

## LABORATORY COMMUNICATION

### State Key Laboratory of Fluid Power Transmission and Control

The State Key Laboratory of Fluid Power Transmission and Control (SKLoFP) was established on the base of the Institute of Mechatronic Control, Zhejiang University. The Laboratory was opened in 1986 with the approval of the Ministry of Education. It was further developed using the loan of the World Bank, and was appointed as a State Key Laboratory in 1995. At present Prof. Yang Huayong is the director of SKLoFP. Prof. Lu Yongxiang, chairman of the Chinese Academy of Sciences, is the leading professor of the Laboratory and is also the chairman of academic committee of SKLoFP which consists of 16 well-known professors and experts in the area of fluid power transmission and control. There are 18 scientists working in the Laboratory now, among them five are professors, ten associate professors or senior engineers, 15 out of 18 are Ph D holders.

Right from the beginning, the Laboratory always follows the guideline of "the first-class talent, the first-class education, the first-class research and the first-class application of research results". In 1997, the Laboratory passed the assessment organized by the National Natural Science Foundation of China (NSFC) and the work of the Laboratory obtained high appraisal from the experts.

#### 1 Main research fields

The main research fields of the Laboratory have been focused on the laws of power distribution, transmission and control with fluid. To meet the demand of engineering and environments, the effort has been made to improve the quality of kinetics and dynamics of fluid power transmission and control. With the innovations in the fluid power transmission and control, the integration of fluid power, mechanics and electronics becomes much more important, therefore, the research fields of the Laboratory have been expanded as well. The current research fields of SKLoFP mainly are:

(i) Electro-hydraulic components and systems. This includes digital controller for electro-hydraulic unit and system, new electro-mechanical transformer based on new materials, new electro-hydraulic valve and integrated actuator, electro-hydraulic control system for power machinery, construction machinery, metal forming machinery, testing machinery and marine machinery etc., real time speed control system for hydraulic elevators, high pressure hydraulic systems, water-hydraulic systems, energy-saving electro-hydraulic control technology, high speed electro-hydraulic transient eruptive driving technique and electro-hydraulic vibration and shock control technique.

(ii) Electro-pneumatic control technique. This covers pulse code modulation (PCM) and pulse width modulation (PWM) pneumatic proportional pressure and position control technique, modular production-line system with pneumatic control, pneumatic system testing and fault diagnosis, pneumatic servo-proportional robot with multi-degree of freedom.

(iii) Applied fluid mechanics. This investigates particle image velocimetry technique, research on flow loss of complicated flow passages and research on hydraulic pipeline dynamics.

(iv) Condition monitoring and fault diagnosis. This studies signal analysis method, vibration monitoring and vibration control, R&D of special transducers and measurement system and condition monitoring and fault diagnosis for mechatronic control system.

(v) Mechatronics system and automation. This field includes robotic control, six-degree-of-freedom servo platform, mobile robot and new technique of sensing.

(vi) Information and intelligence system. It studies system modeling and simulation, information technology and its application to fluid power transmission and control, and humachine intelligence and its application.

## 2 Main research achievements

Besides various fundamental research projects, the Laboratory pays much attention to solving the problems of fluid transmission and control in important civil and defense industries. On the basis of the 6 key patents obtained by Prof. Lu during 1980s in Germany and also our previous work, the various hydraulic proportional devices with internal feedback and necessary controllers, the electro-mechanical converters and test units, have been developed. The Laboratory has developed many other advanced technologies, including the electro-hydraulic proportional components and systems, the electro-pneumatic proportional components and systems, the hydraulic elevator system with energy-saving and speed control, the electro-hydraulic transient eruptive driving components and systems, the efficient and energy-saving fluid machinery and so on. Many research results have reached very high level of the world and some have obtained great economical benefits.

