

The Inaugural "AM Aviation Cup" (AMAC)
International Competition for Innovative Application of
Additive Manufacturing in Large Civil Aircraft

Additive manufacturing (AM) has been listed as one of the twelve disruptive technologies that will determine the future of our economy. It is a symbol and a key technology of the digital revolution in manufacturing. Its developments in the aviation manufacturing sector trend towards increasing design complexity, part-and-function integration and high performance, and brings both social and economic benefits to the aviation sector and the advanced manufacturing industry. AM is quickly becoming the fastest growing and most active technology in the global advanced manufacturing sector, garnering attention and research interests.

Collaborative Innovation Alliance for Additive Manufacturing of Large Aircraft is launching the first “AM Aviation Cup” (AMAC), an international AM competition with the theme of innovative applications in civil aviation. The competition is open to outstanding AM research organizations, enterprises, universities and individuals around the world. It serves to uncover talented teams and individuals with innovative capabilities, to provide domestic and foreign participants with a common platform for competition, exchange of ideas, academic discussions and conceptions for the future, to gather the power of innovative applications of AM in aviation, to spur the exploration of state-of-the-art technologies

in AM, and to promote the application and advancement of AM in the aviation sector.

1. “AM Aviation Cup” Organization Committee

- Host:** 大飞机增材制造协同创新联盟
Collaborative Innovation Alliance for Additive Manufacturing of Large Aircraft
- Co-hosts:** 中国商飞北京民用飞机技术研究中心
COMAC Beijing Aircraft Technology Research Institute
- Organizers:** 中国商飞增材制造技术应用研究中心
COMAC Additive Manufacturing Application Research Center
中国航天科工集团增材制造技术创新中心
The AM Technology Innovation Center , CASIC
中国航发商发增材制造应用研究中心
AECC CAE Center for Additive Manufacturing Research
西安增材制造国家研究院有限公司
National Institute Corporation of Additive Manufacturing, Xi'an
恩维精诚（苏州）科技有限公司
N Dimensions (Suzhou) Technology Co., Ltd.

Guiding institutions, co-organizers, partners and the official media for the event will be announced in the notification for the finals.

2. Competition Process

The competition consists of the preliminary round and the final round, and is divided into three competition units.

1. Press release: 30th June

2. Registration: 30th June - 20th July
3. Verification and confirmation: 30th June - 20th July
4. Delivery of work: 20th August - 31st August
5. Preliminary appraisal and selection: Early September
6. Notification of shortlisted participants: Early October
7. Finals: Late October

3. Registration

1. Participants shall fill in the registration form “The Inaugural "AM Aviation Cup" International Competition Registration Form” and send it to AM@comac.cc before 20th July 2022.

2. Email title and email attachment to be named according to the following format:

"Registration form for AM Aviation Cup, Category 1/2/3 (pick one) - XXX (name of your team)".

3. The competition organizing committee will verify and confirm the information with the teams before 20th July 2022. Follow the official Wechat account of the competition for up-to-date information.

4. Delivery of Work

1. Participants shall submit a description of the work by filling in “The Inaugural "AM Aviation Cup" International Competition Delivery of Work Form” and send it to AM@comac.cc from 20th August 2022 to 31st August 2022. Participants are encouraged to provide additional related documents

as attachments to the email.

2. The email title is to be named according to the following format:

"Category 1/2/3 (pick one) Work Delivery - XXX (name of your team)"

3. The email attachment is to be named according to the following format:

"Category 1/2/3 (pick one) - Description of Work / Annex 1/ Annex 2... - XXX (name of your team)".

4. For information on the event and delivery of works:

Official Wechat account:

大飞机增材制造协同创新联盟

Collaborative Innovation Alliance for Additive Manufacturing of Large Aircraft

Title: Event Enquiry / Delivery of Physical Works - Category 1/2/3 (pick one)

Email:

AM@comac.cc

Titles: Event Enquiry / Delivery of Physical Works - Category 1/2/3 (pick one)

Telephone:

Category 1 - Kang, Ziming +86 189 1195 0953

Category 2 - Wang, Weidong +86 189 1195 0931

Category 3 - Ge, Zengru +86 189 1039 5887

5. Participants are to pay close attention to the information on the preliminaries and the finals, which will be released separately.

