Lightweight Forging Initiative – Phase III (1 December, 2016)

Multilateral International Industrial Lightweight Study focusing on Lightweighting with Forged Steel Components in a Hybrid Car and a Truck Transmission

Speakers / Industrial Members of the Steering Committee
Dr.-Ing. H.-W. Raedt, VP Advanced Engineering, Hirschvogel Automotive Group
N.N. Representative of Steel Manufacturers

Association Member of the Steering Committee
Mr. T. Hain, CEO, IMU Industrieverband Massivumformung (German Forging Association)
(successor of Dr. Tutmann since summer 2016)

Dr. P. Dahlmann, Executive Member of the Managing Board, Steel Institute VDEh

1. Background
2. Proposal
3. Benefits for companies taking part in Lightweight Forging Initiative Phase III
4. Supporting associations
5. Milestones during acquisition
6. Proposed study timeline
7. Cost
8. Contribution of the member companies
9. Q&A for special discussion topics

1. Background, Motivation and Project topics
The Lightweight Forging Initiative was initiated in 2013 and has since worked on two industrial studies (phase I: Passenger car, phase II: Light duty vehicle) as well as on the publicly funded research network “Lightweight Forging” which will run until 2018. In both industrial phases, a vehicle was purchased and completely dismantled. In hands-on-workshops all the components in the vehicles were analyzed and suggestions for reducing the weight were generated, either by the application of higher performance steel, by changing the shape of the part or by conceptional ideas (fulfilling the function in a more weight efficient way). In the passenger car, a possible weight saving of 42 kg was demonstrated. The light commercial vehicle showed a weight potential of 99 kg. See www.LIGHTWEIGHTForging.com for results. The participating steel making and forging companies were able to demonstrate to their customers that steel- and forging technology can successfully contribute to the automotive megatrend of lightweighting. Effects like resource efficiency and decrease of CO2-emissions are additional benefits.

After the technical and marketing success of the first and second phase of the Lightweight Forging Initiative a next step forward needs to be taken. The evolution of the lightweight forging idea should manifest itself in two-ways: On a technical level regarding the type of vehicle under analysis, as well as on a collaborational level.

Regarding collaboration: The first two phases of the Lightweight Forging Initiative have united 24 respective 28 German speaking companies from Germany, Switzerland and Austria. Thus the technical focus was on a medium sized passenger car in phase I and on a typical European light commercial vehicle in phase II (both German manufacturers).
In order to increase customer awareness with a greater impact of the message that we need to convey, an internationalization of the Lightweight Forging Initiative is necessary. Companies from the high-tech (and high-cost) countries worldwide should unite in the goal to demonstrate new steel and forging technologies to their customers. The multitude of ideas needs to be demonstrated. The effectiveness of the weight saving potential of all these ideas can be shown by summing them up. So it continues to be logical to use a demonstrator car for transporting the study results. The interests of Japanese, North American and European industries is represented best in a Toyota Mini-SUV RAV4 Split-Axle AWD Hybrid (combustion engine with Toyota “SynergyDrive” electric CVT on the front axle + electrical motor on the rear axle). The RAV4 is sold worldwide. It represents modern hybrid powertrain technology and thus provides also the necessary technological step forward: In phase I and II the vehicles had a combustion engine, phase III would evolve into the analysis of an electrified powertrain. A hybrid car represents a relevant powertrain technology. Hybrid cars will reach a worldwide market share of more than 25% in 2020 and will dominate the market until full electrification kicks in. The cost of a hybrid car (especially a used one) will be in the range of the passenger car of phase I or the light duty vehicle of phase II (i.e. it is affordable).

A second working strand is proposed analyzing a truck transmission. Phase I and phase II have analyzed a DCT and manual transmission. The impact of steel performance on transmission design has been analyzed (see results presentation of phase II). We expect, that we will find similar relationships in a truck transmission which will give a significant (probably double digit) total weight benefit. The importance of transmission steel performance on lightweighting efforts can thus be demonstrated more intensively. Also, we feel that after the analysis of a car in phase I and of a light duty vehicle in phase II we should explore the heavy duty segment in phase III. However, as the analysis of a full heavy-duty vehicle cannot be realized due to excessive cost, analyzing a transmission seems like a good compromise in terms of scope, effort and expected results. A third working strand will focus on the market introduction of new transmission steels.

