

»TIMES-TURNAROUND«



FROM BICYCLE BOTTLE CAGE VIA LE MANS INTO SPACE:
ULTRA-LIGHTWEIGHT INNOVATION FOR A SUSTAINABLE FUTURE

Compendium by Rainer Kurek and Claude Maack

for the AMC-SUSTAINABILITY SUMMIT 2023
and the Gradel-INAUGURATION for xFK in 3D industrialization

With a foreword by Olaf Stauß, Konradin Industrie
and an epilogue by Claus-Peter Köth, AUTOMOBIL Industrie

Exclusive interviews on the sustainability lightweight construction of the future

- with **Pierre Bischoff**, World Champion in Ultra-Cycling
- with **Jeroen Bleekemolen**, Le Mans Champion and
- with **Hans Kammerlander**, mountaineering legend.

First edition and " Limited Edition" for the start of production of the xFK in 3D ultra-lightweight production on 04 May 2023 in Hautcharage, Luxembourg.

MANAGEMENT SUMMARY

»FROM BICYCLE BOTTLE CAGE TO LE MANS INTO SPACE«

First of all: With the **ultra-lightweight innovation xFK in 3D**, AMC GmbH and GRADEL Sàrl offer a **concrete solution for a sustainable future**. No more and no less: From sustainability problems to sustainable solutions!

Against the background of an increasingly fragile energy supply and increasingly ambitious climate and environmental protection requirements, international industrial structures are faced with the challenging and central task of contributing to significant savings in primary energy through concrete measures that can be measured and assessed. Energy, climate, environmental, resource and transport transition are of major geopolitical and socio-political importance.

Since the energy, climate and environmental balance of future low-energy and low-emission processes and products depends first and foremost and above all on **effective sustainability lightweight construction solutions**, the approximately 300-pager "**xFK in 3D – FROM BICYCLE BOTTLE CAGE VIA LE MANS INTO SPACE**" conveys how the conception, development and realization of the highly innovative ultra-lightweight technology xFK in 3D was implemented – from 2015 until today. Clear, understandable, comprehensible for everyone and deliberately presented simply.

The highly innovative process technology xFK in 3D makes a valuable, well-founded and substantial contribution to the necessary "Times Turnaround" for the environment and nature.

The comprehensive compendium on process technology describes the basic technological concept of the ultra-light, waste-free and additive manufacturing process using simple lightweight construction examples, functional models and exhibits – especially for automotive engineering, for which proof of the functionality of xFK in 3D in the workshop and under operating conditions is essential for all was first provided. Various testimonials from leading lightweight construction experts and sustainability specialists accompany text and images on the **innovation principles of sustainable ultra-lightweight construction**.

"xFK in 3D – FROM BICYCLE BOTTLE CAGE VIA LE MANS INTO SPACE" illustrates the labor-intensive, sometimes arduous and courageous path from xFK to 3D basic research, which was carried out with various colleges, institutes and technical universities, to the first product demonstration, which was carried out by many outstanding and renowned international industrial partners: from Germany to distant Japan.

The industrial research and experimental development from the initial component idea to the first usable xFK in 3D ultra-lightweight component is based on an easy-to-understand, force- and stress-

optimized, multi-axis adjustable and material-optimized design, which has been awarded with GERMAN INNOVATION AWARDS, the ENLIGHTEN AWARDS 2019 and 2022, as well as the GERMAN INNOVATION AWARD 2021 in GOLD – "**Lightweight Design for a lighter world**".

Innovation management for xFK in 3D in basic, technological and applied construction research has been oriented from the outset towards a positive relationship between sustainability quality and sustainability award. Using concrete xFK in 3D applications, the compendium describes how ecology and economy can and "must" be considered equally in the context of prototyping, experimental and series development in order to reduce greenhouse gas emissions – purposeful, transparent and illustrated with numerous images.

