

## ПАНЕЛЬНАЯ ДИСКУССИЯ

# МУЛЬТИДИСЦИПЛИНАРНАЯ ПЛАТФОРМА УСКОРЕННОЙ СЕРТИФИКАЦИИ И КВАЛИФИКАЦИИ КОМПОЗИЦИОННЫХ МАТЕРИАЛОВ. ЭФФЕКТИВНОСТЬ ЧЕРЕЗ БЕЗОПАСНОСТЬ

**ДУБИНСКИЙ СТАНИСЛАВ**

НПП «АпАТЭК», Сколтех



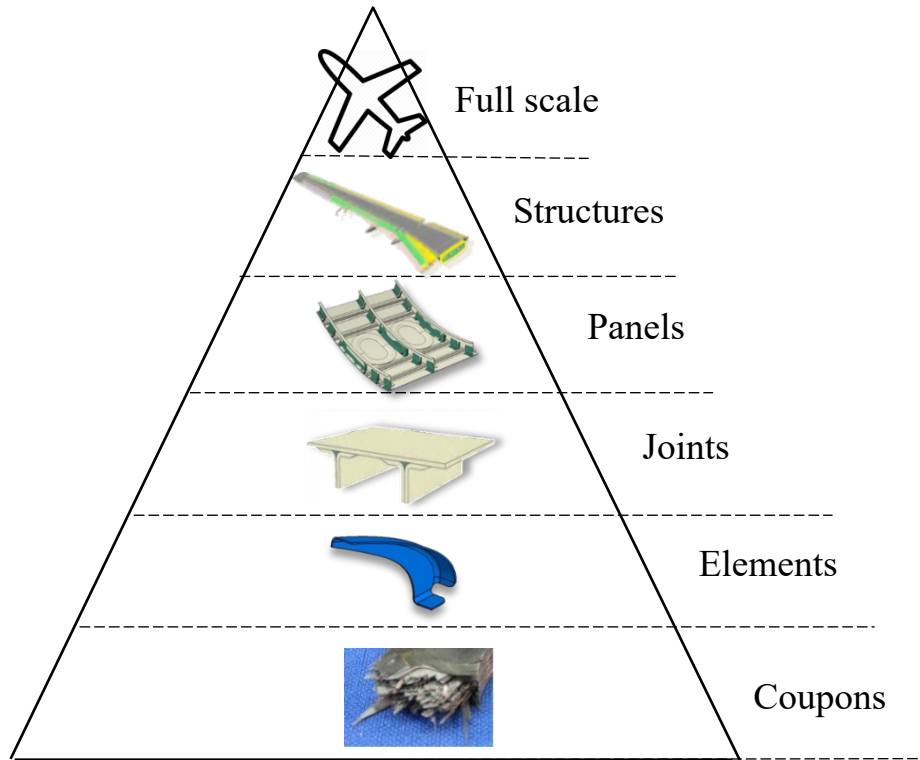
Мультидисциплинарная платформа ускоренной сертификации и  
квалификации композиционных материалов. Эффективность через  
безопасность

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Сертификация конструкций, изготовленных с применением  
материалов нового поколения и прорывных технологий: сегодня и  
завтра

