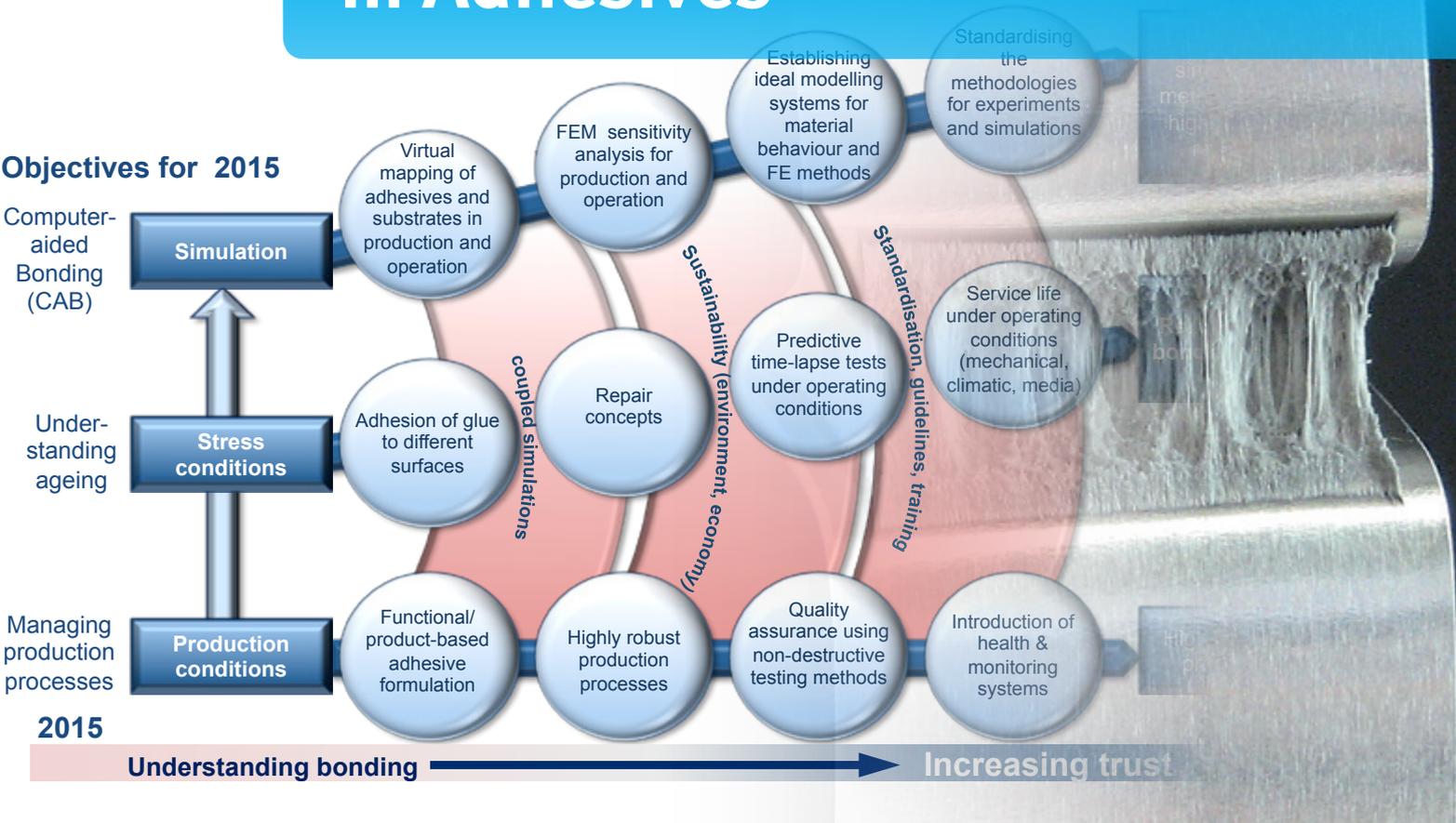


ADHESIVE BONDING ROAD MAP

Increasing Trust in Adhesives



IMPRINT

Authors

This paper is based on two expert workshops „Roadmap Klebtechnik“, which took place on January and February 2015, with the participation of a large number of contributors.

