



HP 멀티젯 퓨전 소개 및 교육산업 사례

이주현
Application Engineer

수십년간 2D 인쇄를 이끌어 온 경험 활용



Printing Systems

Printhead and Agents

○ Printhead

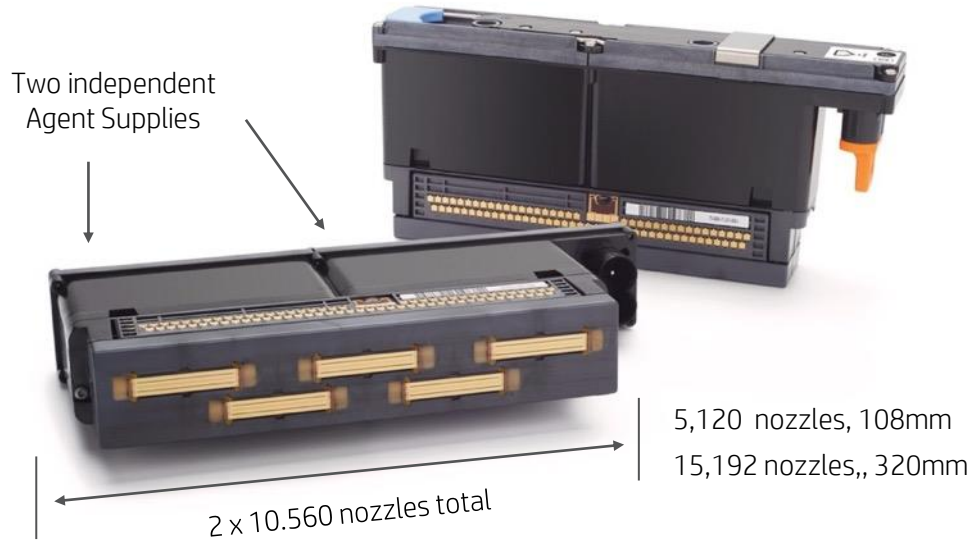


○ Agents



Printing Systems

HP Production Expertise

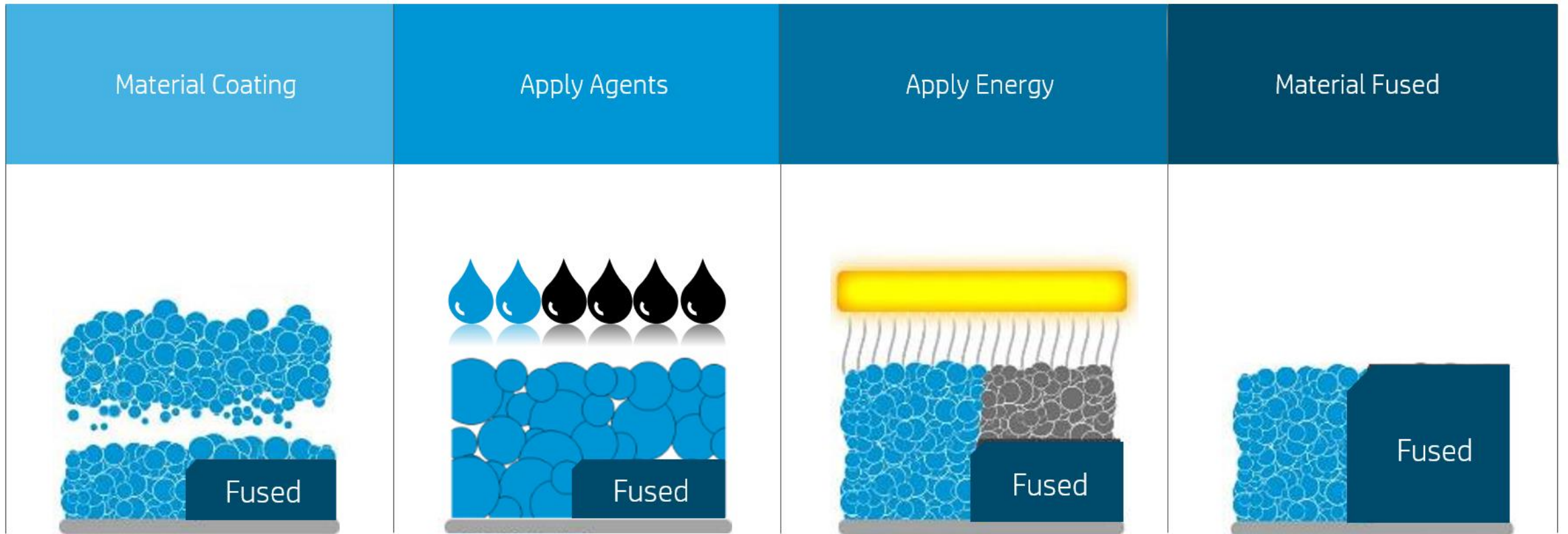


2.8 meter wide Thermal Inkjet digital printing



HP Multi Jet Fusion

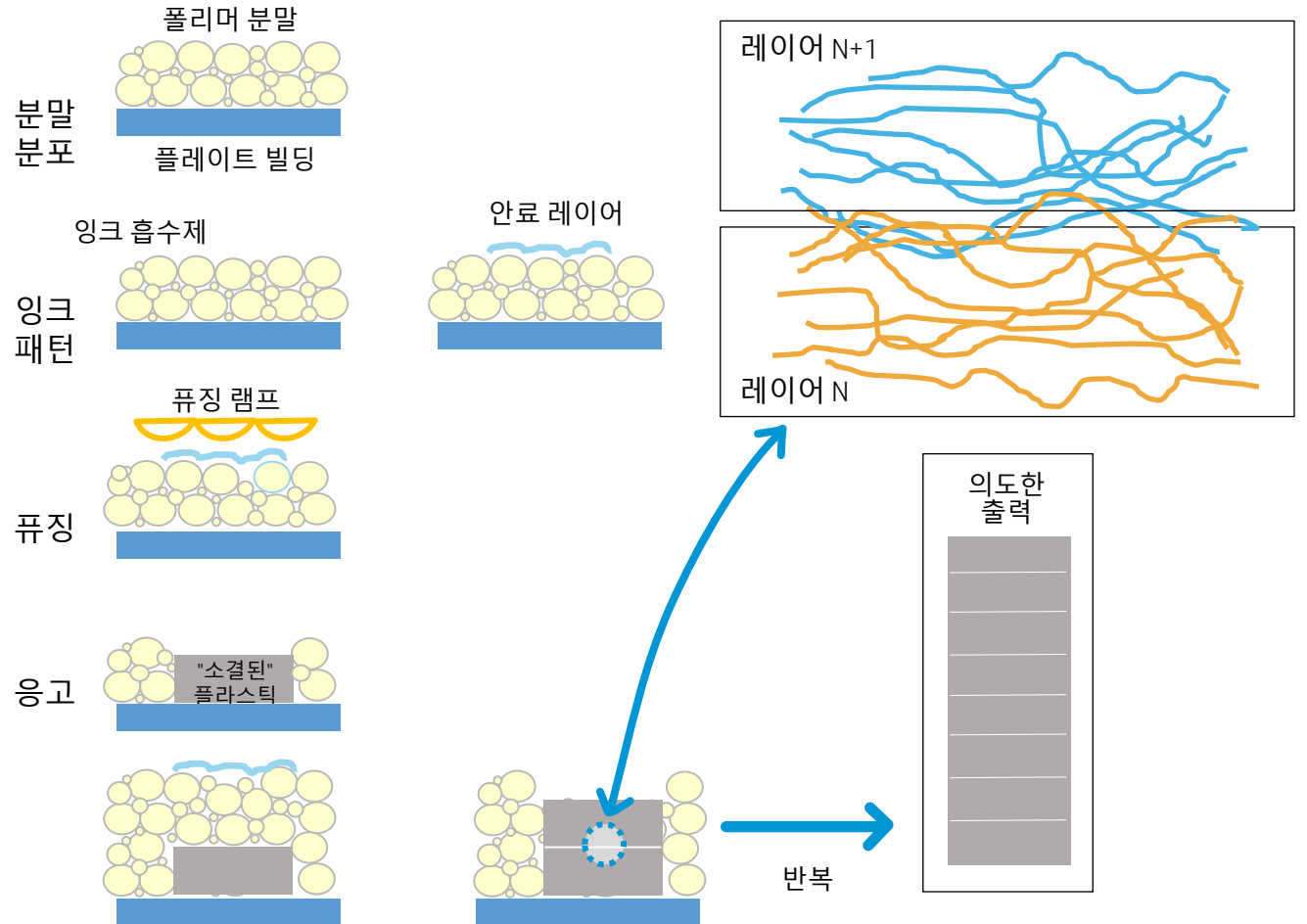
Basic elements of the process



HP Multi Jet Fusion

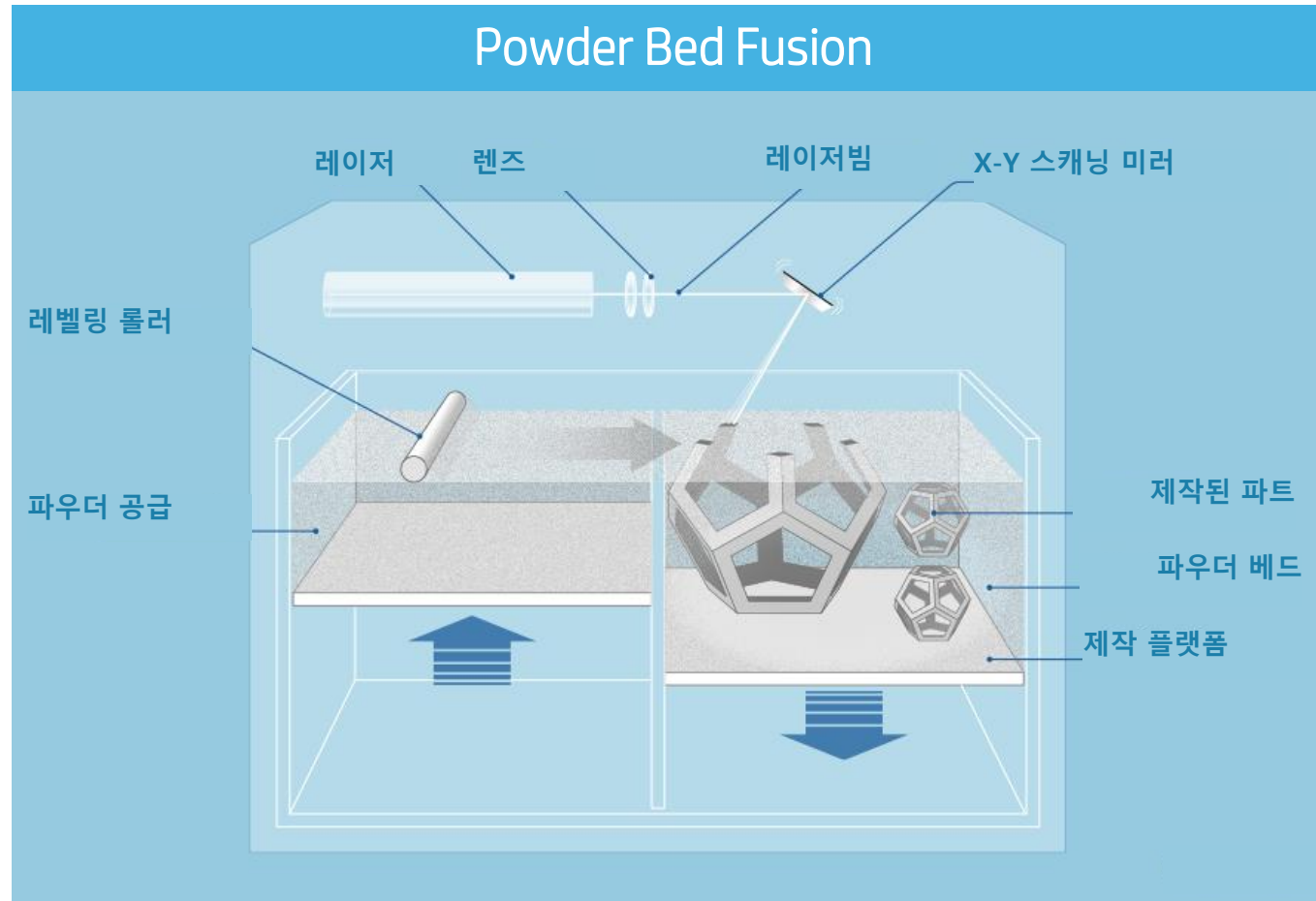
Basic elements of the process

영상 확인: <https://youtu.be/hgLnn7AWq9c>



HP Multi Jet Fusion

Differences from other technologies



Safety

재료 및 장비의 안전성

- HP 3D 프린터 재료는 유해하지 않으며 안전한가
- MJF의 재료와 에이전트는 화학물질의 위험성을 최소화하고 안전성 확보를 위해 엄격한 품질관리와 테스트를 거칩니다. 제품 사용규정에 따라 의도한대로 사용되면 안전하지만 경구로 섭취하거나 흡입, 또는 장기간 피부에 접촉하도록 설계되지는 않았습니다. 추가정보는 www.hp.com/go/msds에서 확인할수 있습니다.
- 소형중 인체에 유해한 요소가 발생하지는 않는가
- 소형중 발생하는 휘발성 유기화합물질 및 오존의 발생여부와 관련하여 미국, 유럽, 호주, 싱가포르 등 여러 나라에서 요구하는 사항을 만족시켰습니다.

HP Customer Information
No critical particle emissions from HP Jet Fusion 3D printers
Device performance undergoes strict safety consideration

Customers expect safe particle release behaviour from their HP Jet Fusion 3D printing solutions. Evaluation needs to initially emitted – in Indicative testing is a high level of safety.

HP 3D HR PA12
Summary of Regulatory Compliance and Environmental Attributes

HP Customer Information
No health and safety issues with HP Multi Jet Fusion Technology
3D printing materials and emissions are strictly tested

