University of the Aegean
Department of Shipping,
Trade and Transport

(Amended version for the website)

Digital Ship
CONFERENCE & EXHIBITION
Athens, 1 & 2 November 2017

Digital maritime Spare Parts: 3D printing shortens the supply chain

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Presentation Structure

THE AVAILABLE TECHNOLOGY
Definition - Processes-Materials

THE GROWTH OF THE ADDITIVE MANUFACTURING INDUSTRY

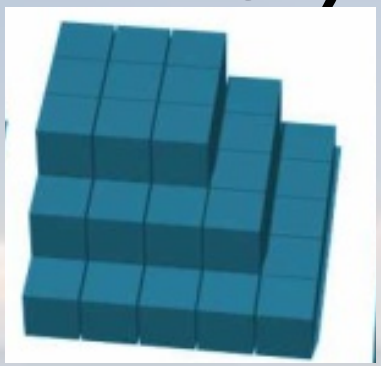
Lessons learned from the introduction of additive manufacturing in other industries

CHARACTERISTICS OF THE MARITIME SECTOR
Additive manufacturing in/and the shipping industry

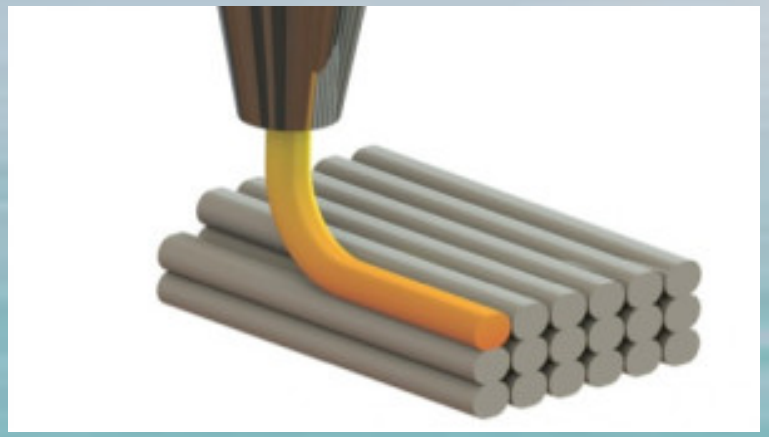
The spare parts supply chain in the shipping industry

Discussion - Conclusion

Additive manufacturing *(ASTM F2792)*



is the process of **joining materials to make objects from 3D model data,** usually **layer upon layer,** as opposed to subtractive manufacturing methodologies.



http://www.brdisolutions.com/about-3-d-printing-aka-additive-manufacturing

From the digital design to manufacture

Digital design

Physical object

http://marketsreports.blogspot.gr/2014/03/additive-manufacturing-medical-devices.html

ASTM (2013) groups them in seven types

In some processes the material is

-squirted,

-squeezed or

-sprayed

and in others

-fused,

-bind or

-glued.

The power source is

-thermal,

-high-powered laser beam,

-electron beam,

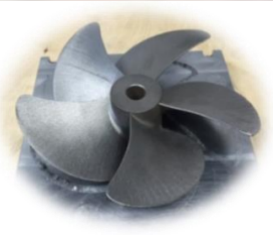
-ultraviolet laser,

-or photo curing.

Raw Materials for the process

ABS plus, PLA, petg

metals



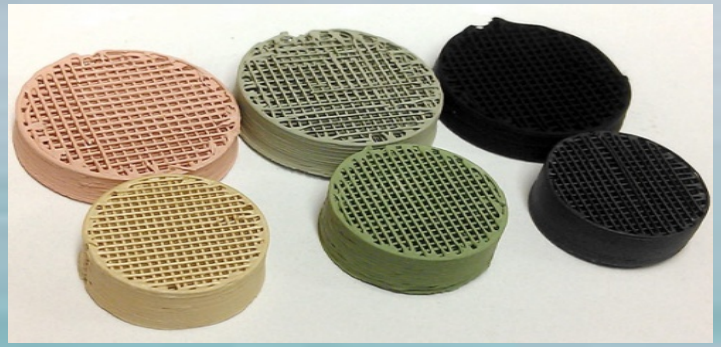
Pilot Project 3D printing of Marine spares