Editor

Joint Committee on Adhesive Bonding (GAK), supported by the research associations

Dechema (the Society for Chemical Engineering and Biotechnology)

The German Welding Society (DVS) Research Association on Welding and Allied Processes

FOSTA (the Research Association for Steel Applications)

iVTH (the International Association for Technical Issues related to Wood)

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Research within the field of adhesives is a key factor in the development of innovative products in many industries. However, there is still a need for extensive research in order to allow the use of adhesives in production processes to be managed more effectively and to enable the service life of bonded joints to be predicted more reliably. Which are the specific fields where research is urgently required? In order to answer this question, the Joint Committee on Adhesive Bonding (GAK), which consists of members from a number of industries, has updated the adhesive bonding road map that it first created in 2007.

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When the forecasting period of the first adhesive bonding road map, which was drawn up by the Joint Committee on Adhesive Bonding (GAK) in 2007, came to an end at the beginning of this year, a new road map was created.

The previous version of the road map had successfully identified future research areas in the field of adhesive bonding and had predicted potential developments. This success was reflected in the wideranging subjects of the many innovative research projects based on the old road-map.

GAK was faced with the challenge of producing a new version of the road map which would be just as successful as the first. In order to achieve this objective, a general strategy and innovation workshop was held to identify and define current topics, questions and problems in the field of adhesive bonding. The goal was to describe in general terms the path that adhesive bonding would take over the next few years. In another more specialised workshop, the theme of simulation in adhesive bonding, which was considered to be particularly important and forward-looking, was analysed in more detail in order to forecast future developments.

The two-day general workshop took place in Wermelskirchen in Germany in January 2015, while the specialist workshop, which also lasted for two days, was held in Düsseldorf in February 2015. The workshops were organised by Dechema and Fosta, research associations which are members of GAK.

Strategy and innovation workshop

The 33 participants in the first workshop in Wermelskirchen were representatives of the automotive, transport (bus, rail and rail freight), adhesives manufacturing, application system, construction and consultancy industries, together with representatives of the research associations that make up GAK (see end of text).

In an initial brainwriting session, the participants identified existing urgent requirements, questions and problems relating to the practical aspects of adhesive bonding. Small workgroups were formed for each industry which produced successful and comprehensive overviews of current needs, demands and wishes in the field of adhesives.

During a “look over the fence” the participants investigated the question of whether adhesive bonding could replace or become involved in other areas in the field of joining. In addition, they attempted to establish the extent to which adhesive bonding might lose its share of certain markets to other rapidly growing joining technologies.

Finally, the scenario technique was used to represent the relevant requirements, trends and social developments. The workshop participants drew up deliberately one-sided future scenarios on the subject of the following four concepts:

- » Environment/hedonism/green issues
- » Legislation/regulations
- » Technology
- » Raw materials

These scenarios were then developed further, represented in visual form and applied to the subject of adhesives

and sealants. At the end, the results of this process were condensed into a few main areas of action, inserted into a timeline and, after the workshop, summarised in a report by the moderator. The result was a provisional graphical representation of the projected developments in adhesive bonding.

Workshop on simulation in adhesive bonding

Without being aware of the results of the first workshop, which had been summarised by the moderator, a total of 21 representatives of the automotive, aviation, adhesives and CAE software industries, together with members of research associations, met in Düsseldorf in February 2015 to discuss the subjects of simulation and adhesive bonding (Figure 1).

First of all, the research association representatives gave the industry participants an overview in their presentations of the relevant research findings of the last ten years. Next the representatives of industry identified the future research required in the field of simulation in adhesive bonding. The subject areas were broken down into different fields under the heading of computer-aided bonding or CAB (Table 3).

