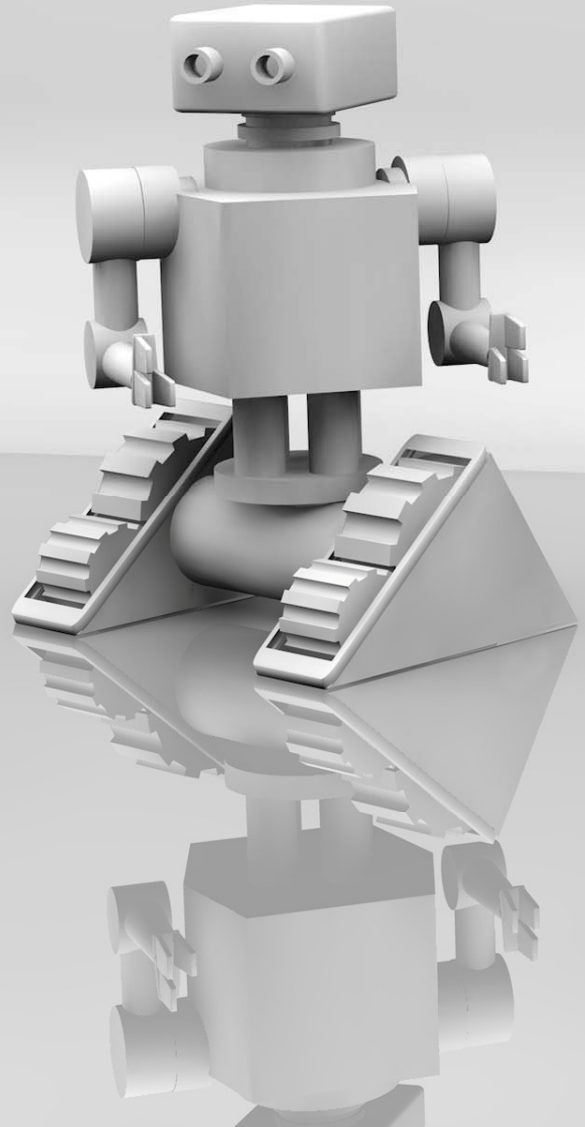


3D printer,

Society Changes It,
or It Changes Society?

The Exploration and Practice of the Digital Nature is Asked Now !

inkcube.org

Masahiko FUJII

inkcube.org

Keio University Institute at SFC

3D printers are steadily coming into use!

Two Different Directions (Ways)
to Think about Relationship Between 3D Printer and Society.

Society Changes 3D Printer

How 3D Printer Responds to
the Demands of Society?

New Weapon (New Tool)
to Deal with Social Changes.

This is the Main Trend
and the Way We Think 3D Printer Now.

3D Printer Changes Society

The Difficulty of Turning
the Movement

Change Supply Chains, Laws,
Education and our Thinking.

How We Change the Structure of Society
with 3D Printer and Make Innovation?

3D Printer
(Additive Manufacturing)

Society Changes (Usage of) 3D Printer

Contributions of 3D Printers under COVID-19

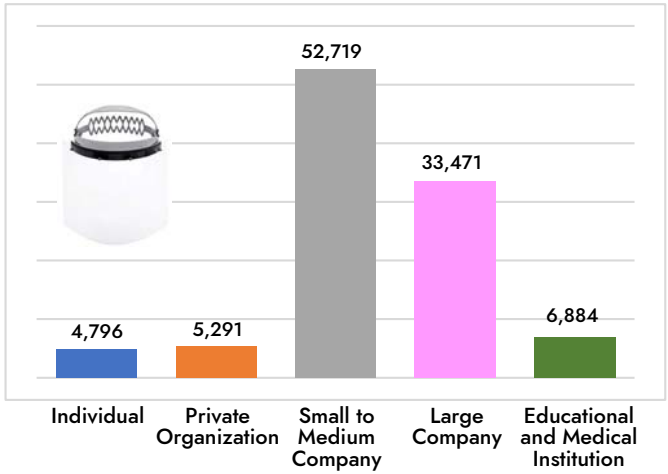
Advantage of 3D Printer : Mold-less and High Digital Affinity

COVID-19 Pandemic

3D Printers have contributed to infection prevention activities such as PPE (Personal Protective Equipment) production and rapid supply of parts for medical equipment.