HP Multi Jet Fusion 3D printing solutions are thoroughly checked for potential impact on health and safety of users. This includes printing materials and their handling, as well as the release of particles and substances during operation. Based on comprehensive testing, no health risks are expected when the innovative HP devices are used as intended.

Thermoplastics not classified as hazardous

Printing substrates such as HP 3D thermoplastic material (e.g. HP 3D High Reusability PA12 material) for HP Jet Fusion 3D printers are not classified as hazardous – according to the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)¹, the assessment criteria for mixtures in the European Union (Regulation (EC) No. 1272/2008, as amended)², and applicable requirements in the United States (OSHA CFR 1910.1202, as amended)³. Therefore, from the chemistry perspective, they are neither classified nor labelled as toxic, carcinogenic, mutagenic, toxic to reproduction, sensitizing or corrosive. And as the material powders consist of particles with an average diameter of approximately 50 µm, their physics properties do not present the toxicological intensity typically seen with smaller solid particles.

In fact, HP Jet Fusion 3D printers feature enclosed systems for powder management, which are designed in a way which reduces the likelihood of inadvertently coming into contact with printing material powder. Large models are equipped with a special installation for actively removing residual particles. Outside the machine, incidental levels of particles can simply be removed with a special vacuum cleaner certified for collection of combustible dust⁴ or wiped off e.g. the skin with cold water – as depicted in the respective safety data sheets and/or user guide.

