



COMSOL Assists Master Chef in Winning International Competition

BY DAGBJØRN SKIPNES, NOFIMA NORCONSERV AS

Every chef, whether a professional or just a hobby cook, knows the importance of determining how long a dish must be heated and at what temperature. It's not just a matter of avoiding under/over-cooking, the dish should reach the table at a pleasing temperature. We also know that food continues to cook when removed from heat; a roast will often stand for 15 minutes or longer after coming out of the oven to allow the meat to settle and the juices to remain in the beef. Indeed, cooking the perfect meal has always been an art — but it's also becoming somewhat of a science. This was discovered by Norwegian master chef Gunnar Hvarnes, who recently won the silver medal at the “culinary olympiads”, the Bocuse d'Or, for his preparation of halibut. Very interestingly, he enlisted our aid in using COMSOL Multiphysics to help him prepare his masterpiece.



Prize-winning chef Gunnar Hvarnes (left) and the author (right) in the test kitchen at the Culinary Institute.

Promoting Local Foods

The project began when the Norwegian Centres of Expertise — Culinology initiated and funded a project to promote halibut for both the local and export markets. They thought it would be a good idea to sponsor a chef in the Bocuse d'Or competition and also to design a project that would encourage a collaboration among research, chefs and culinology to help make food more innovative and tasty. For this, they enlisted the help of Nofima, a research group majority owned by the Ministry of Fisheries with roughly 500 employees who pursue R&D for the aquaculture, fisheries and food industry in Norway.

Chef Hvarnes was working on some ideas for halibut dishes but the results weren't exactly to his liking. His special dish starts with some halibut which is minced and mixed with spices. He then

takes a halibut filet and rolls it with this mixture. This fish cylinder is then coated with a special bread crumb crust. He started by experimenting with a number of key factors: the diameter of the fish roll, the thickness of the crust, the temperature of the frying oil, cooking time and others.

In the competition, he had to keep the dish warm for 15 minutes before it arrived in front of the judges during which he was preparing side dishes and decorating the plate. In practice, though, he was having trouble determining how to arrive at

the optimum serving temperature at the proper time.

Coincidentally, our facility has a test kitchen where Chef Hvarnes was working, and it's just one floor up from our offices. So he stopped by and asked if we might be able to help him understand what was going on inside the fish roll as he cooked it.

Heat Not Concentrated at the Exact Center

For this, we set up a relatively simple 2D COMSOL model (Fig. 1). It's impor-

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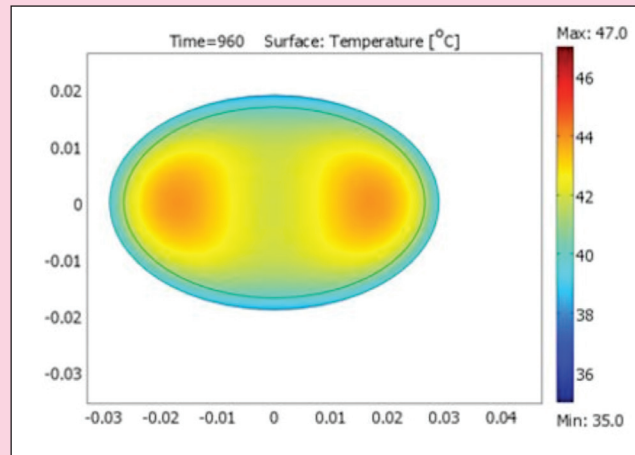


Fig. 1. The award-winning halibut dish from Chef Gunnar Hvarnes and the COMSOL analysis showing the hot spots that emerge during cooking. (photo courtesy of NCE-Culinology, Tom Haga)

tant to note that the fish roll is not a circle but rather an oval; as we discovered, the warmest point is not in the center but rather at two points towards the outside during cooling. Thus, measuring the temperature in the center and basing further steps on this false data continued to lead to less than perfect results. Based on model findings, one of the first things we did was show him where to place his thermometer to determine the maximum temperature inside the fish. We also studied how long the fish should remain in the frying oil, how long it would take to reach the desired temperature in the center (48° C) and how long to let it cool so the heat could distribute itself equally through the dish. In addition, an important factor is that the breadcrumb crust acts as an insulating layer, and our simulation showed how thick this crust should be to meet his requirements.

For this pure convection heating problem we needed only two domains: the fish and the crust. And while the fish fibers exist in a very complex pattern and there is also the minced mixture inside, we found that in the model we could assume that the fish consistency is uniform throughout. Determining the material properties involved some research. I did

some initial measurements to find the heat-transfer coefficient of the fish and also found its specific heat capacity with a differential scanning calorimeter. I was able to find information about its density in a literature search.

Setting up the model took just a couple of hours, and finding the necessary parameters took a day or two. Then we spent roughly three days in the kitchen and lab to verify the model. We placed thermocouples in the fish and confirmed the hot and cold spots as predicted by the COMSOL model.

When setting up the model, Chef Hvarnes told me the maximum temperature at which he could cook the fish and the desired temperature when it was being

served. Together we determined the best size for the fish roll, the thickness of the crust along with how long to cook it and at what temperature.

Having perfected his dish with the help of COMSOL, he then went to Geneva, Switzerland, last June for the Bocuse d'Or competition, which takes place every two years. Working in 18 m² contest kitchens set up facing the public, 20 chefs took up the challenge of creating two meals, one using Swiss veal and another using Sterling white halibut, within a certain time limit. With the understanding he gained from the COMSOL model, Chef Hvarnes was able to create a dish that was awarded the silver medal and 9000 euros in prize money. ■

About the Author

Dagbjørn Skipnes has worked for Nofima Norconserv AS since January 1993. He graduated with a M.Sc. from the Norwegian University of Science and Technology in Trondheim. He has been working in the field of thermal processing of foods and fish-processing technology, and since 1997 Dagbjørn has focused on the minimal processing of convenience fish products and was involved in the establishment of the sous-vide fish processing company Fjordkjøkken AS. Most recently, Dagbjørn has been completing his Ph.D. at the Norwegian University of Life Sciences.