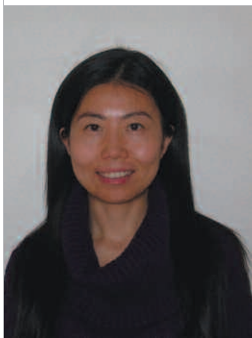

Why I'm Studying Shot Peening

In 2005, I left Beijing, where I majored in Mechanical Engineering and worked as a Stress Analysis Engineer for over ten years, and moved to Montreal to study. Montreal is renowned for its expertise in the aerospace industry, specifically in aircraft assembly and engine manufacturing. Bombardier Aerospace, the world's third largest commercial aircraft manufacturer, as well as Bell Helicopter Textron Canada, the world's largest producer of civilian helicopters, are both located in Montreal. Montreal is one of the world's largest aerospace hubs, along with Seattle and Toulouse, France. In May 2006, I began my Ph.D. studies at École Polytechnique, associated with University of Montreal. At the same time, I started research at the Aerospace Manufacturing Technology Centre (AMTC) of the National Research Council of Canada (NRC) as a guest worker. The research project is entitled "Finite Element Simulation of Shot Peening and Stress Peen Forming Process." In May, 2007, I attended the Electronics Inc. Shot Peening workshop in Montreal and passed the first level exam.

Shot peening is a cold working process widely used in the aerospace and automobile industries in order to improve metallic components subjected to fatigue loading and stress corrosion cracking or fretting, mainly due to the favourable residual stress. Large numbers of parameters, such as shot size, shot velocity, shot type, target material and peening angle, etc., greatly influence the shot peening effects. In addition, shot peening effectiveness depends greatly on peening intensity and coverage. I took advantage of my ten years of experiences in Finite Element Method (FEM) and developed a more practical shot peening model, with the ability to consider random shot peening process and to relate peening intensity and coverage to shot peening results. By combining FE modeling with Design of Experiment (DoE), it is possible to study the influence of most shot peening parameters and to optimize the shot peening process.

The peen forming process is an important forming technology in aerospace since there is no need for dies and presses or subsequent thermal processes. For a wing skin, which has a larger curvature in the chordwise direction than in the spanwise direction, a technique called stress peen forming is applied. In stress peen forming, the component is elastically pre-bent along the spanwise direction during peen forming. I have developed a FE model to study the influence of the pre-bending moment on the resulting deformations.

I took part in the 10th International Conference on Shot Peening and presented an article titled "Finite Element Simulation of Shot Peening and Stress Peen Forming Process". In this conference, I found that most of the papers presented and compared experimental results of specimens with and without shot peening. However, few analytical methods and approaches were presented that can predict the peening results as a function of treatment parameters, or that relate the influence of shot peening parameters to the resulting strength improvement obtained by peening. It is very important to analysis this well-controlled shot peening process because it can provide the best peening results and also greatly reduce experimental costs. I have developed an OFDF system (Optimisation of Fatigue strength with DoE and FEM). With this system, it is possible to simulate the real shot peening process, to predict the fatigue limit of the

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shot peened component and to optimize the controlled shot peening process.

The center of the global economy is shifting more and more towards Asia, especially to China. With its increasing role in the world economy, China's position in the global competitiveness ranking is attracting widespread attention. I am proud of my country and after graduation, I plan to bring the technology that I have developed in Montreal home in order to contribute to research on shot peening control methods in China.

In China, shot peening methods are used in the automotive and aerospace industries. In automotive manufacturing, shot peening is mainly used to strengthen the fatigue life of coil springs, leaf springs, torsion bars, gears, transmission components, bearings, camshafts, crankshafts, connecting rods, etc. International experience shows that it takes around 10 years for the family car consumption rate to increase from 20% to 60%. For example, United States spent 14 years to increase the rate from 10% to 90%, Japan spent 11 years to increase from 20% to 60%. The same trend may happen in China. By 2021, the urban household consumption of autos could reach around 60%. It is expected that in the next ten years, China's automobile industry will undergo great improvement. At the same time, due to wide application, the shot peening technology will be greatly improved during this period.

The aerospace industry is a significant symbol of the nation's strength. In November 28, 2008, China's first aircraft jet ARJ21-700, which was developed completely independently by the Chinese aerospace industry, made a successful flight in Shanghai. The success of ARJ21-700 represents a new milestone for the Chinese aerospace industry, and with it great research and development experience for building large aircraft. China is thus confident in being able to develop its own large aircraft before 2020. Shot peening is useful for improving different aircraft components, such as gas turbine engines, shafts, landing gears, etc., and will be very important for forming the wing skin during this period.

I appreciate greatly my supervisors, Martin Lévesque at École Polytechnique de Montreal and Claude Perron at Aerospace Manufacturing Technology Centre of the National Research Council of Canada. With their support, I am able to learn very much about the art of shot peening. There are fewer national boundaries for knowledge. I wish that all engineers everywhere in the word would cooperate to improve this technology for the benefit of all.