Agents in line with rigorous safety requirements

As required, HP fusing, detailing, and colouring agents are labelled in accordance with applicable regulations. Detailed safety information might be provided in the respective product documents. To ensure users are safe during printing operation, indicative testing⁵ of HP Jet Fusion 3D printers was performed using respective HP agents. Results showed that relevant emissions were well below applicable limit and guide values^{6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100} as detailed below. For safe handling, the agents can be washed off with mild soap and water in case of skin contact.

Particles emissions well below critical levels

Indicative fine dust emissions testing of representative HP Jet Fusion 3D printers¹⁰ shows that devices are well below applicable U.S. Permissible Exposure Limits^{11,12}, German Occupational Exposure Limits (Vale¹³), Australian Workplace Exposure Standards¹⁴, Singapore Occupational Exposure Levels of Toxic Substances¹⁵, and the respective China ILO standard¹⁶ when installed, operated and maintained according to manufacturer instructions¹⁷. The number of released particles in the ultrafine size range (UFR) is checked against guide values for particle emissions as defined by ANSI/CA/UL Standard 2304¹⁸ for 3D printing systems in non-industrial indoor spaces. Customers might also note that UFR emissions are far below the precautionary German Blue Angel guide value as defined by the strict DE-UZ 325 award criteria¹⁹ for office printing systems²⁰. The Blue Angel scenario can be applied as an auxiliary reference for 3D printing systems since no mandatory workplace exposure limits are available for UFRs to date.

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Safety

재료 및 장비의 안전성

- HP는 사용자에게 충분한 안전 및 보건가이드가 안내하였는가
- HP는 장비 설치를 위한 Site Preparation 단계에서 고객에게 장비운용시 요구되는 안전사항들을 체크하고 안내 해드리며 고객은 해당 가이드를 따를 책임이 있습니다.
- 3D프린터 제작 및 판매, 관리에 있어 기업은 어떠한 추가적인 환경적 노력을 하고 있는가
- HP는 1992 년 제품 설계 및 개발 단계 전반에 걸쳐 지속 가능성에 영향을 미치는 요소를 고려하기 위해 Design for Sustainability 프로그램 (원래 Design for the Environment)을 개발했습니다. 이후 HP는 재료의 혁신, 제품의 내구성 및 수리의 편의성, 에너지 효율성, 제품의 재활용율을 높이는 설계등을 연구해오고 있으며 이를 통해 재활용 및 재생가능한 재료의 사용을 늘리고 환경오염이 우려되는 재료를 줄이기 위해 노력 해왔습니다.

hp HP Jet Fusion 3D 4200/4210 Printing Solution
Site Preparation Guide

Air exhaust

To reduce the number of air changes needed per hour and improve stability and control of the environmental conditions, HP highly recommends using the air exhaust kit and connecting it to an air extraction system, to remove air expelled by the top cover fans.

Air exhaust system specifications

The pressure relative to the atmosphere at hood output should be -10 ± 5 Pa.

There are various possible ways to distribute the air pipes; among others, two pipes for each printer (one for each air collector), or two pipes connected to a main pipe. Make sure that the installation is compliant with the following air extraction flows:

- (300 ± 18 ft³/min)
- h (141 ± 9 ft³/min)
- h (441 ± 26 ft³/min)

cts, one for each collector, connected with an inverted Y pipe connector to a ct diameters for best air extraction are:

- r: 200 mm (7.87 in)
- er: 200 mm (7.87 in)
- ter (after inverted Y): 250 mm (9.84 in)

± 45 m³/h
250 mm

Ø 200 mm
240 ± 15 m³/h

Ø 200 mm
-10 ± 5 Pa

g a valve to improve flow control.

8 mm (56.5 in) above the floor. Calculate the hose length taking into account s, leaving enough margin to allow the top cover to be opened.

Solution home / Product Design for the Environment / General

Do you follow “Design for the Environment” principles to promote sustainable product design?

Print

Modified on: Wed, 24 Jun, 2020 at 10:15 PM

Yes. Design plays a critical role in determining a product's environmental impacts. We apply rigorous design principles to improve the environmental performance of our products across the life cycle.

In 1992, we developed our Design for Sustainability program (originally Design for the Environment) to formally consider factors impacting sustainability performance throughout the product design and development phases.

We use a science-based approach to evaluate our products, identify and prioritize improvement opportunities, and set goals. Among our main design priorities, we work to increase the use of recycled and renewable materials and replace materials of concern; enhance reparability; continually improve product energy efficiency, and build in accessibility features. Our program has continually evolved in response to technological and scientific developments, changes to our supply chain, and customer demand.

HP Design for Sustainability addresses a broad range of issues across the product life cycle.

- **Materials innovation**—Progress toward a circular economy requires keeping materials in use for as long as possible and ensuring they can be easily reused or recycled. We continually work to eliminate materials of concern, increase materials efficiency, and circulate materials through use of recycled content.
- **Durability and reparability**—We design our products to be highly durable and easy to repair, and we extend the life of our personal systems through refurbishment programs. This benefits customers while capturing more value from natural resources and reducing environmental footprint.
- **Energy efficiency**—Energy consumption during product use is one of the largest contributors to our carbon and water footprints, so continually improving product energy efficiency is central to our sustainable design strategy.
- **Products-as-a-service**—Service-based models deliver better value to customers with reduced environmental impact and capital costs. Customers can access the latest technology, while HP manages the fleet. An ongoing relationship engagement and provides valuable insights on customer behavior and needs. Service-based offerings support the transition to a circular economy. Regular maintenance increases product longevity and decreases waste. Fewer individual product shipments and customer store visits decrease GHG emissions. Value is recaptured at end of service through product repair, reuse, and recycling.
- **End-of-service options**—Rapid innovation is increasing the urgency to move toward circular models where products stay in use as long as possible and materials are responsibly recycled and repurposed at product end of service. As part of designing for end of service, we consider factors such as availability of spare parts, ease of disassembly, materials identification, and ability to separate materials. Our repair, reuse, and recycling programs help keep products in use, and at end of service, support responsible collection and processing to recover and reuse as much material as possible.
- **Social impact**—Through innovative partnerships and materials sourcing, we improve livelihoods. Through our supply chain engagements, we increase the availability of recycled materials while supporting safe workplaces, healthy lifestyles, and skills development.



