Modeling the behavior of confetti

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What happens when small paper clippings travel inside a pipe, driven by an air flow? Do they stick to the wall or can they flow freely? And above all, can a computer simulation capture this behavior? Follow along and learn how this is set up to see the astounding results!

Tetra Pak is a company that supplies complete systems for processing, producing and distributing liquid food and beverages across the world. A lot of these packages have a hole, meant to be pierced by straws or that have a cap on top. As the packages are produced, these holes need to be cut out. In this process, loads of small paperboard clippings, also called, *confetti*, are produced and need to be removed from the machines. As they are removed, they travel in pipes, like gigantic vacuum cleaners. But the confetti regularly cause jams in the pipes which results in huge losses for the production company, since the machines have to be stopped.

In order to understand how these jams arise, we want to get a better understanding of how the confetti behave in an air flow. We cannot film inside the machine, since it is made of metal, thus a computer model is created to simulate the course of events inside the pipe instead.

For the first part of this computer model we need to define the geometry. A pipe and the confetti are created. Then the materials are assigned: we need paperboard for the confetti and metal for the pipe. This also specifies what happens when the parts come into contact.

In the second, and final, part of the computer model we need to introduce the air flow. This is done by assigning the properties of air to the inside of the pipe. Then, setting a velocity condition at the inlet of the pipe, will make the air move, just like in a vacuum cleaner. This kind of computer model is called FSI-model, which is short for fluid-structure interaction since it models the interaction between a fluid (air) and a deformable structure (paperboard confetti). The computer model is now ready to run and the results obtained can be seen in Fig. 1. Here we can see the trajectory of the confetti, how it moves through the pipe and the velocity of the air.

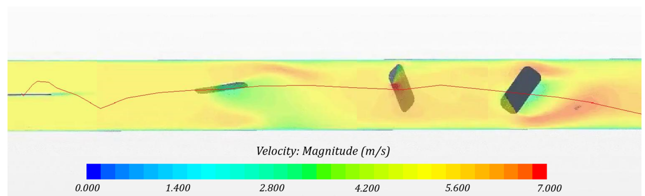

Fig. 1: Result from computer simulation.

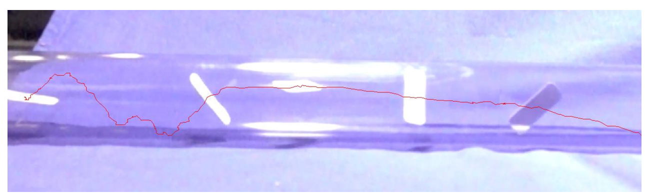

Fig. 2: Result from physical experiments.

But how do we know if the results are valid? After all, this is quite a complex problem to solve. This can be checked, by comparing to physical experiments. For this we need a clear pipe with the same dimensions as used in the computer simulation, your parents' old vacuum cleaner and a high-speed camera. The same kind of footage, as produced by the computer simulation, can now be obtained as seen in Fig. 2. How convenient, our results can now be compared.

Comparing Fig. 1 and Fig. 2 we can see a strong resemblance. The trajectory of the confetti is almost the same, just as how it moves through the pipe. We can claim that the computer model is validated and produces results close to reality. Now it can be further developed to simulate a full jam, which might just solve Tetra Pak's problem.

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Full version of the project report: http://lup.lub.lu.se/student-papers/record/9040215