2. Proposal
- Collect a group of steel making and forging companies from USA, Japan, Europe (approximately 35 companies are necessary to finance the study efforts)
- Run three working strands in parallel, detailed below:
  1. Hands-On Full Vehicle Study to clearly demonstrate lightweighting benefits of forged components
    - Purchase a Toyota RAV4 Split-Axle AWD Hybrid
    - Dismantle and document the car at fka of Aachen Technical University (has worked in Lightweight Forging Initiative Phase I and Phase II: Proven highly competent academic partner with excellent reputation in car technology and lightweighting, [www.fka.de/index-e.php](http://www.fka.de/index-e.php))
2. **Hands-On Truck Transmission Study (+ possible further truck components, depending on the budget)**
   - Purchase a Truck Transmission
   - Dismantle and document the transmission at fka
   o Both strands will unite in **one hands-on lightweight workshop** in Aachen, Germany, with a duration of two/three days in a collaborative, open, discussion-rich atmosphere; focusing on the components of the car and of the Truck Transmission, generating lightweight ideas. The transmission in the car and the truck transmission will be analyzed similar to the transmissions in phase I and II by IPEK of KIT (Karlsruhe Institute of Technology)

3. **Material Market Penetration study by FZG of Technical University of Munich or IPEK KIT, in order to optimize the introduction of newly developed transmission steels into customers’ daily engineering work as well as to promote current transmission steels made by high-tech steel manufacturers**
   - What are current transmission steel design parameter values (max. permissible tooth flank pressures, tooth root stresses, pulsating torsional stress, pulsating bending stress) as stated in current norms and as stated in transmission design program databases (fva workbench, KissSoft, FEMFat, MSC-Products, VDI standards, SAE standards, JIS standards, what other programs are used in the industry ?)
   - What values do we actually have today for modern transmission steels (values from steel manufacturers, values as determined in Lightweight Forging Initiative Phase II, values from recent fva-projects, from our Lightweight Forging Research Project, …)
   - Addressing databases of transmission design program makers in order to introduce new steel grades into these databases
   - Addressing the ISO, EN, JIS, SAE, DIN, …, standard commissions in order to reflect the state of the art of modern transmission steels
   - Address authors of teaching book, engineering books, material data tables etc. with current material loadability data

- For international guest: Offer to visit German/European steel making and forging companies
- To reduce travel efforts: Virtual meetings (recorded Web/Video/Telephone conferences) for
  o kick-off (introduction of fka, presentation of partners, agreement of project plan and next steps)
  o final meeting (overview and presentation of results, upcoming marketing activities, possible next steps)
3. Benefits for companies taking part in Lightweight Forging Initiative Phase III

- Become member of an international multilateral initiative focusing on the automotive megatrend of lightweighting
- Place your company name and logo on website www.LIGHTWEIGHTForging.com / www.massiverLEICHTBAU.de, as well as on marketing material from the Lightweight Forging Initiative (results brochure, technical papers, …)
- Use Lightweight Forging Initiative logo for your national and international marketing activities
- Increase your visibility to international customers
  - for steel makers: To the worldwide high-tech forging industry and automotive industry
  - for forging companies: To OEMs and system supplier customers worldwide
- Use communication and marketing channels of the Lightweight Forging Initiative to exhibit your companies’ contributions to lightweighting to customers internationally
- Gain unprecedented insight into automotive technology due to tear-down and hands-on workshop of the study
- Possibility to create and gain insights along the whole process chain of forged components
- Networking with forging and steel making industries worldwide on a pre-competitive, technically oriented basis and contribute to future success of long rolled steel and forgings by making this technology more attractive to customers

4. Potential Supporting associations

- IMU (German Forging Association):
  - Mr. Hain (Director)
  - Mrs. Bachmann Osenberg (Marketing and Communications)
- VDEh (German Iron and Steel Institute)
  - Dr. Dahlmann (Executive Member of Managing Board)
  - Dr. Wieland (Chairman of the Research Committee of VDEh)
- DS (German Screw Producers Association): Dr. Stefan Beyer
- VDFI (German Spring Association): Wolfgang Hermann
- GCFG (German Cold Forging Group): Tobias Hain
- AISI (American Iron and Steel Institute): David Anderson
- AIST (Association for Iron & Steel Technology): Ronald E. Ashburn (to be contacted)
- FIA (Forging Industry Association): Roy Harding
- JFA (Japanese Forging Association): Futoshi Suzuki
- Iron & Steel Institute of Japan: Shinya Wakimoto (to be contacted)
- JSTP (Japanese Society for the Technology of Plasticity) (to be contacted)
- Role of the associations
  - Reach out to their members for possible cooperation in the Lightweight Forging Initiative
  - Support communication between members and fka during study
  - Support marketing activities which are coordinated by IMU
5. Milestones during acquisition