HP 3D Printers



Multi Jet Fusion

Product Line-up

HP Jet Fusion 500 series
3D Printers



시제품, 소량생산, 백색 및 풀컬러

HP Jet Fusion 4200
3D Printing Solution



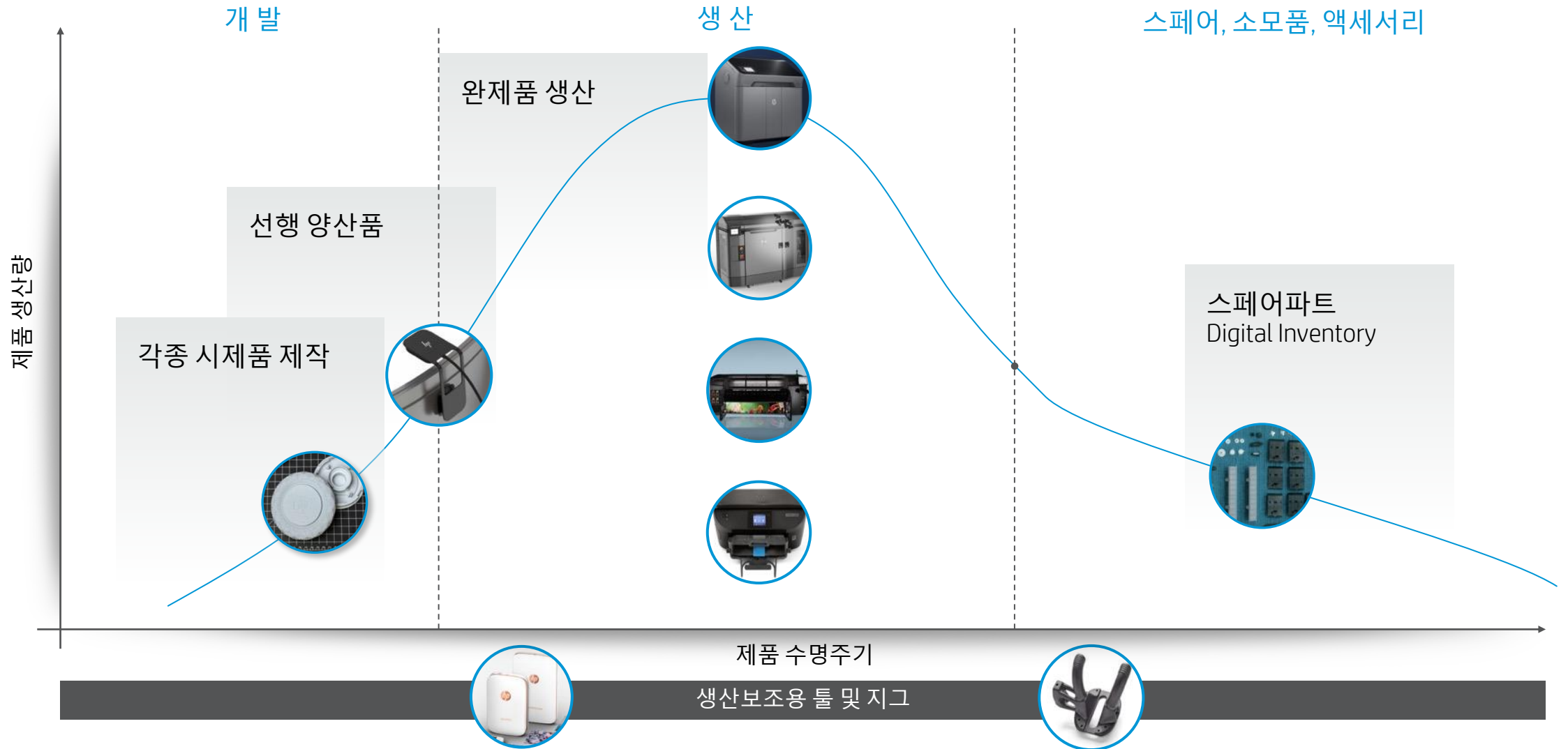
산업용 시제품 및 완제품 생산

HP Jet Fusion 5200 Series
3D Printing Solution



제품 생산 및 양산

Product Life Cycle Application



Product Life Cycle Application

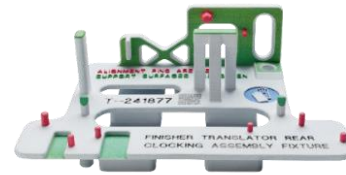




색으로 정보를 제공하는 파트



디자인 시제품



색상 정보를 추가한 지그 및 고정구



개인 맞춤형 보조구



각종 라벨



소비재 / 예술품 / 수집품 / 액세서리

Multi Jet Fusion

MJF 4200 System



HP Jet Fusion 3D 4200 Printer



HP Jet Fusion 3D Build Unit



HP Jet Fusion 3D 4200 Processing Station with Fast Cooling

Multi Jet Fusion

MJF 5200 System



Printer



Build Unit



Natural Cooling Unit



Processing Station

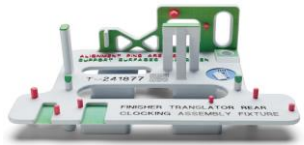


Hovmand Forklift

APPLICATIONS



Application Overview



지그 및 치공구

생산현장에서 제품의 정확도와 반복성을 확보하기 위해 사용할 각종 치공구. 단색 및 컬러 적용 가능. 컬러를 적용할 경우 색상정보를 이용한 작업가이드, 라벨 및 QR코드 삽입가능



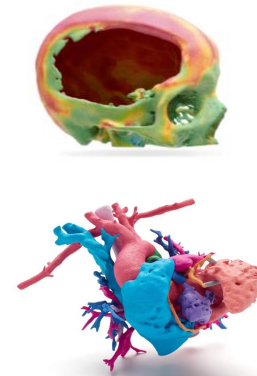
시제품

단순 디자인/전시용 시제품부터 기능성 시제품. 우수한 표면조도와 컬러를 이용하여 완제품의 형상을 구현한 시제품과 우수한 재료물성을 이용한 기능성 시제품 제작



건축/지형정보 모형

우수한 디테일 구현능력과 컬러 조형을 활용한 건축모형 및 지형도제작



의료/인체 모형

의학 스캔데이터를 이용하여 제작한 정밀 해부모형. 교육, 수술계획 등 의료용 목적으로 제작



Data courtesy of Seb/Automatisme

산업용 완제품

3D프린팅의 장점인 복잡한 형상의 구현과 우수한 물성을 이용하여 실제 산업현장 및 제조과정에 사용할 수 있는 완제품 제작



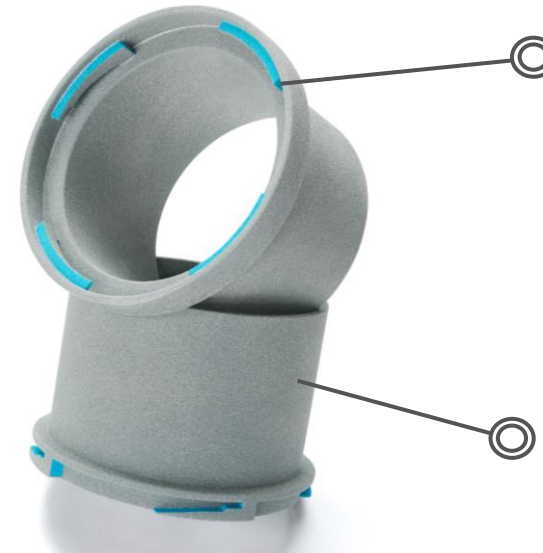
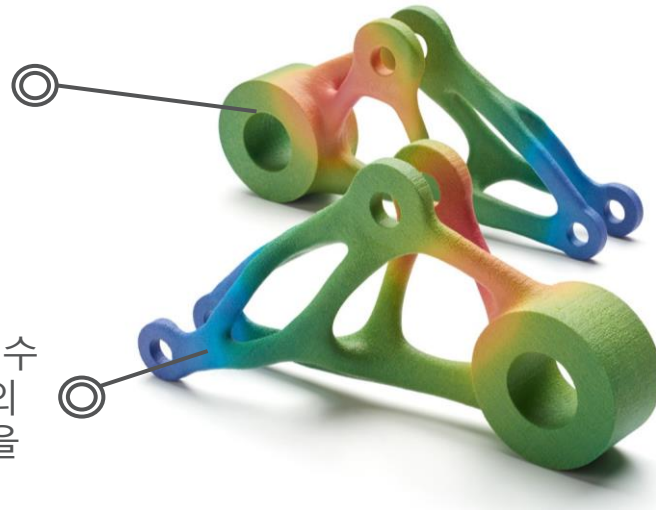
소비재용 완제품

3D프린팅이 제공할수 있는 독특한 디자인을 이용하여 맞춤형 완제품 제작

Application - 시제품

완제품의 색상을 시제품 단계에서 확인할 수 있어 디자인 결정과정을 단축

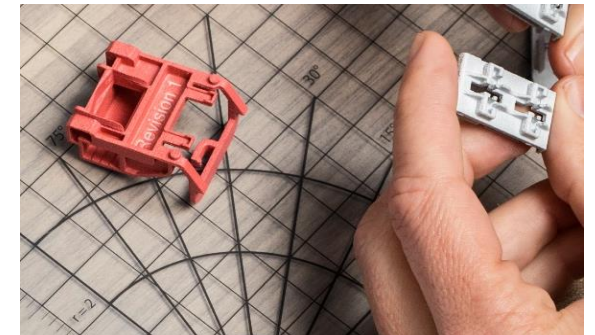
시뮬레이션을 통해 파트에 가해지는 하중을 눈으로 확인할 수 있는 샘플 - 각종 전시회나 회의 과정에서 직접 만져보며 강성을 체험할 수 있는 샘플



