Cost (monthly)	65 hours
Array	Print Volume (per month)	300 parts
	Minimum Operator Time Cost (per print)	7.5 mins
	Total Labor Cost (monthly)	37.5 hours

300 prints per month is where Array can introduce time savings, as it's hardware and software automation gives you the full time savings shown on page 4. Using another cluster of 3D printers increases the operator time spent by a factor of 3.47 at a minimum. This represents 19 minutes per print in the existing lab environment. **Array effectively saves administrators almost 2 hours every working day.**

ELEMENT - Library/Public School Environment (light use, lower demand)

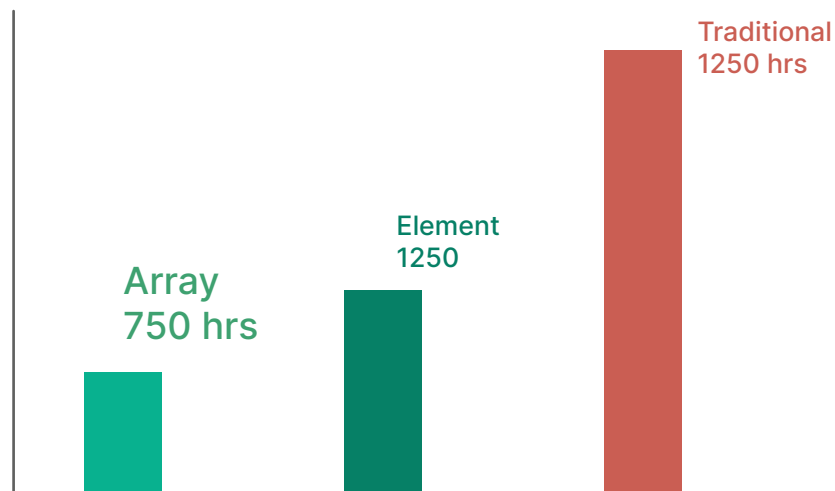
Print Volume (per month)	100 parts
Minimum Operator Time Cost (per print)	14 mins
Total Labour Cost (monthly)	23.3 hours

In this scenario where we are using an Element printer that is fairly close to a standard 3D printer, we are looking at around 100 print jobs per month. Even though Element is closer to a regular 3D printer in terms of hardware automation, *the time savings of ~12/mins per job comes from automation brought about using Canvas Edu/Teams.* This saves administrators roughly **1.2 hours in every working day.**

Time Savings Comparison Table for Each Workflow

Array	Element	Traditional
Throughput	Throughput	Throughput
125 prints/week	125 prints/week	125 prints/week
500 prints/month	500 prints/month	500 prints/month
6000 prints/year	6000 prints/year	6000 prints/year
Total Time Per Part	Total Time Per Part	Total Time Per Part
<i>7.5 mins</i>	<i>12.5 mins/print</i>	<i>27 mins/print</i>
Difference compared to Traditional	Difference compared to Traditional	
<i>3.6x more efficient</i>	<i>2x more efficient</i>	
Yearly Time Spent	Yearly Time Spent	Yearly Time Spent
45,000 mins	69,000 mins	162,000 mins
<i>750 hours</i>	<i>1250 hours</i>	<i>2700 hours</i>
Yearly Time Saved	Yearly Time Saved	
1950 hours	1550 hours	
Cost Per Print	Cost Per Print	Cost Per Print
\$24	\$36	\$105

Additional Time Spent, Annually

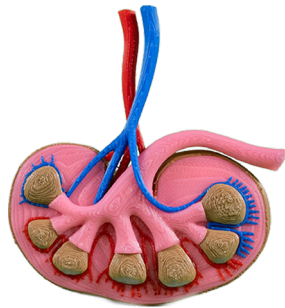


Materials

While Element and Array are able to create parts in a wide variety of materials (including CF Nylon, PEEK, ABS, and TPU), most courses and administrators gravitate towards Mosaic PLA, ABS and PETG for printing purposes. For engineering grade parts, some projects may look to use Mosaic Matrix or even Mosaic PEEK, if lesson plans require stringent physical parameters or a specific finish for the final part. If flame retardance, elasticity or conductivity are required, then Mosaic also offers materials like FR-PC, Mosaic Flex and Aero, and Mosaic ESD respectively.

