Cultivation of innovative ability with the construction of innovative team for Undergraduate Students

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Abstract: The construction of innovative team is a key issue for the cultivation of innovative talents, especially in Aeronautics and Astronautics field where the projects depend on the abilities of comprehensive innovation and team cooperation. In order to cultivating innovative talents, Nanjing University of Aeronautics and Astronautics (NUAA) has built the innovation base for the college students who are major in aeronautics and astronautics since 2000. A new teaching mode includes the professional training and team graduation design is created. The practice shows that the teaching mode has remarkable effect on stimulating student's interest in aviation and cultivating the innovative consciousness and innovative ability. Several scientific research teams consisting of teachers guide the teams consisting of students and play an important role in cultivating innovative talents.

1. Creative consciousness and quality of the undergraduate cultivation

The traditional education by courses has been deemed to teach the knowledge for a long time, which is the mature knowledge mostly. It seems that the traditional education conflicts with the creative education. Indeed, the course education is not teaching. The teaching does not mean teaching the book or theories either. Even if in a fundamental course which includes classical theories, it is wrong to treat the course as a non-creative one. What is opposite, it is possible to build up creative thinking though the history of theory established and updated, for examples, from simple mathematics to higher mathematics, from Newtonian mechanics to Einstein’s principle of relativity. It is certainly that creative thinking education is more important in the specialized knowledge education. Specialized knowledge, particularly in engineering, is based on continuous creative work. This is why the new technologies and products keep appearing, such as raree show to television, telephone to cell phone, horse carriage to motor vehicle, air balloon to spaceship. Hence teachers should keep “creative thinking” as the soul of specialized courses all along the students’ education.

In a higher level, the creative thinking is not only a problem of undergraduate’s education for all-round development, but also an important problem of national economy and development. After our country has been opened to the outside world, some fields are depended on the aboard technologies, such as the automobile industry. It is impossible to keep national economy in a continuous development just based on introduction of foreign technologies. These is a typical example, China is the biggest production country of computer, but the most valuable parts like CPU and hard disk are depended on import. Fortunately the government of China has paid attention to this situation, policy of economy transformation and independent creation are established. Establishing students’ creative thinking is also a sense of responsibility. There are three parts:
establishment of patriotism, establishment of creative thinking and ability, revolution of creative education mode.

Education of creative talents includes three parts: 1) ability of creative learning; 2) ability of creative practice; 3) volition of overcoming difficulties. Ability of creative learning is the foundation of creation, there is no creative production without basic theories. “Creative practice ability” should include these abilities: “application of creative technology”, “practice of creative fabrication” and “expression of creative products”. Recently, the department of aircraft design has carried out revolution of undergraduate education, such as “undergraduate creative design laboratory” which offers opportunities to practice aircraft design methods and manufacture. Different testing airplanes are designed and fabricated by undergraduates every year in this laboratory. It is very important for the revolution of education which was actualized as “priority of theory”. The undergraduate’s practice of creation includes design, fabrication and testing flight, so it is a process of “pursuing dream, realize imagine, labor creation”. In the direction of undergraduate’s creation, strict demands are unacceptable while freedom of creation such as the independent thinking and design is needed. So, in such direction, it is better that encourage them not only to learn how to draft and compute, but also to fabricate and take a flight. There have been dozens of micro-aircrafts designed and fabricated by undergraduates recently years, for examples, fixed wing, fly wing, flying saucer, multi-rotor wings, flapping wing, airship, remote control, autonomic fly, etc. The students feel so happy when they see their aircrafts flying in the sky. This feeling of “creating the world by own hands” will never be forgotten all their lives. Expression of creative products is also a process of improving creative abilities. A visual demonstration should be given in a project of aircraft design, and the product need a nice appearance too. Volition of facing difficulties in the creation is very important as well as technical solutions. It should be understood that students feel depression when the program encounter some difficult problems, encouragement of never abandoned and quit should be given to them in time, and help them to understand it is natural that a successful technology product will born through hundreds fails and tries.