PPE, Medical Equipment

- Face Shield
- Mask Cover
- Valve for Ventilator
- Nasopharyngeal Swab for PCR Test
- Doorknob
- Hook for Glove Removal
- Partition Table



Number of Produced Face Shields in Japan (~Sep.,2020)

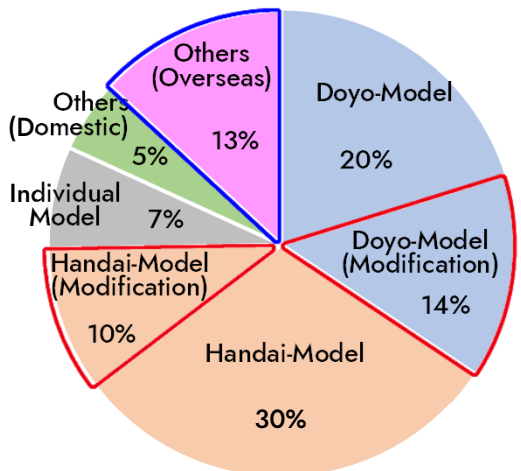
(M. Aoki, Proceeding of 4DFF2020)

- HP released 3D Data of PPE, and more than 30 companies supplied 4 million parts of PPE worldwide.
- In Japan, efforts at FabLab have led to many PPE fabrications at various organizations across the country, and the release of 3D data has led to a rapid increase in the number of productions.

Contributions of 3D Printers under COVID-19

- 3D data for face shield has been disclosed on the internet, and the number of production or fabricator has increased rapidly.
- And many modified versions were also produced.

Digital data makes it easy to share design information.



Disclosed 3D Data for Face Shield (～Sep.,2020)

(M. Aoki, Proceeding of 4DFF2020)

This activity was widely reported.

Is that enough?

What are the challenges for further development?

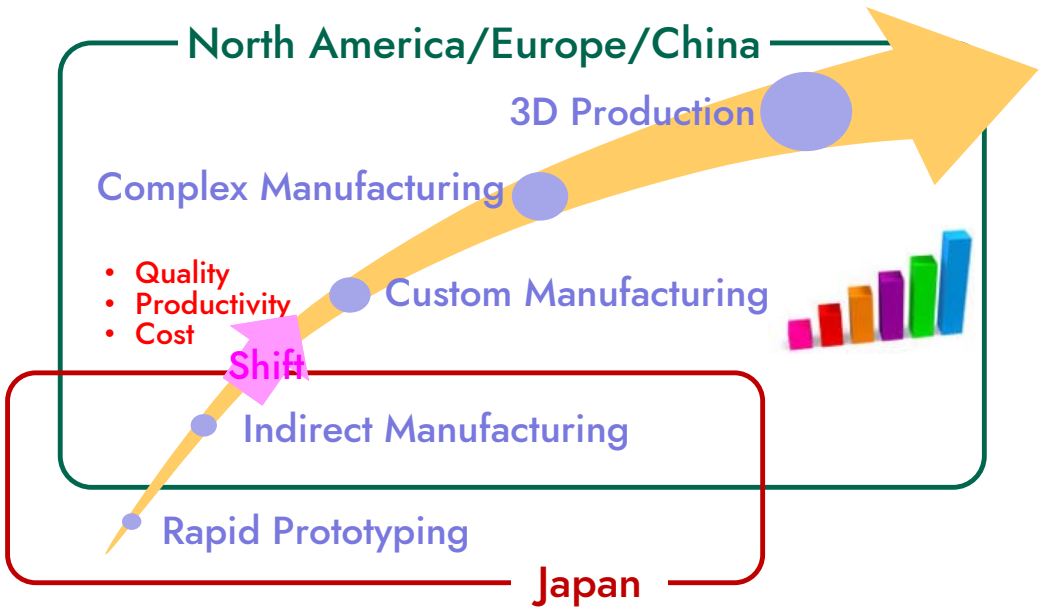
And what are issues for next challenges?

Expertise in handling (modifying) 3D data is required.

Many people can be involved, but efficient operation and responsibility for problems is unclear.

No involvement of medical professionals in many cases (lack of medical perspective).