마찰에 의한 색상 변화를 통해 시제품 단계에서 조립성 및 설계검증

디자인요소 및 지지하중, 강도등의 정보를 라벨 형태로 파트에 표현

Data courtesy of Konstruktion Baumann



“컬러로 출력할 수 있다는 것은 시제품에 새로운 차원의 가치를 더합니다.”
- RCH Studios 시니어 매니저 Clancy Pearson

“색상정보를 더한 출력물을 통해 제품의 표면에 마찰이 있거나 손상이 있는지 여부를 손쉽게 파악할 수 있습니다.”
- Tamas Kofalvi, CEO of EBK – Automotive safety equipment

건축/지형정보 모형

견고한 열가소성 소재를
이용하여 미세한 디테일 구현



6포인트 크기의 글꼴까지
정확하고 쉽게 읽을수
있는 라벨 추가



서포트 재료가 불필요
하므로 부피가 크거나
복잡한 형상 조형시 타
방식에 비해 저렴하게
제작가능



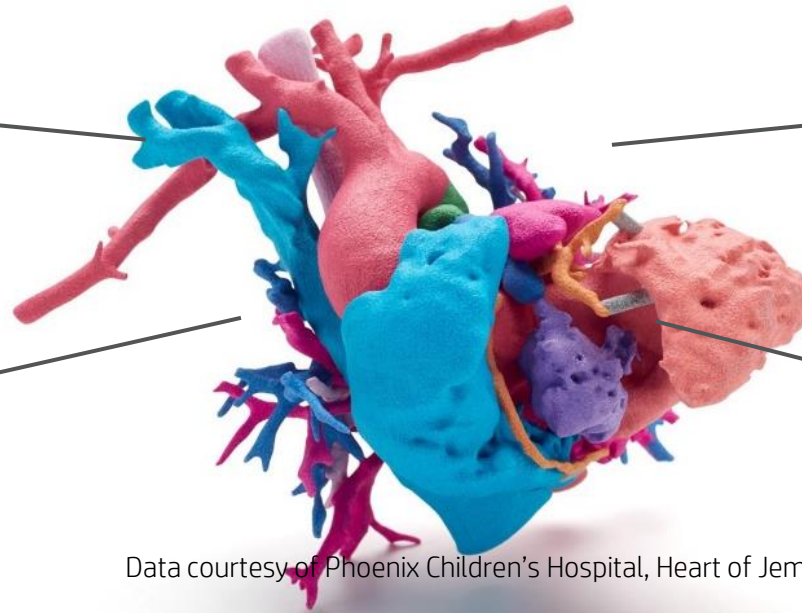
Data courtesy of WhiteClouds

“풀컬러로 출력된 우수한 질감의 제품은 사람들이 프로젝트를 이해하게 하는데 큰 도움이 됩니다.” Clancy Pearson Senior Associate at RCH Studios

의료 / 인체모형

색상을 통해 출력된 부위의 두께를 나타내거나 종양등의 각종 이상증상, 임플란트등을 구분

오토클레이브를 이용하여 출력물의 멸균처리 가능



Data courtesy of Phoenix Children's Hospital, Heart of Jemma

MJF의 우수한 강도로 인해 거칠게 파트를 다루게 되더라도 미세하거나 중요한 디테일의 파손이 적음

JF580장비는 Materialise사에서 현장진료 3D프린팅 장비로 인증을 받았으며 출력물은 시각적 모델링 및 이물란트 성형 패턴으로 사용가능한 정밀도 제공

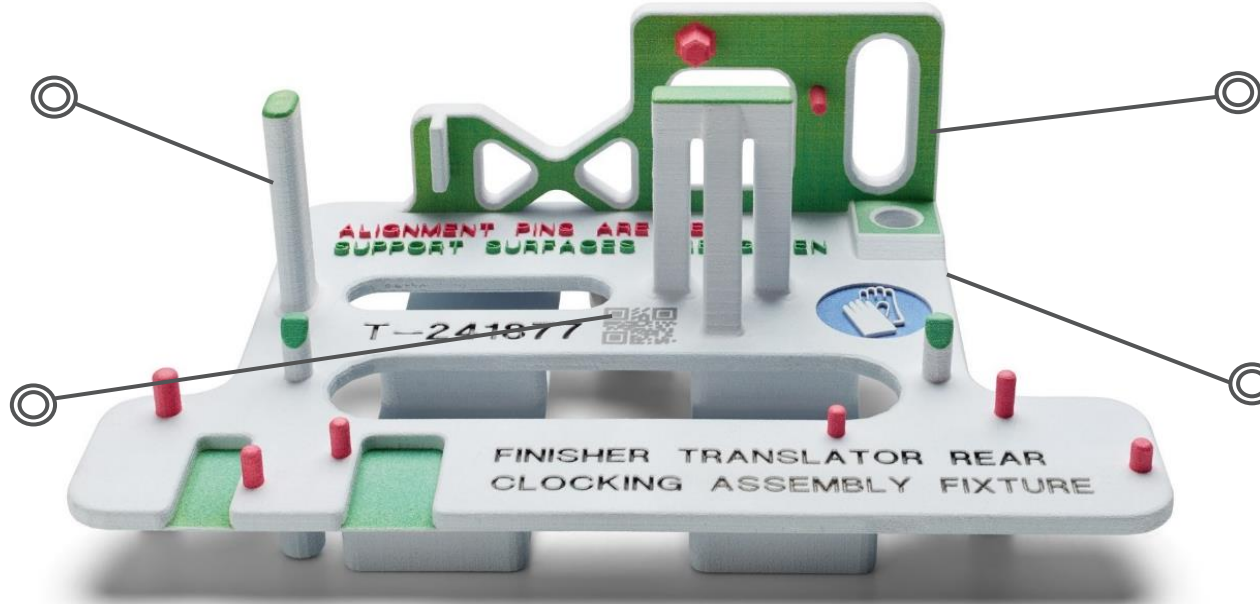
“풀컬러로 출력된 정밀한 인체모형은 학과간 복잡한 해부학적 커뮤니케이션에 도움이 될 뿐만 아니라 의학적 배경지식이 없는 환자와 그 가족들에게 설명하는데도 유용하게 사용됩니다.”

- Dr. Justin Ryan, Ph.D. at Rady Children's hospital

지그 및 치공구

쉽게 눈에 띄는 색상정보

조립지침 및 주문관련
저보를 전달하기 위한
QR코드



밝은 색상을 통해
제조라인에서 발견하기
쉬우며 금속 치공구 대비
가벼워 작업 효율성 증대

생산라인의 거친
환경에서도 사용가능한
수준의 준수한 강도



Data courtesy of Austin Dental Equipment Company (A-Dec)