Sustainability lightweight construction requires "*frontloading*", i.e., the definition of clearly defined sustainability criteria in the early and "pre-steering" concept phase of the product development process. Climate neutrality and "*Green Future*" require forward-looking thinking and approach – **ecology and economy at a glance**.

With the aim of transferring xFK in 3D into broader industrial and scientific sustainability applications and thus enabling innovation and value creation potential for local industrial structures, ultra-lightweight construction was industrialized by the Luxembourg space company GRADEL. Gradel Robotic Additive Manufacturing ("GRAM") promotes knowledge transfer across countries, industries, technologies and materials, which directly benefits the successful achievement of energy, climate and environmental goals. In this context, the compendium "xFK in 3D – FROM BICYCLE BOTTLE CAGE VIA LE MANS INTO SPACE" also describes how linked knowledge and value creation networks from school and university to adult education are being developed. The cooperative cooperation of educational institutions, industry and science for a sustainable economy is a central success criterion, which is considered in many ways in the compendium – "**stronger together, achieving more**".

Effective and targeted lightweight sustainability construction and its simulation-based digitization, innovative, bionically inspired and parametric design principles in "*frontloading*" were essential innovation criteria that characterized the development, technologization and market launch of xFK in 3D from the very beginning. The process technology xFK in 3D has a **lighthouse character in international sustainability lightweight construction** not "only" due to highly qualified partners, AWARDS and testimonials, but also due to the high constructive and geometrical flexibility of the beautiful "*string art design*".

The design methodology, which stringently follows the lightweight construction principle "*form follows force*", means a "**step change**" in function-oriented sustainability lightweight construction. As "*Game-changer Technology*", the process technology xFK in 3D was used to "rethink", technologize and design lightweight sustainability. The USPs, "Intellectual Properties", innovative strength and innovative strength were analyzed and evaluated within the framework of various market and technology studies, in which far more than 100 companies from ten nations and different industries and market segments participated. The innovation criteria of xFK in 3D at component, system and production level also enable efficiency optimization in production in terms of time and costs, since xFK in 3D is basically a "**one shot process in continuous fiber technology**".

The prerequisites for this, however, are load-specific FE simulations, topologically optimized load-oriented geometries as well as iterative and software-based structural optimizations for component and tool. The end-to-end digital CAE-CAD-CAM process chain was realized with the continuous support of

LASSO Ingenieurgesellschaft, with which AMC has been cooperating since 2015. Software-based, measurable and assessable methods characterize the xFK in 3D technology development as well as the determination of sustainability quality and sustainability award.

GRADEL realized the industrialization of xFK in 3D process technology as part of a research project in close cooperation with the Luxembourg Institute of Science and Technology (LIST) and Thales Alenia Space from 2020 to 2023. The project was funded by the Luxembourg Space Agency (LSA), accompanied by the European Space Agency (ESA) and carried out with the involvement of two other associated partners from space, Airbus Defence & Space and OHB Systems.

As part of the ongoing xFK in 3D transformation from petroleum-based fiber materials to (regenerative) natural and bio-based materials, AMC is cooperating with Trier University of Applied Sciences, von der Linden Composites, the German Institutes for Textile and Fiber Research (DITF), the Montessori School Penzberg, TENTA VISION and BMW M GmbH. LIST is developing a bio-based resin for GRADEL in another research project funded by the Luxembourg Ministry of Economy and the Fonds National de la Recherche (FNR), which will enable circularity by being recyclable and which can be processed reliably with GRAM.

The ongoing technology development measures for CO₂ savings and resource efficiency are supported by the Federal Ministry for Economic Affairs and Climate Protection (BMWK) on the basis of a resolution of the German Bundestag. The company portraits of the participating research and development partners are given appreciative consideration in the compendium as well as the systematic, holistic as well as measurable and assessable methods for sustainability assessment about sustainability quality and sustainability award, which are not only important for the "Environment Social Governance" of the future.