ceramics

biological materials

polymers

Alloys



Ceramic filters

Photo: Shah TEAM 3dprint.com/29454/3d-printed-fuel-cells/

Capabilities

It is an integrated production machine

Offers flexibility

Freedom of complexity

Elimination of assembly

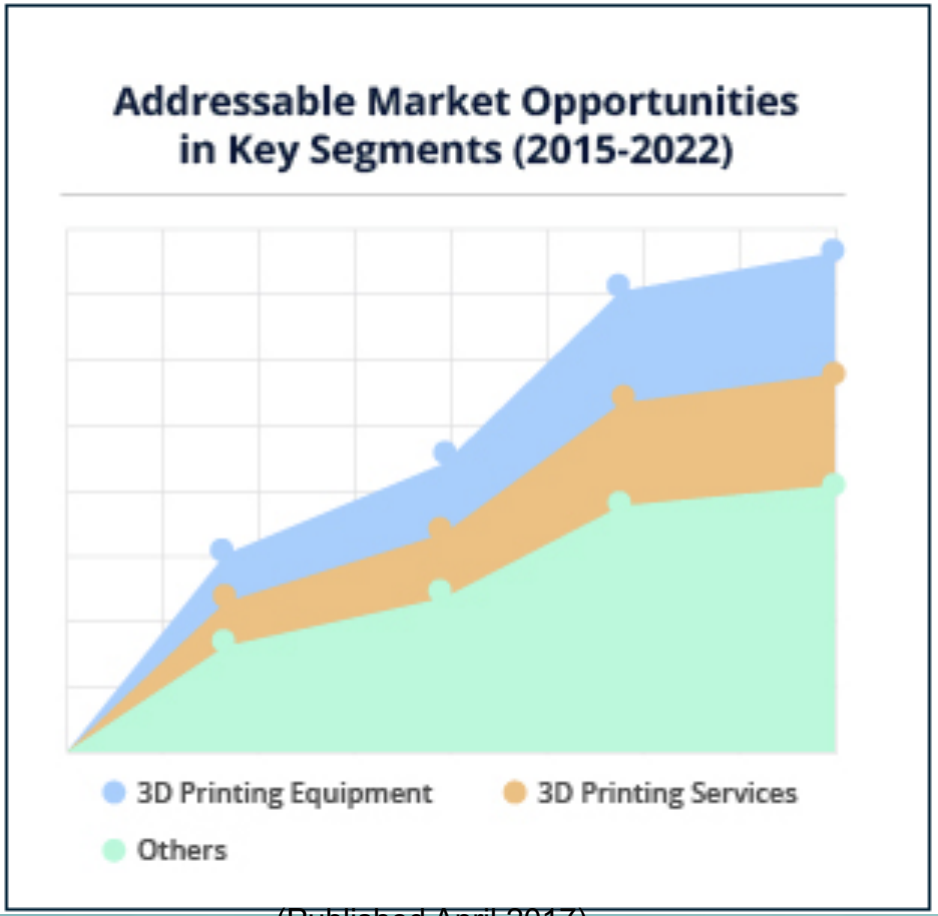
Market size

3D Printing Industry

Surpassed $5.1 Billion

The global **market** for **3D Printing** is projected to reach US$16.8 billion by 2022

(Wohlers Report 2016)



(Published April 2017)

www.forbes.com/.../wohlers-report-2016-3d-printer-**industry**-surpassed-5-1-billion/

Industries with similar characteristics (moving assets) to maritime industry

- Automotive (truck manufacturer)
- Aircraft industry
- Aerospace industry
- Defence

Lessons learned from the introduction of additive manufacturing in other industries

Additive manufacturing is a promising technology

The inventory costs for low turnover spare parts
can be lowered and at the same time increase in customer service.

AM could be beneficial for low demand, single-item situations,
if it is difficult to make it otherwise.

CHARACTERISTICS OF THE MARITIME SECTOR

Maritime assets are capital intensive and downtime has financial consequences.

Operate away from the base in remote areas and are in constant movement.

Maintenance networks involve many actors

The IMO and classification societies impose rules.

Spare parts supply may involve emergency transport.

Assets can be classified as long-lived.

The apparatus is in an environment that is highly corrosive, with vibrations & shocks.

The spare parts supply chain in the shipping industry

Ship (Position A)

Ship (Position B)

Technical Dep.