3D Printer as a Mass Production Facility

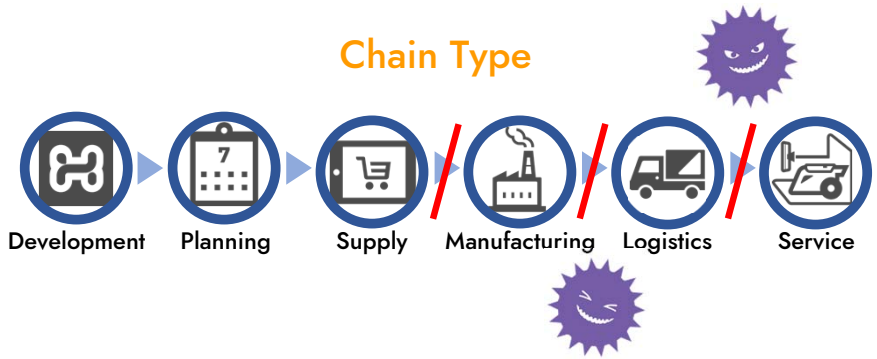


BMW Additive Manufacturing Campus
More Than 50 3D Printers,
Over 300,000 parts manufactured annually
https://xtech.nikkei.com/atcl/nxt/mag/nmc/18/00011/00089/

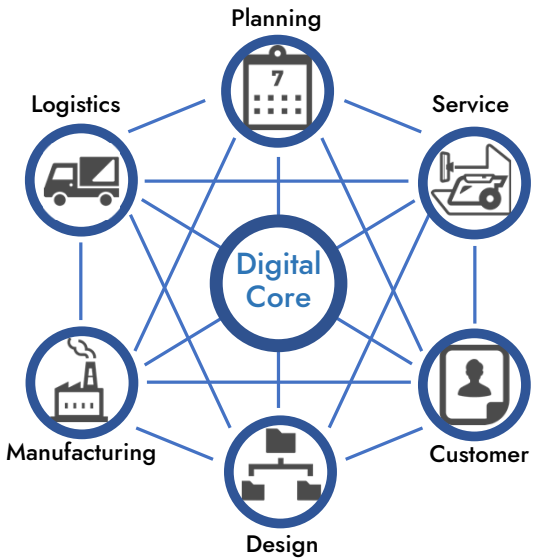
- The development of 3D printers has shifted to meet the requirements (quality, productivity, and cost) of mass production facilities.
- The use of 3D printers started in areas where cost competitiveness can be utilized, such as shortening lead time and reducing mold costs, and is now shifting to mass production in North America, Europe and China. (Japan is behind!)

Supply Chain for Products

Chain Type



Network Type (Eco-System Type)



- 3D printers are being used in more and more cases and an environment (Supply Chain) that facilitates the use of 3D printers is now in place.
- 3D Printer has used only in cases where it is superior to conventional methods.

Is that all we need?

- Exchange of digital data will be easy.
- The impact of supply chain decoupling will reduce.

- It is necessary to create a new environment (new supply chain) where 3D printers can be used and utilized more effectively,
  and to think about how to use 3D printers to take advantage of their true nature.

3D Printer Changes Society

: Issues and Approaches for Changing Society

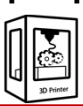
Features of 3D Printers

Previous 3D Designs (Designer)

- Releasability from Molding Die/Cutting Blade Reachable Range (Shape Restrictions)
- Limitation on the Number of Materials
- No Color (Few Color)

Optimization of the Design (Function, Strength, Cost, etc.) under the Limitations of Existing Manufacturing Methods (Injection Molding/Cutting).

For this purpose, education and K/H inheritance have been carried out.

3D printers are HERE! 

These Limitations Have been Removed.

Complex Shapes / Internal Structure

Mixing of Materials / Sloped Distribution

Full Color (Surface / Internal)

The approach to optimizing designs based on 3D printers is a completely different.

Examples of Directions to Go with 3D Printer

- 3D printers are being used more and more, but only when they are superior to conventional methods.

That's not a bad direction.

- It's now the time to challenge things that can only be done with 3D printers!

1. To get new functions and mechanisms,

   complex internal structures, material mixing, gradient distribution, integrated modeling.

   - Transformation to new design thinking (DfAM, DAVoF).

2. A new supply chain drawing the nature of digital data (3D data).

   - New project type supply chain.

3. Capturing the long tail market.

   - New 3D data handling technology (tool) allowing anyone to handle 3D data
   - Essential new data format.