- IMU, VDEh, Raedt: Sending out proposal to other associations and selected interested companies in November 2016
- Potential members: If helpful, please have bilateral or multilateral discussions with your association, or with Dr. Raedt, Mr. Hain, Mrs. Widdermann (IMU), Dr. Dahlmann, Dr. Wieland, Dr. Keul (VDEh)
- Potential members: Please send statement of interest (informal, verbal) by February 1, 2017
- IMU / VDEh: Send concrete membership contracts to interested partners after February 1, 2017
- Depending on feedback and signed membership contracts: Decision about start of phase III by February 28, 2017

6. Proposed study timeline

- Start of phase III on March 1, 2017 (contract with fka, purchasing of RAV4 vehicle and truck transmission, start of dismantling process by fka)
- Meeting in September 2017 in Aachen, Germany
  - Background on lightweighting efforts in the automotive industry
  - Background on emission regulations worldwide and in comparison between the world regions
  - Introduction into electrified powertrain
  - Introduction into lightweight study on RAV4, results from RAV4 dismantling and benchmarking
  - Hands-on-Workshops for analysis of parts and generation of lightweight ideas
- This means: For companies taking part the real work starts only in September 2017
- Detailing of lightweight ideas by consortium members September-December 2017
- Collection and analysis of lightweight potential by fka: January 2018
- End of study: April 2018
- Preparation of study results presentation + communication phase: Mai 2018-Spring 2019
- International LightweightForging Customer day: Spring 2018 (probably as regional events in the US, Japan, Europe; to be discussed)
- Euroforge conference & fair November 2018 in Berlin

7. Cost for participating member companies

- 10,000 € for companies who took part in phase I and II
- 12,500 € for companies who took part in phase I or II
- 15,000 € for companies who join the Lightweight Forging Initiative for the first time in phase III
- Travel cost for taking part in hands-on-workshop in Aachen
- Work efforts for working on lightweight design ideas to be included in results brochure / papers / website / presentations. Necessary work efforts range between one day (present one lightweight idea in PowerPoint) and to several weeks (make detailed CAD and FEM analysis of several ideas). Contribution effort is fully up to members’ decision
8. Contributions of the member companies
   • Attendance of technical personnel (1-2 people per company) in virtual and hands-on-meetings
   • Contribution of lightweight potential ideas (for content and format of lightweight proposal ideas: See results presentation of phase I and II)

9. Q&A for special discussion topics
   • Why Toyota RAV4 Split-Axle-AWD-Hybrid
     o The RAV4 sells worldwide
     o It represents most modern powertrain technology with hybrid split-axle AWD
     o It has sufficient customer acceptance for marketing lightweight ideas of forging industry
   • Why International Project ?
     o ULSAB (sheet metal lightweighting for body-in-white) is one of the projects after which LightweightForging was designed. ULSAB was international from the start and created a huge market interest and lead to severe market penetration of high-performance sheet steel. LightweightForging will benefit from the internationalization through much higher press and customer interest when companies from Japan, US and Europe unite to showcase their high technology with relevance to lightweighting.
     o After two project phases we need new content for creating interest in our work. Internationalization of LightweightForging adds an interesting newness to our work
     o International cooperation will enable us to learn internationally. The issue of know-how loss is minimized by assembling a group of high-tech companies on comparable technological level. Finally, each partner can decide in the course of the work how much input into the project will represent a good balance between marketing opportunity and knowledge sharing
   • Why now ? Would we not see clearer in 2-3 years if the trend is moving towards hybrid or electric cars ?
     o We have worked on the first phase in 2013 and published in 2014. We continued with the second phase in 2015 and published mainly in 2016. In order not to lose media and customer awareness and interest, we should work on the third phase in 2017 and publish 2018
     o Competing technologies are catching up. Sintered products are showcased, claiming that transmission gears can be produced with powder metal technology (see http://www.hoganas.com/pm_gearbox_initiative). It is necessary to demonstrate the performance of forged products especially in the field of carburizing steels without hesitation
In 2-3 years we will see the market trend until 2024 years just as clearly, as we see it now for 2021. We have forecast figures which show that hybrid technology will be the upcoming propulsion technology. Thus a hybrid powertrain will not only give a fresh new topic for LightweightForging, but represents a relevant technology, too.

- Do we have enough resources in order to continue the work now?
  - The start of phase III would be in March 2017 so fka can purchase the car and the truck transmission and start disassembly. However, the participating companies will need to contribute effectively only from September 2017, so nearly a year from now.
  - In the meantime we should try to create more market penetration efforts with the results from phase I and II and the research network. Proposals are welcome!