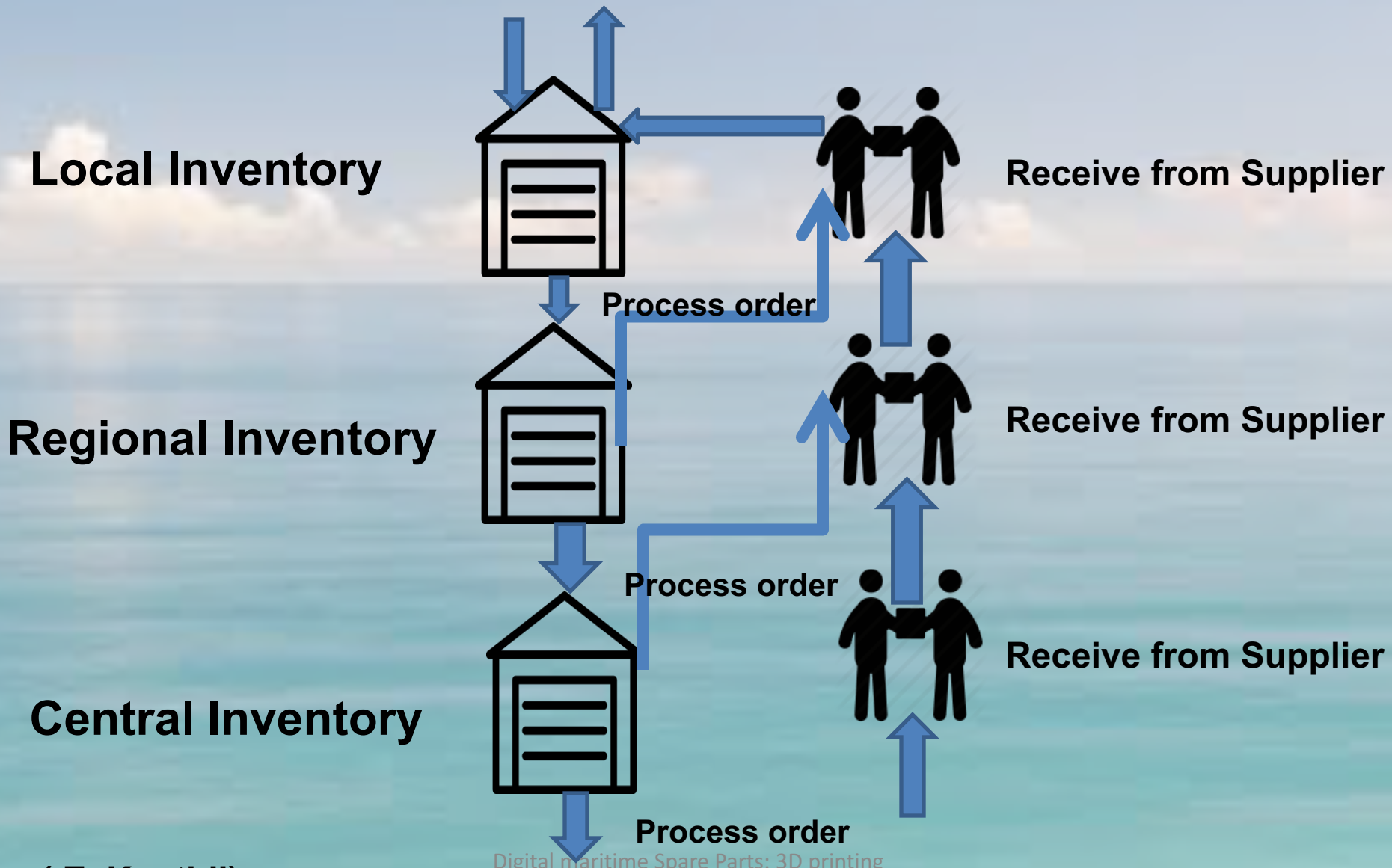
Land office

Procurement Dep.

Supplier

(E. Kostidi)

Local, Regional or Central Inventory



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Spare parts manufacturing

Instead of inventory

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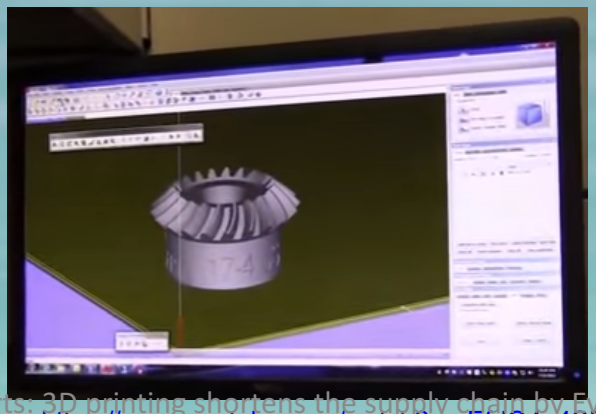

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www.windindustrial.com/3d-metal-powder.html