New (3D) Design Thinking

Integrated Modeling
Complex Internal Structure
Material Mixing / Sloped
Distribution of Material

New Design Thinking

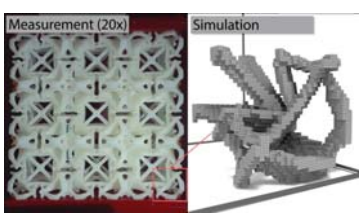
DfAM
(Design for Additive Manufacturing)

STEAM Education
(Science, Technology, Engineering, Art, Mathematics)

DABoF
(Database of Function)

Surface/Internal Structure
Material Info.
Physical/Chemical Reaction
Linking
Function
Property

Weight Reduction and
Performance Improvement



Metamaterial with New
Physical Properties
(Meta Material)

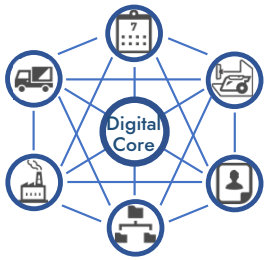
Desai Chen, Computational discovery of extremal microstructure families, Science Advances, Vol.4 (2018)

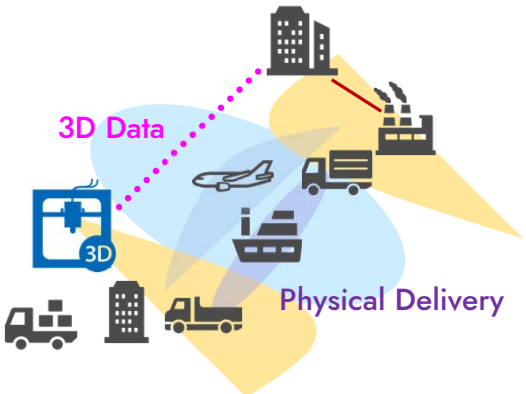
New Motion Mechanism that
Does Not Require as Much
Production Accuracy.

https://www.youfab.info/2016/winners/ready-to-crawl?lang=ja

New Project Type Supply Chain

Current Supply Chain





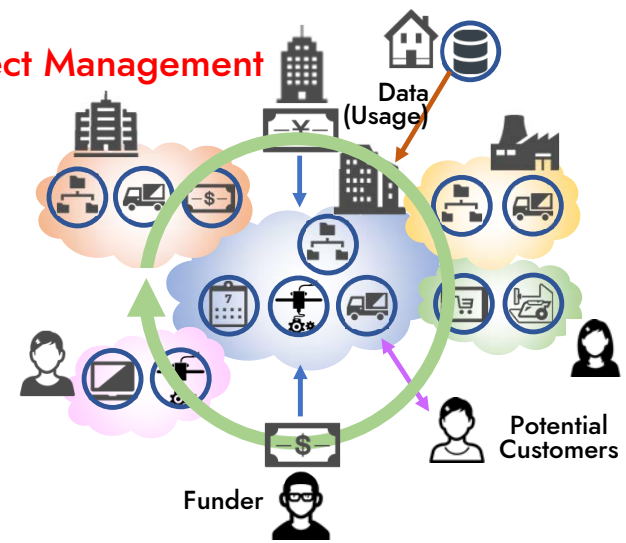
Digital Data Delivery

Building a New Supply Chain
Applying the Nature of 3D Printers

Change the Tide

Project Management

Need for project management to share objectives, to distribute roles and profits appropriately.



Project Type Supply Chain

Various member can be involved in various roles.