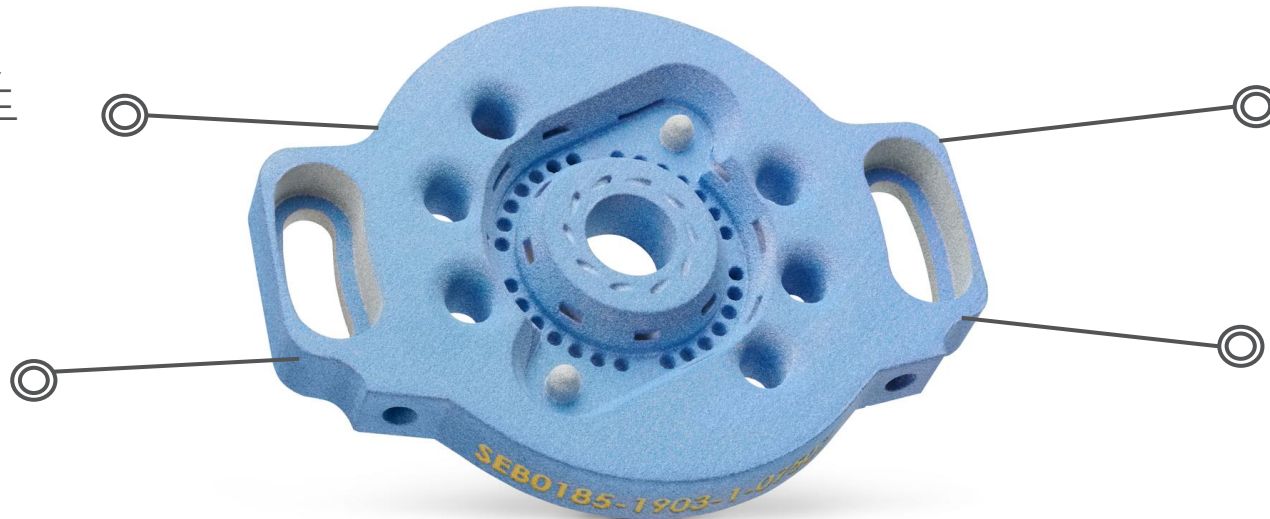
“컬러 출력은 기존에 우리에게 선택사항조차 아니었던 모든 유형의 가능성을 열어줍니다. “...단순히 색상이 추가되는 것이 아니고 새로운 단계의 시각적 커뮤니케이션이 추가되는 것 입니다.”

- Mark Wynn, Technical Specialist at Yazaki North America Inc

산업용 완제품

사용 설명서, 주문정보 및 추적정보를 포함한 QR코드

눈길을 끄는 색상과 각종 시각적 정보, 그리고 로고를 더해 고객에게 제공할 제품 출력



스티커 대신 지워지거나 떨어질 우려가 없는 CE/UL라벨

순정품임을 보여줄수 있는 워터마크 등의 정보 수록

Data courtesy of Seb/Automatisme

“색상과 시각정보의 조합을 통해 조이스틱의 방향과 버튼을 누르는 압력이 컨트롤러에 어떠한 정보를 입력하는지 명확히 인지시킬수 있습니다, 부품의 다양한 부분에 색상정보를 추가할수 있는 디자인 능력만 있다면 이전에 생각지 못했던 많은 작업을 수행 할 수 있습니다.” Jeff Guida, President and CEO of Shareroller.

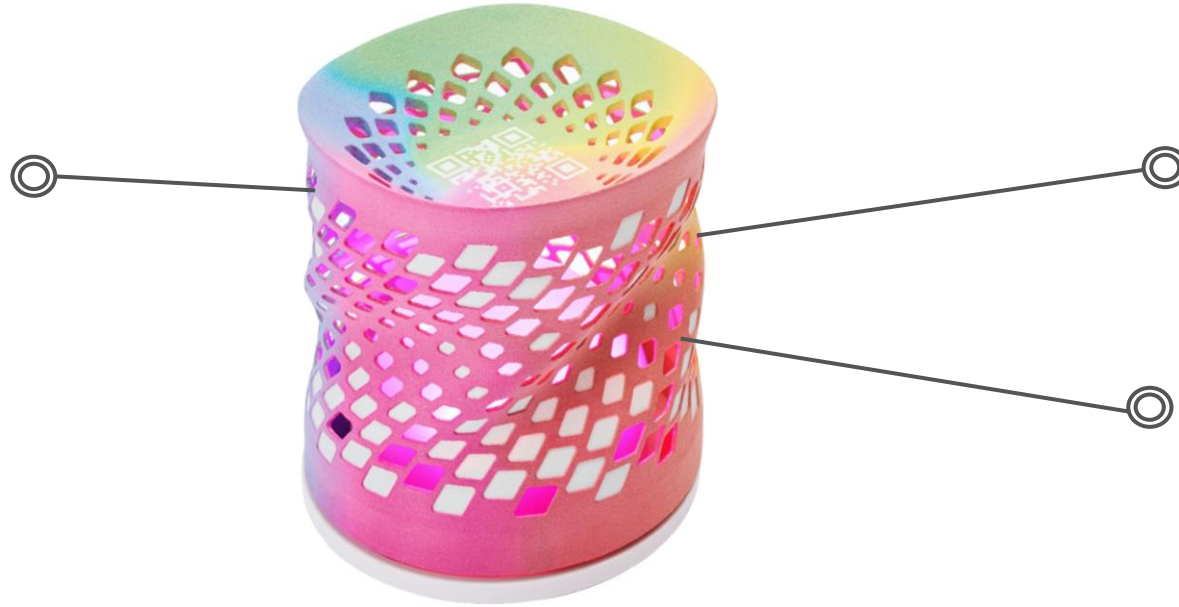


Fast Radius; Airbus services company Satair

소비재용 완제품

3D프린터만이 가능한
독특한 디자인

제품의 두께를 조절하여 빛이
새어나올수 있도록 제작



맞춤형 디자인과
자유로운 색상 선택으로
차별화된 제품 제작

복잡한 디테일과 견고한
재료강성



Data courtesy of Microsoft

고객 사례



MJF Application for Education

Clemson University



- 미국 사우스캐롤라이나의 공과대학
- 2007년부터 3D 프린팅을 도입하여 학생들이 직접 설계한 제품 출력
- 풀컬러와 우수한 물성이 제공되는 파트를 다음날 수령



MJF Application for Automotive

Fit/Assemble - Fuel nozzle & adaptor

EBK HUNGARY
Mérnöki, Termelő, Kereskedelmi Kft.



EBK Hungary

- 자동차 및 산업용 솔루션을 제공하는 서비스업체
- 헝가리 부다페스트의 Szent Istvan 대학과 파트너십
- 학과 제품설계 과정에 3D 프린팅을 소개 및 적용