5. Awards

At the preliminary stages, seven entries will be selected in each category for the finals, which is a live presentation. There will be a champion, a runner-up, a second runner-up and several prizes of excellence for each category. Winners will be awarded with trophies, prize money and event memorabilia.

6. Other Details

1. Participation in this competition is voluntary. Participants are to abide by the rules and regulations of the competition.

2. The works submitted by the participating teams are completed independently. The works shall not contain content from other individual(s) or organization(s), published or unpublished, other than as a reference. The participating teams shall abide by the above statements and the organizer reserves the right to reject any entry/work in the event of an intellectual property dispute.

3. The organizing committee promises that the works and personal information provided by the participating teams will not be disclosed to any third party. At the same time, the participants are obligated to keep the competition information confidential and will not use the entries of the

competition for other competitions, or publish them in other media for any purpose before the end of the competition.

4. The entry documents and articles shall not contain any content that has a negative impact. (The organizing committee reserves the right to reject any entry.)

5. The competition is free of charge.

Category 1: Frontier of Aviation

1. Theme

Exploration on state-of-the-art aviation AM technologies

2. Scope

This category is open to domestic and international enterprises, research institutes, universities, institutional groups and individuals. The work shall focus on futuristic, revolutionary and disruptive technologies and research in the AM of aircrafts. This includes, but is not limited to, original creations on aircrafts of the future, systems, components, novel designs, new methods, and futuristic applications of AM in the aviation sector.

3. Instructions

- a. The work shall include reports, models, tools, software, physical objects and other forms. For innovative aircraft designs, a digital model (CAD), an analysis report and a description of work must be provided. These can be supplemented with other supporting materials such as tools and software. For other forms of entry, an analysis report and a description of work must be provided, as well as supporting materials such as tools, software and hardware.
- b. The work must be original, futuristic, revolutionary and disruptive. Participants can unleash their imagination and creativity by combining the advantages of AM and future development trends to envision

aviation products of the future or other aircrafts (and its major components) with innovative optimized designs, novel design methods or novel manufacturing methods. The characteristics and advantages of the works/methods shall be fully explained in the description to reflect the characteristics of AM.

- c. Participants are encouraged to submit physical articles, such as AM display pieces of innovative designs for the frontier of aviation.

Category 2: Aviation Applications

1. Theme

Engineering application of AM in aviation

2. Scope

This category is open to domestic and international enterprises, research institutes, universities and institutional groups. The work shall focus on application of AM in the aviation sector, and it shall be practical and realizable, with high potential for application. With the goal of technical realization of aviation products, the work can include, but not limited to, AM pieces that are already in service or has a high potential for application in an aircraft and its systems and components. Participants may choose one of the following two topics:

a. Topic 1:

Participants may select AM components or assemblies, and their associated technologies and methods that are already applied to aircrafts, or possessing high value and potential for AM application as entry for the competition. In the description of work, participants shall explain in detail its characteristics and advantages, and analyze the feasibility of the design, tool or software from the perspective of its process and the evaluation of the properties. Furthermore, it shall be clarified if the work has been, or is in the process of being, applied to existing aircraft models.

b. Topic 2: Innovative Designs of Typical Joints

Design requirements:

The loads and constraints of the joint are shown in Figure 1 (refer to attachment for the CATIA file). The loads are applied on the surface highlighted in yellow as shown in picture 1 (top right). It is a joint surface, which cannot be optimized, while the green surfaces encompass the volume that can be optimized; picture 2 in Figure 1 includes the part constraint and the channel for its fastener. The surface highlighted in green is the only part that can be optimized. The transparent cylinder is the fastener channel. The space occupied by the fastener channel must be free of material. Please refer to the CAD model for details; The pink square is the lower datum plane of the joint, and optimization can only be carried out in the space above the pink square. The specific optimization design space can be set according to the actual load and constraints. The joint is to be optimized for minimum weight, without any static load failure or plastic deformation under the given specific loads.

