FSW Machine Parameters and their Interaction

Name: Jonathan Record
Status: Graduate Student
Address: 609 East 200 South
Provo, UT 84606
Phone #: 801-375-3842
Work #: 801-422-5189
E-mail: jhr@et.byu.edu

Objective:

The lack of knowledge about FSW parameters and their interaction is the motivation behind this study. The objective of this work is to establish a steady-state model that describes relationships between FSW process inputs (feed rate, spindle speed, tool depth) and various measurable outputs for 7075 aluminum.

Background:

Despite the in-depth research over the past decade, the fundamentals of the FSW process are not well understood. There is a lack of understanding regarding essential parameters, how parameters affect one another, and how they might be utilized to best control the FSW process. Most openly published literature on weld parameter interaction come from observations made during experiments. Most have neglected the most fundamental aspects of the process, and lack the breadth to instill any confidence in the trends observed. Interactions between weld parameters have not been studied.

In-depth studies which focus on how FSW parameters affect the process, resulting weld qualities and properties are required. This is illustrated in Figure 1. This information is crucial in order to better understand the process fundamental, influence tool design, and guide better process control schemes.

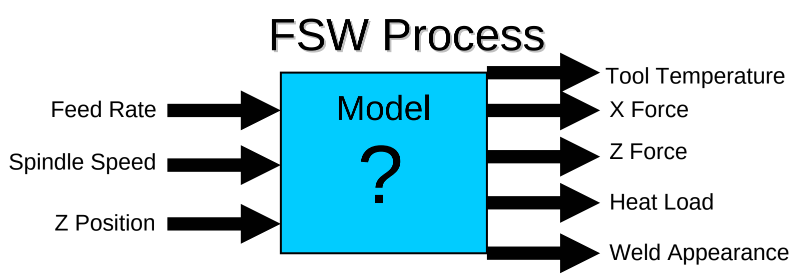

Figure 1. Schematic illustrating the parameters to be investigated.

Approach:

This thesis work will investigate the relationships between different FSW parameters in 7075-T7351 aluminum. The goal is to develop a steady state model that establishes relationships between multiple input and multiple outputs. As part of this work, the author will investigate change in tool temperature, loads and torques as a function of input parameters and explore interactions.

7075 aluminum (3/8” thick) will be used with a standard tool with 0.25-inch pin length. The tool is instrumented with 3 thermocouples. All processing will be performed on a custom built, instrumented friction stir welding machine which records many process variables. A 3-factor, 4-level Design of Experiments will be used and data analysis will be sufficient so the conclusions will be statistically sound. Feed rate, spindle speed, and tool depth will be varied throughout the experiments since these are the variables that are controlled directly. The welds will be allowed to reach steady state for a given set of input conditions, and the multiple outputs will be recorded and analyzed.

Status of program:

Testing will begin shortly for this study. However, new insight has already been discovered about FSW while the experimental setup (shown in Figure 2) has been developed and tested. For example, thermal couple imbedded in the tool revealed that the center tip of the pin is the hottest part of the tool. This is contrary to many papers and conference discussions which believe the outer diameter of the tool to be the hottest location. Many new discoveries are anticipated based on the instrumentation, scope of work and analysis to be performed.

Figure 2. Practice weld and machine set up

This study aids in understanding how parameter inputs affect the process performance and reliability. Methodology developed in this thesis will be used to investigate FSW parameters for high temperature materials and other tools. Furthermore, the relevance of this project comes into play for those who would want to automate FSW in a production facility. FSW parameter studies also help provide a general understanding of the FSW process which can help with the development and use of new materials, new tool designs, and new applications.