2. Innovative group cultivation and innovative team construction

The aeronautics and astronautics belongs to the field of high technology and science and big project. It depends on the capability in the comprehensive innovation and the ability of the team cooperation as well. So the construction of the innovative team is much more important significance for fostering innovative talents in aeronautics and astronautics. A new teaching mode integrating the comprehensive professional training and the team graduation design is created in the aeronautics and astronautics college of NUAA. The innovation teams of aircraft design, constituted by the students voluntarily since the third grade, is set up with the help of the teachers’ instruction in this mode. The target of this team is to design, manufacture and test a Mini Unmanned Air Vehicles (MUAV). Finally, the achievement of the team will be evaluated by the experts and teachers as the graduation design. A graduation design team usually includes six members who play the roles of “Chief Designer”, “Chief Engineer”, “Mechanical Analyst”, “Structure Designer”, “Control System Designer” and “Manufacturing Engineer” respectively. The team needs to complete the whole process of aircraft design including the innovative concept design, aerodynamic analysis, structure design, manufacturing, assembly and flight-test by themselves under the instruction of a teacher As a comprehensive training, this project not only needs students
to learn lots of extracurricular knowledge, but also needs them to learn how to deal with the practical engineering problems. Our students benefit much from it. A lot of innovative MUAV are worked out and flight successfully in this project, such as the mini rotorcraft, the solar power UAV with 3.5 m span, the joined-wing aircraft “Pegasus” and the tilt-rotor aircraft. The education mode has practiced for the several years and shows the great power in activating the student’s interest in the aviation and cultivating the innovative consciousness and innovative ability.

Innovative activities in science and technology in NUAA have developed from several students to innovation teams, and been forming team innovative atmosphere. And “XunJie”, “space discovery”, “QIQI”, “Yu fairy”, “air-robot”, “airboat”, aero-modeling teams and so on are the best of innovative groups, who won lots of prizes in nationwide undergraduate innovative competitions and professional aeronautics and astronautics innovative competitions. For example, they designed 48 works, such as “little rocket” and “hydraulic/pneumatic car”, and obtained the excellent achievement in the third hydrodynamics innovative experiment-designing competition in major of power engineering, which held in 2006. Innovative activities of the students who major in aeronautics and astronautics have drived innovative activities of the other colleges. The effect of the cultivation shows not only in innovative activities in science and technology, but also in other fields. The students of aeronautics and astronautics won lots of national or provincial competitions in mathematics, physics, mechanics, etc. For example, NUAA had kept ranking group second in the 5 years of 2000-2004 in national undergraduate mechanics competition, and e many members of this team major in aeronautics and astronautics. The students of aircraft manufacturing engineering and mechanical engineering set up more than 70 teams to take part in combining with course design and the second national future aircraft design in 2007, and 16 works were picked up, of which 11 works won the prizes in amateur, including 2 first prizes and 2 second prizes. Students of aeronautics and astronautics and other colleges work out together lots of excellent jobs such as “new power charger”, “electronic crane”, “V-car”, “mini airboat”, “unmanned rotorcraft”, etc. Furthermore, lots of these works won prizes in national or provincial competitions and some of them have been applied in the society.

A lot of researchers and teachers instructing the students training team play an important role during the process of the innovative talents cultivating And NUAA has been also awarded for organizing students to attend innovative activities in science and technology in aeronautics and astronautics.

