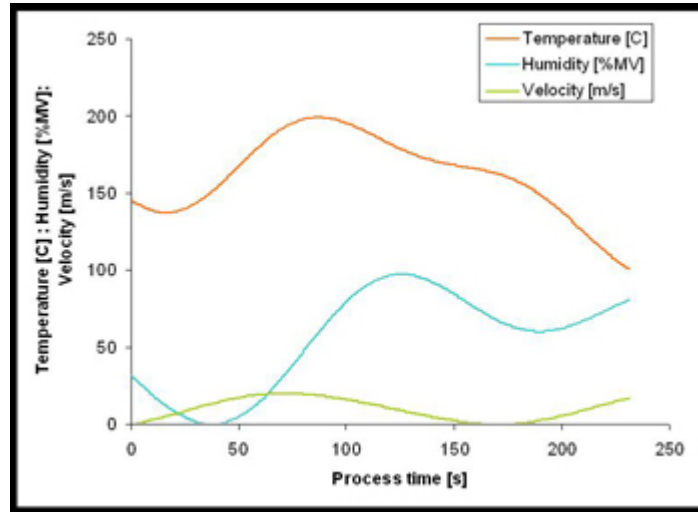


In the case of food processing and manufacturing, an important optimization challenge is finding processing conditions that simultaneously ensure safety, meet quality criteria, and maximize the processing yield (and therefore economic returns). It is difficult/impossible to find these best conditions solely by experience when operating commercial ovens in food manufacturing systems (Figure 1), because there are multiple control variables (e.g., temperature, humidity, impingement velocity, and cooking duration) affecting the outcome. In addition, many food processing operations, such as cooking meat patties, are very complex phenomena to express analytically. Therefore, it is not surprising that most studies of optimization have been devoted to relatively simple problems that have just one or two control variables (e.g., retorts for canned foods).



*Figure 1. JSO-IV Jet Stream Oven (Stein DSI, FMC FoodTech, Sandusky, Ohio).*

Our recent (and ongoing) study has been building a foundation for process optimization of meat patty cooking in moist air impingement oven systems, which is very complex problem. The goal is to maximize processing yield, which directly relates to economic return. However, this must be accomplished within the context of: (a) regulatory constraints specifying the target level of *Salmonella* inactivation, and (b) target limitations for quality (e.g., surface color). To accomplish the above objectives, a mathematical model for the cooking process (heat transfer, moisture transfer, fat transfer, microbial inactivation, and color changes) was developed, and a computer program was written to numerically solve the model. Artificial neural network models and various global optimization techniques (genetic algorithm, simulated annealing, and ICRS/DS) were then combined and evaluated, in terms of the potential for these techniques to find the optimal conditions for existing oven configurations (e.g., single- or double-stage systems) and for the theoretically best (i.e., “future generation”) configurations (Figure 2).



*Figure 2. Example of optimal dynamic control profiles for moist air impingement cooking system.*

The results of this project have shown that it is feasible to apply optimization techniques to complex food processing operations with multiple control variables. However, the specific results (e.g., maximum possible yield) are highly dependent on the various components of the cooking model (e.g., surface color) and the constraints applied to the problem. Now, based on these discoveries, we will: (a) continue to refine the optimization strategies for these types of complex food processing operations, and (b) seek to investigate and validate practical solutions for commercial meat cooking systems.