In recent years, the Laboratory has undertaken over 200 research projects. The most recent ones are "the Fundamental research on the mechanical/fluid power transmission system with energy-saving and new power transmission model (NSFC Key Project)", "Control of mobile offshore platform (863/Ocean Project)", "Research and simulation of electro-hydraulic proportional energy-saving system for 160T mobile crane (State Key Project)", "Fluid power control system for a navy vessel winch" and so on. 31 projects have been supported by NSFC and over 30 projects by the government. Through these projects, many important results have been obtained and some of them have been given awards. The major awards are as follows: "Electro-hydraulic proportional flow control valve with two port's" won the second class of the National Scientific and Technological Invention Award; "Electro-hydraulic proportional pressure control valve with new principle" won the third class of the National Scientific and Technological Invention Award; "New technology for electro-hydraulic proportional control" won the first class of Scientific and Technological Progress Award of the State Education Commission; the other 27 projects won the awards from the provincial government and the ministries. In addition, 15 invention patents have been approved and 15 books and more than 400 research papers have been published.

## 3 Training of talents

The Laboratory offers various research programs for students leading to the MS and Ph D de-

grees, also for postdoctoral fellows each year. Up to now, 22 postdoctoral fellows, 67 Ph D candidates and 190 MS. students have completed their research programs.

The SKLoFP pays much attention to cultivating excellent talents. Among the 18 full time researchers, 12 are under 45 years old, 80% of the key projects have been conducted by the young researchers under the age of 40. One of the young scientists won the title of National Model Worker, two obtained the title of National Outstanding Researcher, one was involved in the Talent Cultivation Program of the Ministry of Education, and the other two were granted the Talent Fund of the Ministry of Education.

#### **4 Academic exchange and cooperation**

The SKLoFP places much emphasis on the academic exchanges and cooperation with its counterparts both at home and abroad. Every year many well-known scholars and experts are invited to give lectures in the Laboratory. In recent years 13 scientists of SKLoFP have been sent to overseas for academic exchange and joint international projects. Some famous scholars, like Prof. W. Backé (Germany), Prof. K. Takahashi (Japan), Prof. Karl Hedrick (USA) and Prof. Masayoshi Tomizuka (USA) have been invited to visit the Laboratory.

Every year SKLoFP provides research fund to the scientists all over the world for their research projects. Since 1995, 29 projects supported by this fund have been carried out. These projects focus on the researches of control theory and application, which include electro-hydraulic control, water-hydraulic system, robotic control, signal processing, mechatronic system and automation etc. and many great achievements have been made.

Since the first Hangzhou International Conference on Fluid Power Transmission and Control (FPTC) held in 1985, the SKLoFP has organized this academic activity every four years, which is regarded as one of the three most influential international fluid power conferences in the world. Some other important academic conferences, such as 1998' Fontiers of Mechanical Engineering Conference (supported by NSFC) and the 4th International Conference on Frontiers of Design and Manufacturing (FDM' 2000) were and will be organized by the Laboratory.

The China Fluid Power Net International (<http://sklofp.zju.edu.cn>) and China Fluid Power Industry Information Network (<http://sklofp.zju.edu.cn>) have been set up within the Laboratory. This makes much easier for SKLoFP to exchange information with related institutions and industrial partners.

The Laboratory has established close relationship with many industrial partners both at home and abroad. In September 1997, the FESTO Pneumatic Center was set up under the cooperation of Zhejiang University (SKLoFP) and FESTO Co. Ltd. (Germany). Other cooperations have also been established with the Shanghai Baoshan Iron and Steel Co. Ltd., the 2nd Automobile Manufacturing Company Group (Wuhan), the Aeronautic Industry Inc., Ningbo Huaye Machine Manufacturing Co. Ltd., and Xizi Elevator and Escalator Co. Ltd., etc. As a consequence, some scholarships, such as Huaye, Xizi and Huafeng have been set up to both junior faculties and students.

## 5 Equipment

The Laboratory is well equipped for researches on fluid transmission and control, mechatronic system and automation, etc. All the test rigs in the Laboratory consume up to 1000kW of electricity. The major equipment includes automatic measuring control system of electro-hydraulic equipment, a high pressure network and power resource with pressure-stability control, an electro-hydraulic control system with energy-saving for production machinery, a water-hydraulic test system, a high-performance test system for hydraulic elevator with car speed control, a test platform for elevators, a test rig for high speed hydraulic system, a six-degree-of-freedom electro-hydraulic servo platform, a signal detecting and processing apparatus, an automatic modular production system and the test stand and video-signal processing devices for flow visualization and field-bus based modular production line of pneumatics.

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