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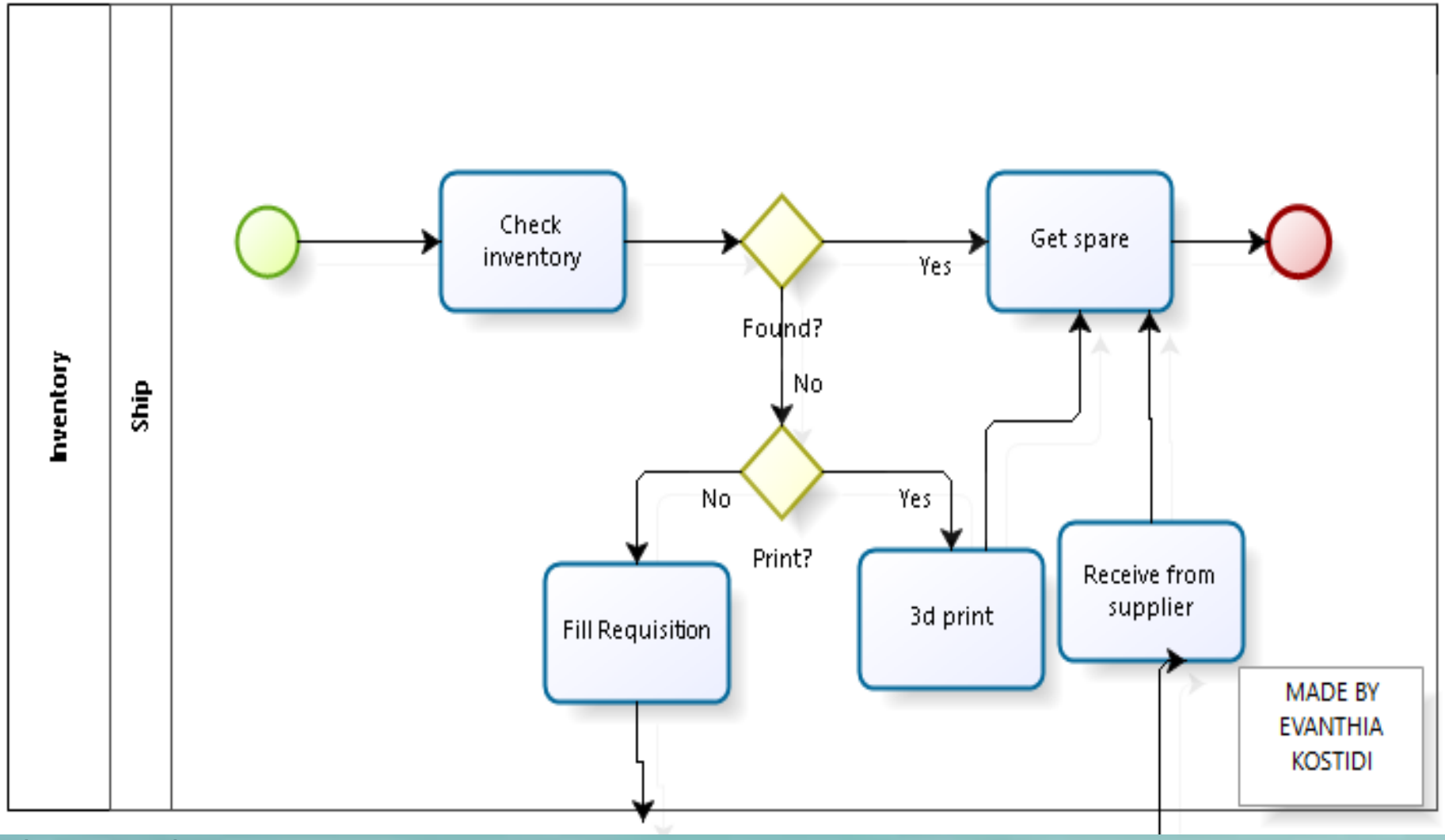
https://www.youtube.com/watch?v=rEfdO4p4SFc

(3D PRINTING) An alternative new technology future scenario



(E. Kostidi)

Overcoming skepticism

Is a spare part made by the AM comparable with the part made by the traditional method?

ISO/TC 261 and ASTM F42 joint plan

for AM Standards work in the direction

to assure that there will be methods

to test processes and parts.

Overcoming skepticism

The cost of the AM machine, and the cost to build the part.

as the market advances, patents expire, and demand grows,

the machine cost as well as the production cost will fall.

Further Research

Which of the processes best suits the installation on board a ship?

How will the intellectual rights be protected?

How the required files will be distributed?

Where in the supply chain is optimum to have the AM of the parts?

How will the personnel be trained in the new technology, taking into consideration that

the salesman at the supplier will be made manufacturer?

Summing up

The shipping industry can learn from other industries that already adapted AM in one way or the other, but further study that will take into consideration the special characteristics is needed.

Thank you