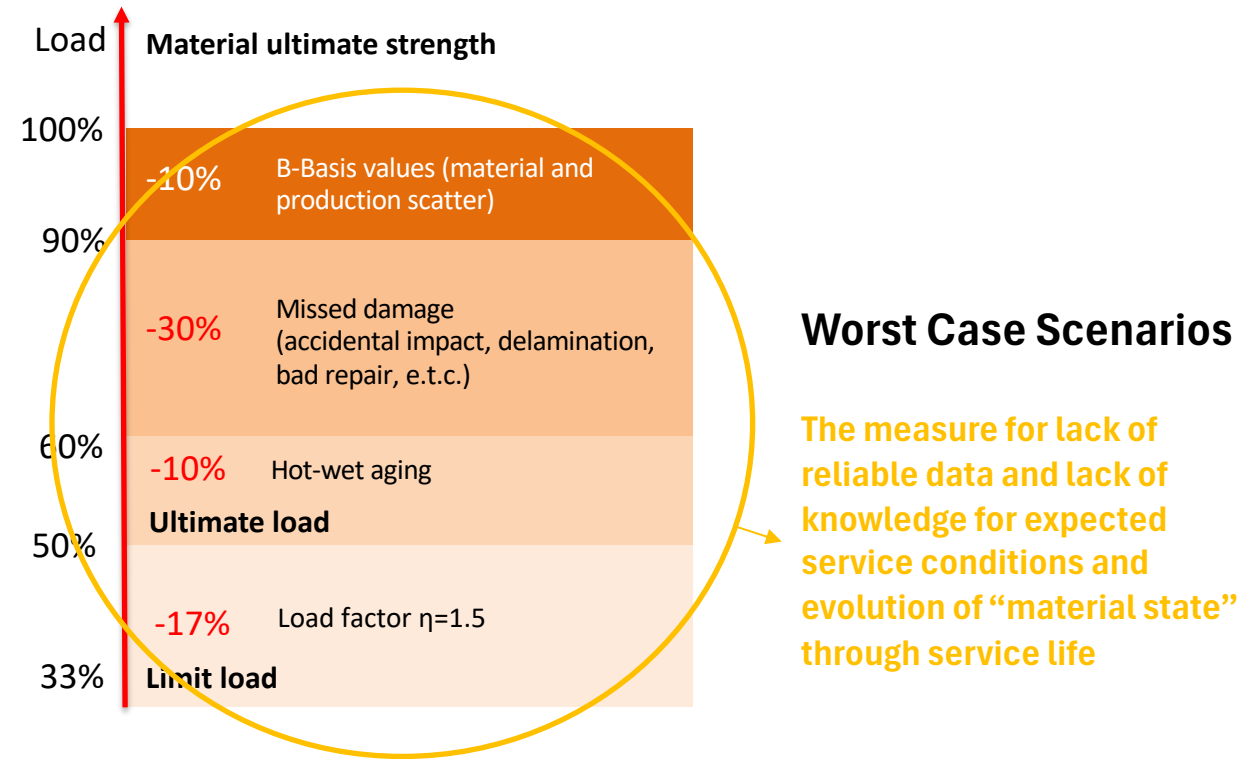
The Certification of New Generation Materials and Disruptive  
Technologies: Today and Tomorrow

# TODAY. State-Of-The-Art Design, Testing And Certification Methodology



The accomplishment of comprehensive R&D program focused on development of CFRP wing and empennage, produced by brand new manufacturing process resulted in new state-of-the-art certification methodology, which incorporates:

- ❖ World best practices of safety provision and applied regulations
- ❖ Local long-history experience in development, manufacturing and certification of aircraft structures
- ❖ Huge amount of testing and analysis performed in recent decade for high performance CFRP



All scenarios leading to strength reduction occur in worst possible consequence:

- all material and design structural properties have zero safety margins;
- the aircraft comes into service with all possible non-detectable defects of the maximum allowable size;
- the maximum allowable temperature and equilibrium moisture saturation are achieved during the first flight;
- impact damage of the maximum non-detectable size occurs in all critical areas of the aircraft during the first flight;
- with all of the above scenarios having taken place, the aircraft experiences a limit-loading event during the first flight.

# TOMORROW. Introduction of AI for Structural Certification, Material Qualification and Health Monitoring Through The Service Life

## Material Qualification

- ❖ Detection of correlations and relationships between properties of different nature from Big Data libraries
- ❖ Prediction of structural performance and behavior of novel structures on the basis of data from service experience
- ❖ Detection of various deviations in behavior of structure and load applies system during testing
- ❖ Prediction and simulation of external factors impact (environment, aging, loads exceedance, e.t.c.)
- ❖ Cross analysis of tests of various types for determination of material digital passport
- ❖ Real time support and update of Structural Materials Handbook

## Testing

- ❖ **Digital Twins.** The digital copy of the couple “test object – loading system” and data registered during test program may be used without additional testing for certification of modified structure or for other service conditions.
- ❖ **Test program optimization.** Basing on the analysis of testing history the neural network can optimize test program and loading sequence
- ❖ **Recognizing the laws of structural response.** The neural algorithm of structural response based on registered laws and correlations between load and stress can help to
- ❖ **The damage detection.** The stress-strain patterns determined by strain gauges, DIC and FEM methods can indicate the potential damage area and predict the fracture
- ❖ **Predictive maintenance.** The neural algorithm may predict the potential failure of loading system and test equipment for predictive maintenance.