3. Setting up undergraduate innovation base, providing the guarantee for students’ innovative activities

NUAA has set up a batch of the innovation training bases to cultivate the creating talents of the college students since the "tenth five-year". The main trainees are major in aeronautics and astronautics. For example, “aircraft innovative design lab”, “micro-aircraft innovation lab”, “energy and power innovation lab”, “electromechanical integration innovation lab” and related “intelligent control system innovation lab”, “embedded system innovation lab”, “electronic design innovation lab”, “science and technology activities center”, “engineering training center”, aero-modelling team, etc. These labs managed by students are always open for students to do some innovative researches and experiments. Taking “aircraft innovative design lab” as an example, students could set up their teams and work together to design, fabricate and flight-testing the new
concept aircraft. Under the teacher’s instruction, several mini aircrafts are worked out in this lab each year, such as double fuselage aircraft, joined-wing aircraft, short take-off aircraft, solar power aircraft. The success in the aircraft’ experiment greatly stimulates the students’ enthusiasm on innovation activities.

Energy and power innovation lab is based on scientific research strength in aircraft power. It provides students who want to learn something beyond the lessons a platform to putting their innovative designs into practice. Their innovation projects are proposed by themselves and then instructed by professors such as “function design and experiment research of planet explorer”, “barrier-crossing concept vehicle with unmanned intelligence”, “movement navigation based on image processing”, “flight attitude driven by three-DOF motor”, “speed control platform”. These projects improve students comprehensive design abilities remarkably.

Electromechanical Integration Innovation Lab is a platform where college students could do some digital electronic fabrication, machining and testing jobs. Lots of products, such as aircraft parts, robots and home appliances have been created in this lab.

Student Technology Center is an early base for technological activities. Students need to submit their applications and then be selected to join this center. This center is operated by students and, if they want, some instructors could help. Seven studios in the center are open, including Electrical and Electronic Studio, Radio Studio, Robot Studio, Aero-modelling Studio, Software Studio, Network Studio and Graphics Studio.

Aero-modeling Team is another important student organization which encourages students to join in some national competitions, such as “China air robot competition”, “Non-powered flight competition”, “National Aero-modelling competition”, etc. We won many prizes, National Aero-modelling Innovation Team Championship and Electrical Airdrop Championship for instance. The members in this team improve their abilities greatly by doing this kind of works themselves.

4. The learning and improvement of teachers

In order to instruct and cultivate the creative talents, it is the first thing to improve the teachers’ creative consciousness, education thinking and knowledge updating. The education thinking here means the responsibility of the teachers in the cultivation of creative talents. The teacher should just read the education assignments or give some hints to our students on their creative aspect on the class? Of course, it’s not possible in every class of the foundation subjects. But it’s possible for the professional subjects. In order to reach this goal, it requires the teachers themselves to keep creative consciousness. Then they can discover the new questions and the new creative points in the following steps. It strongly demands that the professional teachers need to pay attention on the latest knowledge, theories and techniques which can be added into the education plan. It also required teachers introduced the new research directions. The new subject of aircraft advanced design technique was based on this kind of method. When imparting classical knowledge of Aircraft Design, teachers should introduce students the new technique and development direction of Aircraft Design. Based on this point, a new re-organized textbook came out several years ago. For the development of new technique, more contents will be added into practical education and multimedia courseware. And many pictures about advanced aircraft technique will be provided to make students understand the newest technique better and improve creative consciousness.
On the other hand, in addition to refresh the knowledge of their own subjects, teachers also need to extend their knowledge level to foster creative compound students, especially in our field. Aircraft design was supported by hydrodynamics and solid mechanics in a long time. Electrics and information areas are less comparatively. In the modern aircraft design, no matter macro-plane or micro-plane, auto control and electronic technique has already take a large proportion. The learning of these across-subject knowledge, established the foundation to organize across-subject research team and students team. On the contrary, through the collaboration between teachers from different areas and the construct of across-subject students’ innovative team, teachers could improve themselves. With the improvement, teachers could also fosters creative compound students and organize across-subject students’ innovative team better.

Finally, it is necessary to inspire the enthusiasm of students to dedicate themselves to the service of motherland in the manner of aviation. On the professional class, don’t forget to give an idea to create new aircraft, emphasize each aircraft technique was the result of innovative and each aircraft was the outcome of innovative work. Reminding students’ patriotism and creative consciousness at every moment is the responsibility of our teachers.