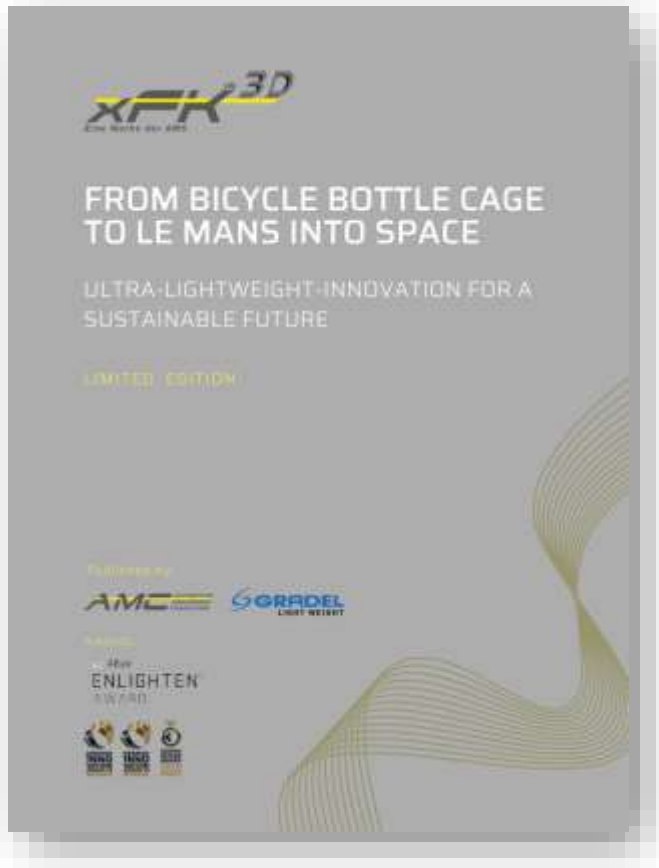
Thus, reading the compendium "xFK in 3D – FROM BICYCLE BOTTLE CAGE VIA LE MANS INTO SPACE" not "only" provides the recipe for the structurally optimized, hybrid and systemic ultra-lightweight construction xFK in 3D, but also various strategic, procedural and structural hints, such as "*Corporate Social Responsibility*" (CSR) through practical and social Actions oriented towards the needs of society can be met. The "*Managerial Effectiveness*" and Innovation Therapy are based on world-leading management thinkers from different faculties and disciplines, who made the coordination and organizational leadership of the international project consortium possible in the first place.

This structural prerequisite for the development of sustainable process technologies such as xFK in 3D to save resources already during the design phase represents another major focus of the compendium "xFK in 3D – FROM BICYCLE BOTTLE CAGE VIA LE MANS INTO SPACE", as part of the "**SUSTAINABILITY SUMMIT 2023**" of the AMC and the "**INAUGURATION**" of GRADEL (www.gradellw.com) as a "**Limited Edition**" on

Thursday, 04 May 2023

will be presented.

For more information:



AMC GmbH / GRADEL Sàrl, May 2023 (first edition)- LIMITED EDITION
310 pages, in color, in both languages (English and German)

Further relevant information can be found at:

www.automotive-management-consulting.com
www.gradellw.com

If you are interested, please contact Mrs. Constanze von Nell-Breuning, Tel. +49/8856/8 05 48-50

Availability of the compendium, by the Publisher: AMC GmbH, Im Thal 2, Glaspalast, D-82377 Penzberg

Authors: Rainer Kurek / Claude Maack Copyright: All rights reserved. Disclaimer: The xFK in 3D Compendium represents the personal opinion of the authors. Dates and facts are conscientiously researched or come from sources that are generally considered acceptable. An obligation cannot be derived from this. Editors and authors disclaim any liability.

Price: € 295.- plus VAT (D) and postage. Duplication and reproduction in whole or partially, only with the express permission of the publisher.

OUR AWARDS



**GERMAN
INNO
VATION
AWARD '19
WINNER**



**GERMAN
DESIGN
AWARD
GOLD
2021**

