Certificate of Advanced Studies

Additive Manufacturing

As a growing manufacturing option, additive manufacturing offers opportunities for innovation in many ways. New business models, cost optimisation and accelerated product development cycles are just a few examples of what additive manufacturing has to offer. The CAS Additive Manufacturing provides you with a starter package of know-how on manufacturing methods, processes, design and post-processing, with which you can properly evaluate the technology and adopt it sustainably.

Berner
Fachhochschule

Table of Content

Stand: 31.03.2023

1 Environment

Additive manufacturing - also known as 3D printing - has evolved since the 1980s from a quick and cost-effective solution for prototyping to a technology used in serial production. Models generated by Computer Aided Design (CAD) are broken down into separate slices and built-up layer by layer by a 3D printer, whereas conventional subtractive manufacturing removes piece by piece of the material. This layered process enables the production of models of almost any complexity.

In the CAS Additive Manufacturing we will guide you through the diverse processes, materials, and applications of 3D printing and give you insights into current technical innovations. We'll show you…

- the numerous benefits of the additive manufacturing technology
- how additive manufacturing enables new products and complements traditional manufacturing in many ways.
- how to use the advantages of additive manufacturing for innovative product ideas.
- how to decide if additive manufacturing is the right manufacturing method for your component.
- examples of applications in mechanical engineering, medical technology, aerospace and others.

During hands-on workshops with industry partners, you can apply your newly acquired knowledge and gain initial experience in using 3D printers.

2 Education Goals

- You have basic knowledge of the technology, processes and materials of additive manufacturing.
- You understand the process chain for an industrial application of additive manufacturing.
- You will acquire the necessary knowledge for the development and introduction of additive manufacturing.
- You will learn to assess where the possibilities and limitations of additive manufacturing lie.
- You will use additive manufacturing for technical innovations and evaluate new business models.
- You will evaluate the qualitative characteristics of additively manufactured components and know common post-processing methods.
- You will understand which factors determine the costs of additive manufacturing

3 Target audience

The CAS is aimed at the following target group

- Engineers
- Technicians
- Project Managers
- Process Developers
- Business Development Managers
- Product Managers
- General Managers
- Chief Technology Officers
- Chief Digital Officers
- People from mechanical engineering, electrical, metal or similar industries

4 Requirements

You have an affinity for technology or fulfil professional tasks that require a basic technical understanding. CAD skills are not required for participation.