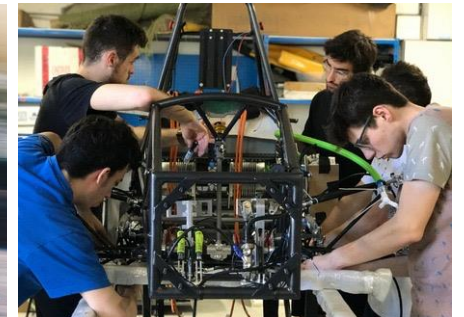


MJF in Automotive

HP고객사례

EEBE e-Tech Racing

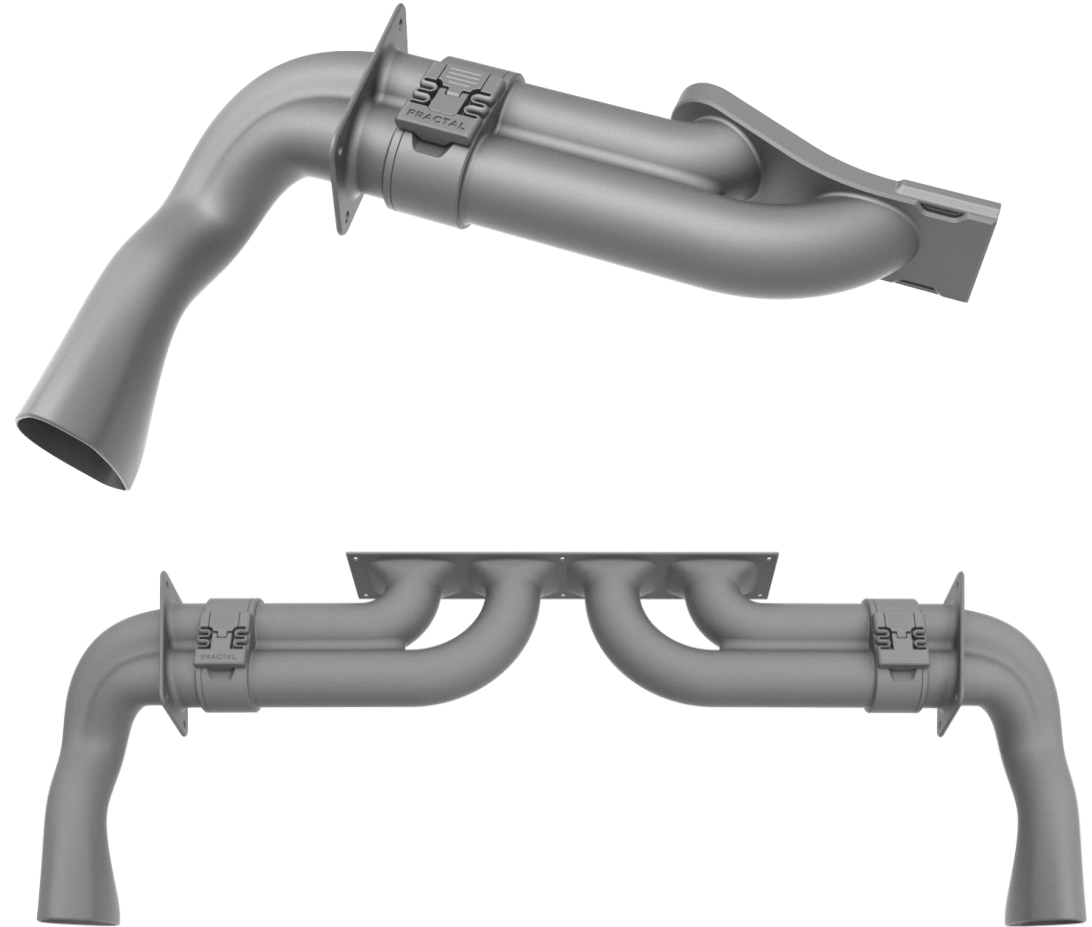
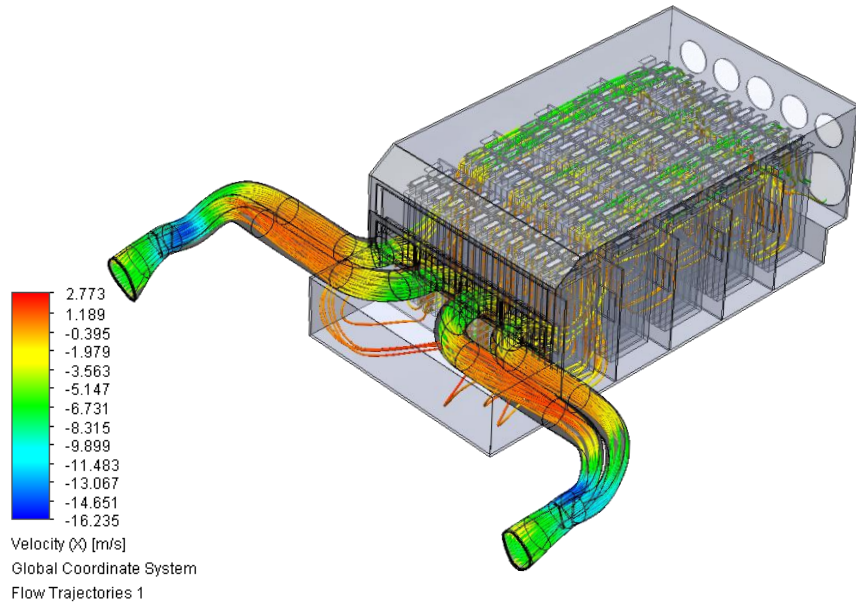
- UPC(University Politecnica de Catalunya) 소속 전기자동차 레이싱 팀
- 차량의 설계 및 개발을 직접 수행하며 경기에 요구되는 규칙, 규정을 준수하는 동시에 최고의 성능을 발휘하는 파트개발에 적합한 솔루션으로 3D Printing 선택
- 대부분의 파트가 소량생산이고 맞춤형 스페어파트 및 도구를 저렴히 제작
- MJF의 Fluid Tightness에 유리한 파트 제작



FINAL PART APPLICATION

BATTERY COOLING SYSTEM

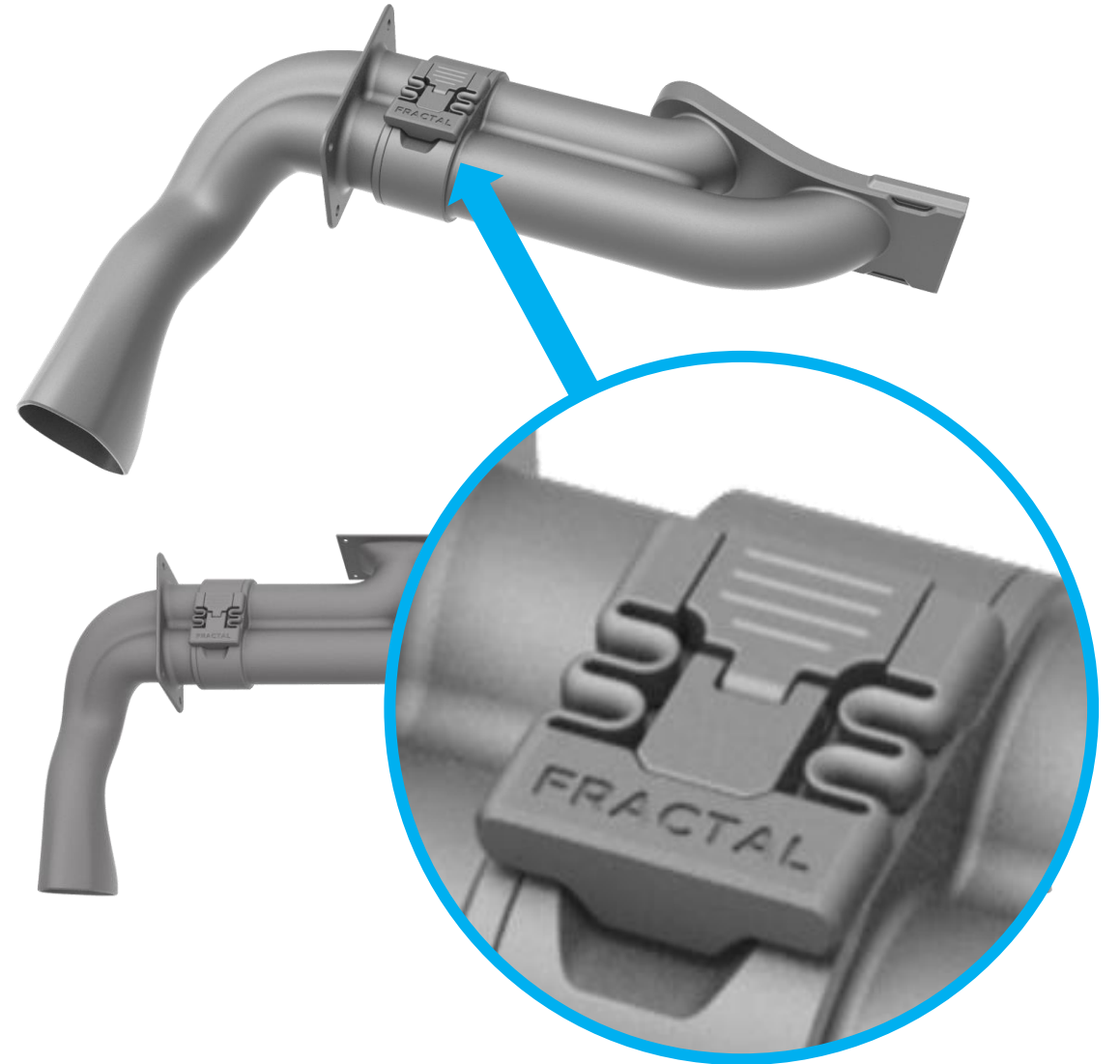
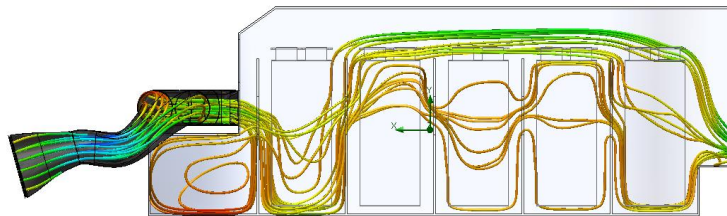
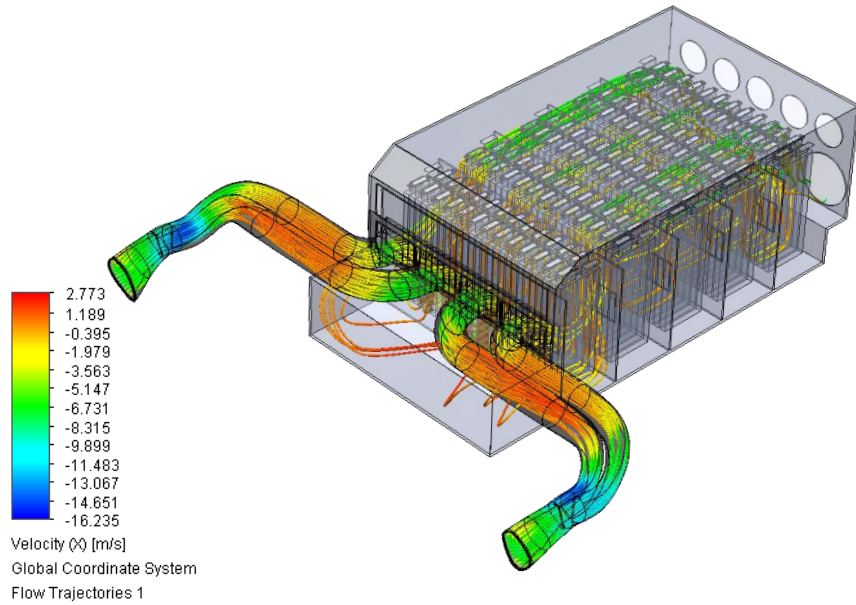
- 경주용 차량에 사용된 배터리 쿨링 시스템
- 주행중 발생할수 있는 비상상황에 대응하기 위하여 빠른 탈착이 요구되므로 단일부품으로 제작이 불가하여 이를 고려한 설계 적용
- 3개의 부품으로 제작되어 주행중 발생하는 진동 및 충격 최소화