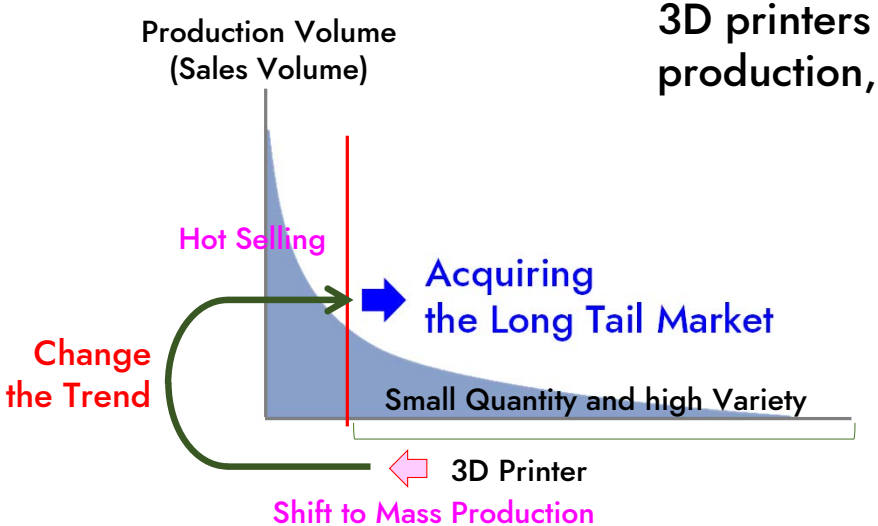
Features of Project Type Supply Chain

- Various Member (Role) Can be Added. (Agile Development, Lean Startup is Possible.)
- Reassign Members According to the Product (Project)

VENTILATOR CHALLENGE UK

M. FUJII, 3D Printer, Society Changes It, or It Changes Society?
- The Exploration and Practice of the Nature of Digital is Asked -, Journal of Imaging Society of Japan, Vol.60, NO. 4 (2021)

Capturing the Long Tail Market and Issues



3D printers should not only go into mass production, but also into the long tail market.

Issues

Who design for mass customization (for me)?
Everyone can use 3D CAD? · · · **NO!**

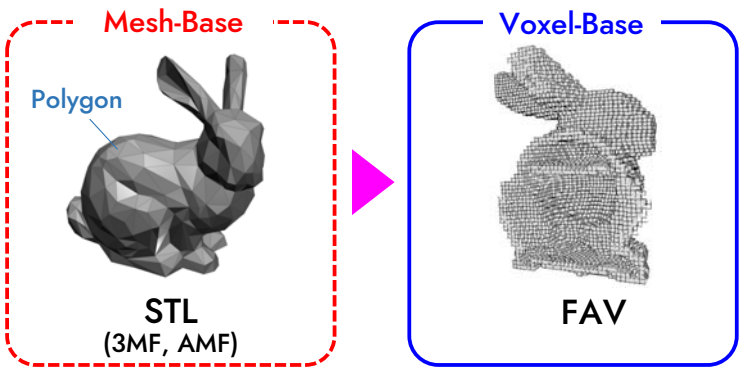
&

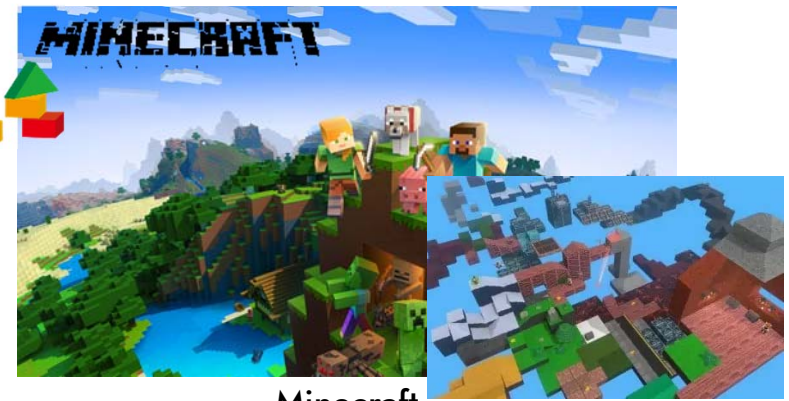
Current 3D data format easy to edit? · · · **NO!**
Current 3D Data Format suitable for 3D designs with complex internal structures, functions or full color?
· · · **NO!**

Solve Issues and Change the Trend

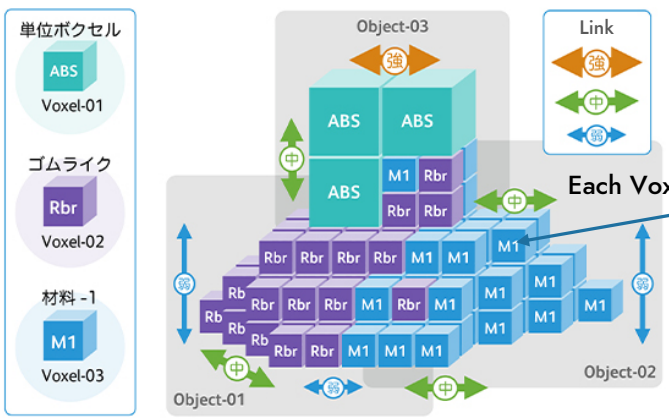
New Voxel-Based 3D Data Format, Design Tool
Solving the Above Issues

New 3D Data Format FAV and Design Tool





Minecraft
(It likes a simple design tool using voxels.)