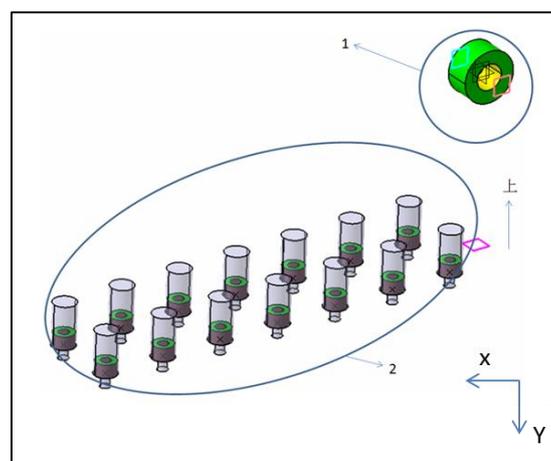


Fig.1 typical joint diagram of civil aircraft

Design loads:

Loads are applied on the surface highlight in yellow, of Figure 1, picture 1.

Load case 1: $F_X = 320 \text{ kN}$, $F_Y = 129 \text{ kN}$

Load case 2: $F_X = -229 \text{ kN}$, $F_Y = -74 \text{ kN}$

Design constraints:

Referring to Figure 1, there are 14 constraint points in total (see CAD model for details). The joint is fixed on a titanium alloy plate by 14 fasteners (CFBL2001-06), with a diameters of 4.76mm. These fasteners are 12-point bolts made of Inconel 718, with a tensile limit of 93kN and a shear resistance of 121.9kN (double shear).

Material:

The material for design optimization is Ti-6Al-4V titanium alloy.

Refer to Figure 2 for material properties.

Thickness (mm)		≤ 4.69	4.76~50.80	50.83~101.60			
Properties (MPa)							
Basis		A	B	A	B	A	B
Ultimate Tensile Strength	σ_{tu}	924	958	896	931	896	945
Yield Strength (Tensile)	σ_{ty}	869	903	827	862	814	848
Yield Strength (Compressive)	σ_{cy}	917	952	855	889	841	876
Ultimate Shear Strength	σ_{su}	600	621	545	579	545	579
Ultimate Bearing Strength	σ_{bru} e/D=1.5	1469	1524	1420	1476	1420	1496
	σ_{bru} e/D=2.0	1875	2641	1793	1903	1793	1889
Elastic Modulus	E	110320					
Elastic Modulus (Compressive)	E_c	113078					
Shear Modulus	G	42749					
Poisson's Ratio	μ	0.31					

Fig.2 Properties of titanium alloy materials

3. Instructions

- a. Participants are provide a report with detailed description of the work, digital models of the part before and after design optimization, and other deliverables. The work may include several optimization solutions. In addition, supplementary materials such as relevant tools, software, process specifications and proof of application may be provided as attachments.
- b. The works must be original, practical and realizable, with high potential for application. In the description of work, participants shall explain in detail its characteristics and advantages, and analyze the feasibility of the design, tool or software from the perspective of its process and the evaluation of the properties.
- c. Participants are encouraged to submit physical articles made via AM.

Category 3: Technological Capabilities

1. Theme

Fundamentals and capabilities of AM technologies for aviation

2. Scope

This category is open to domestic and international enterprises, research institutes, universities, institutional groups and individuals. The work shall focus on fundamental research in areas such as general theory, common methods, software and hardware, general data, airworthiness certification, and standard specifications in the field of AM specifically catered to civil aircraft. The works shall be universal, reasonable and reliable. It may include, but is not limited to, verified design methods, processes, materials, tests, maintenance methods, verified testing methods for certain type of materials, software or hardware that are developed and used, and airworthiness certification methods for verified AM parts.

3. Instruction

- a. The work can be in the form of a report, method, database, model, tools, software, physical articles, etc.
- b. The work must be original, universal, reasonable and reliable. In the description of work, participants shall explain in detail its characteristics and advantages, and provide a case study of its successful application or corresponding qualifications. If the work is focused on design methods, processes, materials, tests, maintenance

and airworthiness certification methods for AM, documents on the corresponding process, work flow, standards and specifications shall be provided. Corresponding hardware, software and tools may be provided as supplementary materials. If the work is a test of fundamental properties, relevant test methods, work flow, database (or data set) of properties shall be provided. Corresponding verification documents, certificates, software, hardware and tools may be provided as supplementary materials.

- c. Participants are encouraged to submit physical articles of the work.