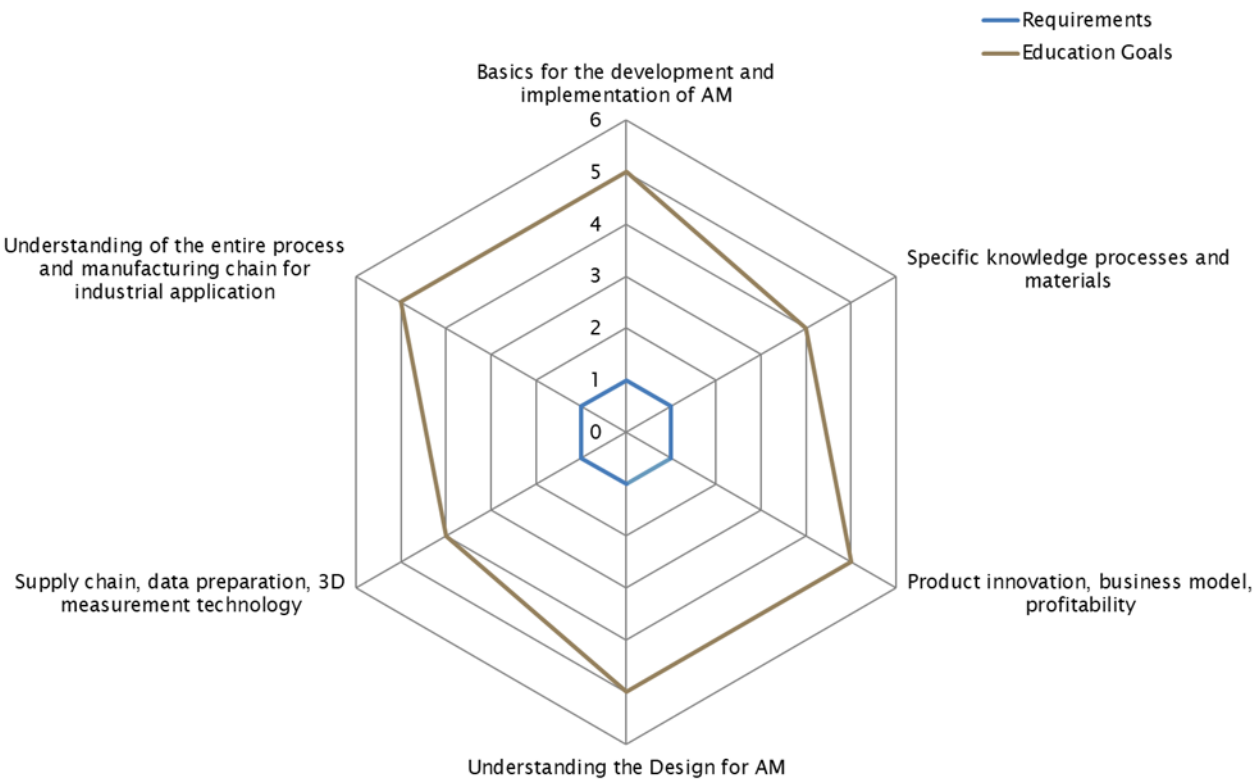
5 Language of instruction

The language of instruction is English.

6 Place of realisation

Bern University of Applied Sciences, School of Engineering and Computer Science, Switzerland
Innovation Park Biel/Bienne AG (SIPBB), Aarbergstrasse 46, CH-2503 Biel, phone +41 31 848 31 11, E-Mail weiterbildung.ti@bfh.ch.

7 Skills profile



Kompetenzstufen

1. Kenntnisse/Wissen
2. Verstehen
3. Anwenden
4. Analyse
5. Synthese
6. Beurteilung

8 Course outline

Teaching Units	Lessons	Days
Introduction and basics of additive manufacturing	16	2
Processes and Materials	16	2
Design for Additive Manufacturing	32	4
Supply Chain of AF	8	1
Industrial Application	32	3
Module of Choice I & 2	16	2
Project thesis (90 hours self study)	8	1
Total lessons	120	15

The CAS programme has a total of 12 ECTS credits. Appropriate time for individual studying and preparation must be planned for each course.

9 Didactics, Presence, Distance Learning

The CAS is predominantly conducted in face-to-face format. In consultation with the class, days can be conducted via MS teams in distance learning or hybrid form with online participation. The teaching language is English. Workshops, guest lectures and company visits are an important element of this CAS.

10 Course descriptions

Introduction and basics of additive manufacturing	
Learning objectives You will understand the basic principle of additive manufacturing, as well as the benefits and challenges of the technology. You will get a first overview of additive manufacturing processes and their applications in industry and research. You will be able to correctly classify the different terminology and have an understanding of the standardisation of additive manufacturing. You will be able to correctly assess legal and safety-relevant aspects.	
Topics and Content	**Lessons**
Introduction to the CAS Additive Manufacturing	1
Definition and historical development of AF	1
Terminologies and standardization	1
Introduction to AF	1
Data protection, legal aspects and security	1
Application areas industry and society (private use, mechanical engineering, medical technology)	1
Additive vs. conventional manufacturing with consideration of economic and ecological aspects	2
Fablab day @Switzerland Innovation Park Biel/Bienne	8

Processes and materials	
Learning objectives You will know the most important additive manufacturing processes and understand their use in an industrial environment. You will understand the manufacturing process from the CAD to the additively manufactured component with the necessary post-processing steps. You will evaluate the selection of the appropriate process for specific applications.	
Topics and Content	**Lessons**
Material Extrusion (FDM = Filament Deposition Modeling) - Process properties and parameters - Material: plastic and composite - Applications - Supply chain and finishing steps	2
Photopolymerisation (SLA = Stereolithografie, DLP, CDLP) - Process properties and parameters - Material: plastic and ceramic - Applications - Supply chain and finishing steps	2
Material Jetting (MJ, NPJ, DOP) - Process properties and parameters - Material: plastic, metal and wax - Applications - Supply chain and finishing steps	2
Binder Jetting - Process properties and parameters - Material: metal, gypsum/sand - Applications - Supply chain and finishing steps	2
Powder bed fusion (MJF, SLS, DMLS/SLM, EBM) - Process properties and parameters - Material: plastic and metal - Applications - Supply chain and finishing steps	3
Direct Energy Deposition (DED, LENS, EBAM) - Process properties and parameters - Material: Metal - Applications - Supply chain and finishing steps	2
Excursus: Lamination - Process properties and parameters - Material: Paper - Applications - Supply chain and finishing steps	1
Summary of all processes with a comparison of advantages and disadvantages.	2

Design for Additive Manufacturing	
Learning objectives You will apply the design principles necessary for additive manufacturing. You will understand and apply digital data preparation. You will learn calculation methods such as FEM, topology optimization, as well as simulation tools. You will apply an additive thinking method to the design of components.	
Topics and Content	**Lessons**
Additive design principles	1
When is it valuable to use AM	1
Topology optimization	1
Positioning and support structures	1
Data format	1
Reverse engineering	1
Metrology, 3D scans	1
Macrosimulation of the construction process and error reduction	1
Design Workshop RIC @Swiss m4m Center	8
Design Day @CSEM	8
Practice Day @Swiss m4m Center	8