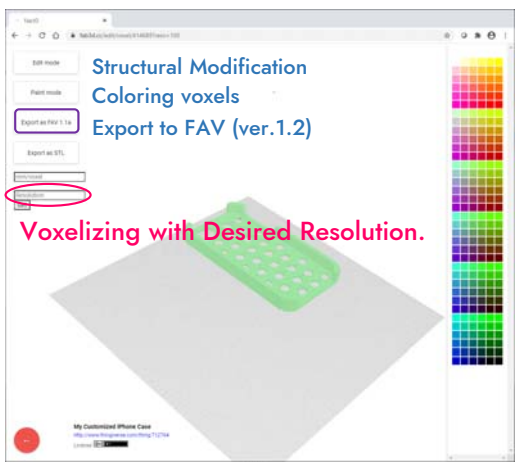
Voxel-Based 3D Data Format (FAV)

Information needed to demonstrate the capabilities of a 3D printer

- Color Information (Surface/Internal)
- Material Information (Surface/Internal)
- Link Information
- User-Defined Information
- Internal and External Structure

FAV(Fabricatable Voxel

FAV was Jointly Proposed by Fuji Xerox and Keio University in 2016 and Registered in JIS in 2019.



3D Data Search Engine and Editor

Advantages of Voxel-Based 3D Data Format FAV

Mesh-Base

STL

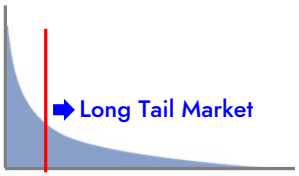
3D Data and Design Tools Become Part of Daily Life

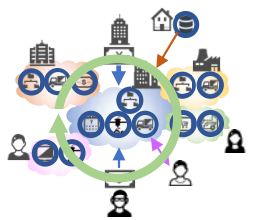
Like 2D Images

Voxel-Base

FAV & Design Tool Based on Voxel

- Everyone can design their own 3D model that they want and 3D Printers can acquire the Long Tail Market.
- 3D Data becomes more accessible and Project Type Supply Chains will be activated.





FAV can also solve many issues of mesh-based 3D Data format.

Mesh-Base

- No Color or Material Information
- Gaps and overlap errors will occur.
- Difficult to describe complex internal structures
- Difficult to edit and compose
- Complexity of working with simulations
- Difficulty in learning 3D CAD
- No compatiblity with other 3D data formats

Voxel-Base (FAV)

- Color, Material, Link and User-Defined Information
- High Robustness
- Complex internal structures can be described.
- Easy to edit and synthesize (Easy Boolean operation)
- Easy integration with simulation (Finite Element)
- Simple design tools can be built.
- Voxelizing from 3D data formats is easy

Conclusion & Proposal

For changing society with 3D printer, we also need to change the way of thinking on copyright and product liability.

- 3D Printer, with high digital affinities, is capable of responding quickly to the needs or challenges from society (change).
  e.g. PPE supply in the COVID-19 pandemic, shift from Prototyping to Mass Production.
- 3D Printer is not a substitute for existing manufacturing methods. By utilizing the nature of the 3D Printer, we can significantly change the structure of society and create a richer human life.
  However, changing the current flow is a hard struggle against the "Normalcy" or "Inertia", and there are high hurdles to overcome. If we do not overcome this hurdles, Innovative change will never occur.
- In order to solve issues changing Society, it is necessary to have new ideas for 3D designs such as DfAM or DABoF and new supply chain called as Project Type Supply Chain.
- To make the best use of 3D data and to promote new approaches, we should move from mesh-based 3D data formats to voxel-based data format FAV, which has rich information of 3D models and easier to design or edit.
- For the time being, 3D Printer and new approaches will not replace all conventional manufacturing methods. We need to be flexible enough to use both.

Thank You for Your Kind Attention!

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