The new adhesive bonding road map

On the basis of the results of the two workshops, the relevant subject areas were developed and summarised. Three key issues were identified:

- » Understanding ageing
- » Managing production processes
- » Computer-aided bonding (CAB)

These three issues were divided up into smaller areas in order to create practical guidelines for industrial organisations and research institutions. Tables 1 to 3 contain detailed lists of the future subjects and areas of action that have been jointly identified. From the perspective of adhesive bonding, the three issues correspond with three desirable objectives:

- » Long-term stability (high-quality products)
- » Reliable processes (reliability of bonded joints)
- » Designing for adhesive bonding (efficient simulation methods with high-quality results)

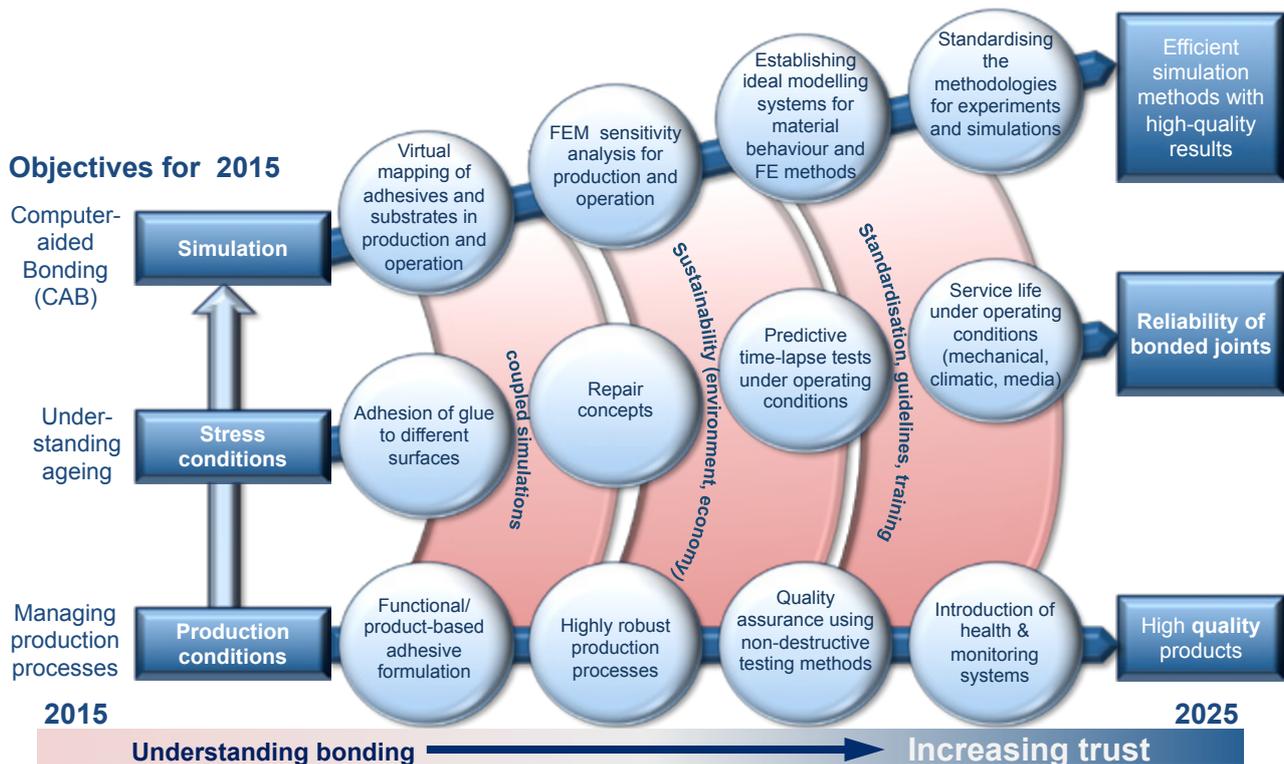


Figure 1: The new road map for adhesive bonding

Table 1: Subjects and areas of action relating to “Understanding ageing”

(Source: GAK)