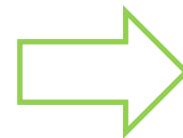
## Manufacturing

- ❖ Data on “Material state as manufactured” by nondestructive technologies

## Service

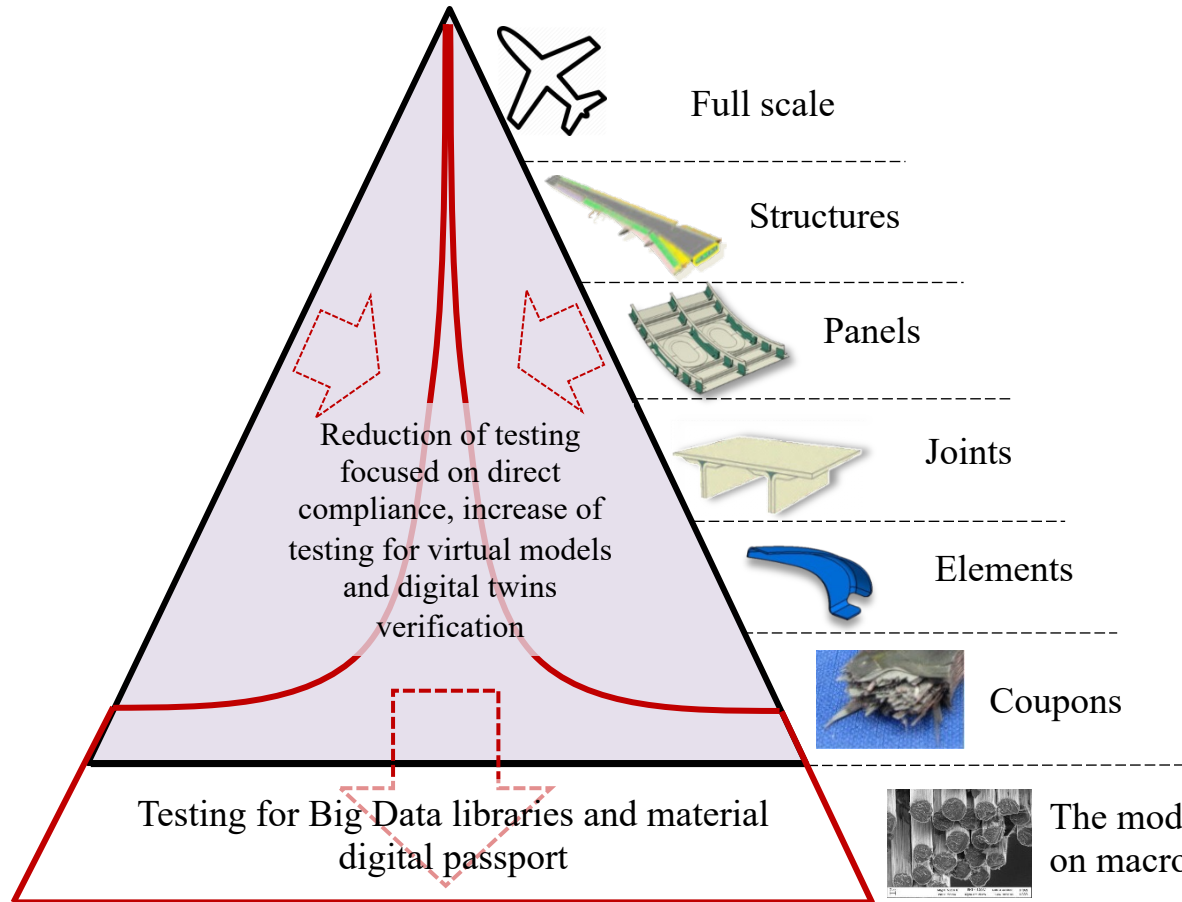
- ❖ Data on service conditions and behavior of the structure in hard-to-reach areas of Far East and Siberia by monitoring from UAVs
- ❖ Data on mechanical response on external loads by traditional and new developed auges and sensors
- ❖ Data on micro-scale “material state” by MEMs and nanosensors

- ❖ **Big Data Libraries**
- ❖ **Non-stop machine learning of neural network**
- ❖ **Constant improvement of algorithms**



**Material State in  
composite structure**

# TOMORROW. Certification Based on Big Data Analysis and AI Capacities



- ❖ Certification based on realistic data, instead of worst case scenarios
- ❖ Collecting data on all stages of service life (manufacturing, testing, service)
- ❖ Machine learning algorithms for “material state” prediction
- ❖ Constant improvement of “material state” model
- ❖ Tests for to capture microscale effect on macroscale properties