Industrial application of 3D printing	
Learning objectives You will know the advantages of additive manufacturing for an industrial application. You will be able to distinguish additive processes for industrial technical applications from conventional manufacturing processes. You will be able to evaluate business models and calculate costs.	
Topics and Content	**Lessons**
Supply Chain of AF	8
Serial production	1
Prototyping	1
Fixture construction / Tooling	1
Function integration	1
Customization and Personalization	1
Spare parts, maintenance and repair	1
Excursus: Design and Architecture	2
AM Adoption and Project Management (Requirements, Feasibility Analysis, Agile Development, Manufacturing, Testing)	8
Business models and economics	4
Costing	2
Company visit @Campofer	8
Future prospects	2

Module of Choice I & II

Learning objectives

You can choose between two in-depth courses from suggested topics. These two events will be announced after the start of the CAS.

It is perfectly acceptable to attend both modules.

Project Thesis

Learning objectives

Within the project thesis you will put into practice what you have learned.

In an individual or group project, you will work out a thematic focus of your choice with the support of experts. It is up to you whether you want to go in the direction of product development, business models or research.

The aim is to integrate and holistically consider what you have learned within the project thesis. For this purpose, selected experts from the courses are available for a certain period of time with a supporting function. The project thesis deals with a certain task with practical reference. The technological possibilities of additive manufacturing are to be exhausted in this project thesis and made transferable.

Procedure

The thesis comprises approx. 90 hours of work and includes the following milestones (see also schedule):

1. define topic, and ideally organize a contact person / supervisor within the company you work for.
2. create and enter (upload to Moodle) a disposition (Word template, 1 to 2 pages).
    a. Title
    b. Environment
    c. Problem
    d. Approach (procedure, methods)
    e. Name and contact addresses of the group members, and of the contact person / supervisor in the company
3. possible revision of the project outline according to feedback from BFH.
4. assignment of an expert by BFH.
5. execution of the work in own time schedule.
6. 2-3 meetings with the expert (organized by students).
7. final presentation in front of class, expert and lecturer (15' presentation, 15' discussion).
8. submission (upload to Moodle) of the thesis to the expert and to BFH.

11 Qualification

Proof of competence	Weighting	Type of qualification (Rating on scale or fulfilled/not fulfilled)	Proof of competence
Project report	10	Project work , 0-100%	Project report
Total	10		

The weighted average of the success rates of the individual proofs of proficiency is converted into a grade between 3 and 6. A grade of 3 (average success rate of less than 50%) is unsatisfactory. Grades 4, 4.5, 5, 5.5 and 6 (average success rate between 50% and 100%) are sufficient.

12 Teaching methods

- Lectures
- Case studies, group work, exercises, assignments etc.
- Practical labs
- Company visits and guest lectures

13 Lecturers

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Prof. Eduard Bachmann	BFH	eduard.bachmann@bfh.ch
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Marco Heinemann	Campofer 3D-Druck AG	m.heinemann@campofer.ch
Dr. Sébastien Lani	Switzerland Innovation Park Biel/Bienne	sebastien.lani@sipbb.ch
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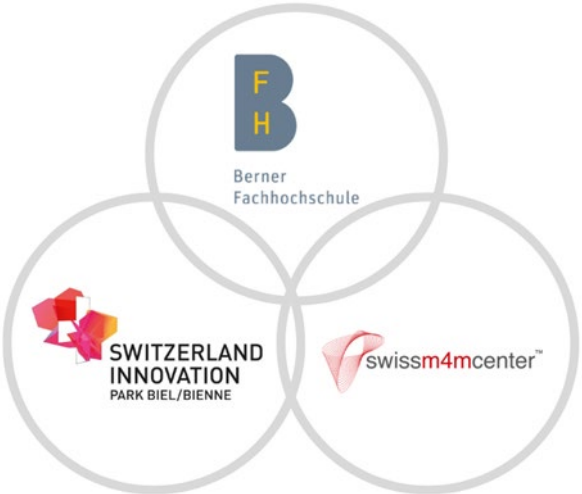
14 CAS partner

This CAS is a cooperation project of

Bern University of Applied Sciences

Swiss m4m Center

Switzerland Innovation Park Biel/Bienne



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15 Organisation

Project team
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Changes may be made to content, learning objectives, lecturers and required proficiency levels. The lecturers and the Head of Studies are authorised to make adjustments to a CAS on the basis of current developments in a subject area, the specific previous knowledge and interests of the students, or for didactic and organisational reasons.