Predictable time-lapse tests	Adhesion of glue to surfaces	Repair concepts	Predicting service life in operation
Correlation with real ageing	Defining surfaces	Repairing bonded joints	Understanding adhesion/cohesion
Informative measuring methods	Primers, coatings	Temporary joints	Predicting faults
Ageing tests coordinated with loads	Interpreting fracture patterns correctly	Bonding as a construction aid	Fatigue resulting from temperature/climate
Understanding ageing behaviour	Bonding on dirty surfaces	Repair concepts for long-term stability	Representing real load cases
Designed for a life of 30 years	Test methods		Solutions for large ΔT and $\Delta\alpha$
	New materials and surfaces		

Table 2: Subjects and areas of action relating to “Managing production processes”

(Source: GAK)

Adhesive formulation	Robust production processes	Non-destructive testing	Monitoring bonded joints
Universal adhesives	Training	100% monitoring in production	Incorporating monitoring into the planning process
Self-healing adhesives	Fixing concepts	Networked systems, sensors	Include bond sensors in the production process
Reducing tension with $\Delta\alpha$ effects	Tolerances	Quality assurance	Characterising surfaces
High temperature resistance	Influence of materials	Practical non-destructive testing	Understanding adhesion/cohesion
Adhesive selection systems	Automated surface pre-treatment		Functional adhesives
Needs-based adhesive formulation	Basic bonding		Continuous monitoring
	Hybrid joints		
Secure sources of raw materials	Thermal expansion		
	Evaluating problem factors		

Table 3: Subjects and areas of action relating to “Computer-aided bonding”

(Source: GAK)

Adhesives and substrates	Basic principles, sensitivity analyses	Modelling/FE methods	Standardisation of methods
Considering additional adhesives and substrates	Thermomechanical influences	Modelling material behaviour	Testing and documentation guidelines
New testing methods	Adhesion, cohesion, interface	Geometry of the joint	Standardising the recording of material and structural properties
Considering real load cases	Co-bonding adhesives and CFRP	Linked simulation of production and operation	Simplified recording of material cards
Failure behaviour	Micromechanics	Network dependencies	Linking continuum and fracture mechanics
Repair adhesives	Damage	New element formulations	Standardisation and guidelines
Considering surfaces	Long-term vibration behaviour	Detailed model vs. substitute model	Standardisation and guidelines

The overall, long-term objective of all the research and development activities was defined as “increasing trust in adhesive bonding”. During the last phase, the participants selected a few important subjects and areas of action from the many that had been identified as being relevant in the future. These were then cast in graphical form (Figure 1).

Conclusion

In overall terms, the workshops have shown that the subjects highlighted in the old road map remain relevant, but with a shift of focus. Many of them are included in the new road map in a slightly modified form. Some old topics have become general cross-disciplinary activities which are now important or even crucial to the future of adhesive bonding. In addition, new areas of action have been identified as being of future importance, such as training in the use of adhesives, repair concepts and non-destructive testing.

The fact that existing subjects are still regarded as important is due to the complexity of the materials, processes and applications. The resulting tasks cannot be completed easily or quickly and will therefore require ongoing commitment. We now have to wait to find out to what extent the forecasts correspond with the actual future developments. Whatever happens, the Joint Committee on Adhesive Bonding (GAK) has succeeded in producing a new road map on adhesive bonding that will function as a guideline for future research projects for the industrial, research and government organisations involved in the network. This will enable us to achieve the objective of increasing trust in this innovative joining method in the long term and laying the foundations for new value-added applications.

Joint Committee on Adhesive Bonding or GAK

The Joint Committee on Adhesive Bonding (GAK) was founded in 2005 on the initiative of:

- » Dechema (the Society for Chemical Engineering and Biotechnology)
- » The German Welding Society (DVS) Research Association on Welding and Allied Processes
- » Fosta (the Research Association for Steel Application)
- » IVTH (the International Association for Technical Issues related to Wood).

All four research associations are members of the German Federation of Industrial Research Associations (AiF). Their objective is to evaluate ideas for research projects in the field of adhesives across different industries and disciplines.

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