You can learn more about these materials by contacting our Materials Team at education@mosaicmfg.com

Mosaic PLA



Key Features

- ✓ Easy to print
- ✓ Stiff
- ✓ Economical
- ✓ Low shrinkage
- ✓ Matte finish

Low Cost

Mosaic PETG



Key Features

- ✓ Strong
- ✓ Glossy finish
- ✓ Excellent surface quality
- ✓ Low Shrinkage

Low Cost

Mosaic Flex

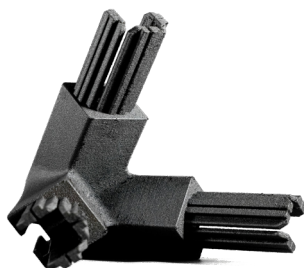


Key Features

- ✓ Flexible
- ✓ Durable
- ✓ Abrasion Resistant
- ✓ Chemically Resistant

Moderate Cost

Mosaic Matrix



Key Features

- ✓ Stiff
- ✓ Strong
- ✓ High thermal resistance
- ✓ High strength-to-weight ratio
- ✓ Excellent surface quality

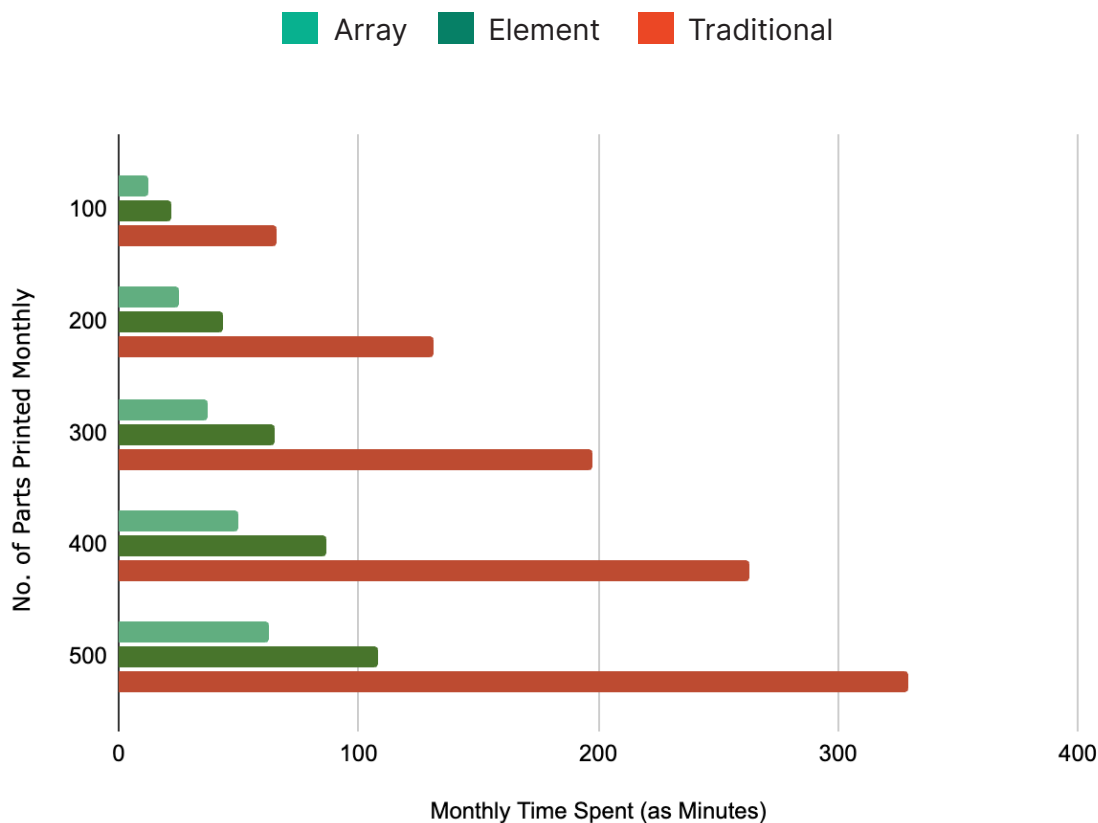
Higher Cost

Looking Towards The Future

Allow students to harness the power of 3D printing technology while minimizing the burden to your team. Instead of relying on spreadsheets and email chains, with Canvas Edu, you can easily manage student projects with our robust interface. Couple this with Array's capacity to run hundreds of prints without operator intervention, and you have a scalable solution for 3D printing in universities.

Mosaic and Array make it easier for you to take the leap into 3D printing by providing an end-to-end solution that fits your needs, no matter how specific.

Total Operator Time Spent Monthly, in Hours



Array's ability to produce individual components quickly, without very little user input and is one of the strongest selling points for conventional 3D printing machines and applications. Array turns all of those dials up, by innovating on these already powerful capabilities and providing solutions that can and will grow with your individualized 3D printing needs.

In a university environment, this allows institutions to service a far greater number of students, providing access to labs that would have previously been highly limited to specific courses. Administrators also see greatly reduced labour time and Canvas Edu provides a easy and intuitive platform for managing courseloads and print queues. Those software features are designed to keep teachers teaching, without being booged down by the high labour demands of typical, high volume 3D printing solutions.



Mosaic Manufacturing Ltd. is a digital manufacturing company creating the next generation of product delivery systems. Founded in 2013, Mosaic began by enabling 3D printers to create substantially more useful and valuable products. Now, we're working to scale this technology to help millions of people get value from the upcoming waves of customization and personalization.

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