FINAL PART APPLICATION

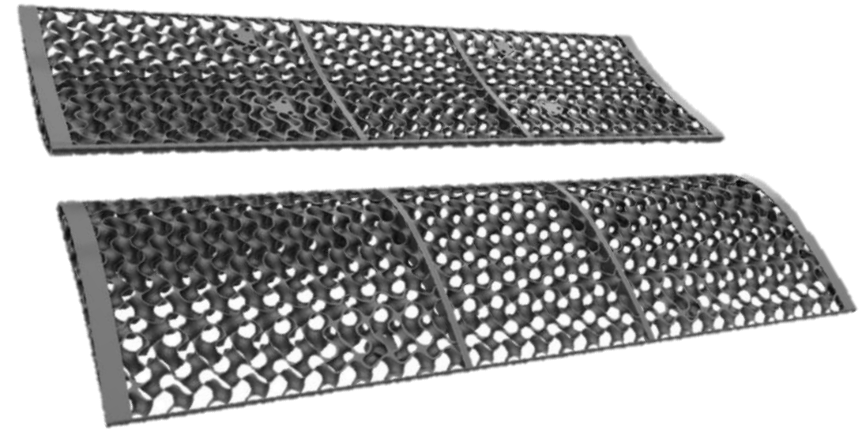
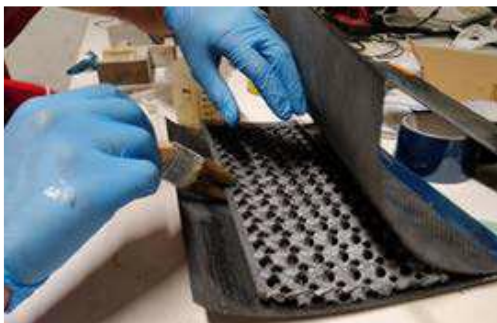
BATTERY COOLING SYSTEM

- 경주용 차량에 사용된 배터리 쿨링 시스템
- 주행중 발생할수 있는 비상상황에 대응하기 위하여 빠른 탈착이 요구되므로 단일부품으로 제작이 불가하여 이를 고려한 설계 적용
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Tooling

복합소재용 툴링



ASSEMBLY VIEW

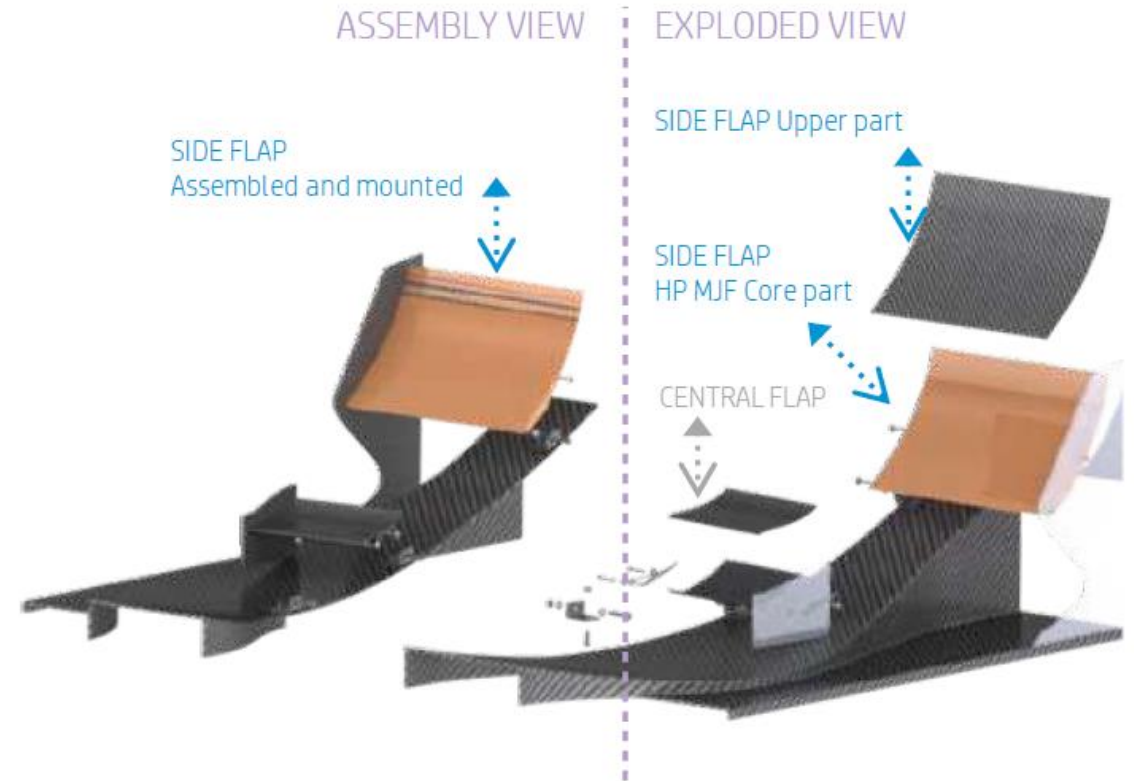
EXPLODED VIEW

SIDE FLAP
Assembled and mounted

SIDE FLAP Upper part

SIDE FLAP
HP MJF Core part

CENTRAL FLAP





감사합니다.

Juhun.lee@hp.com

