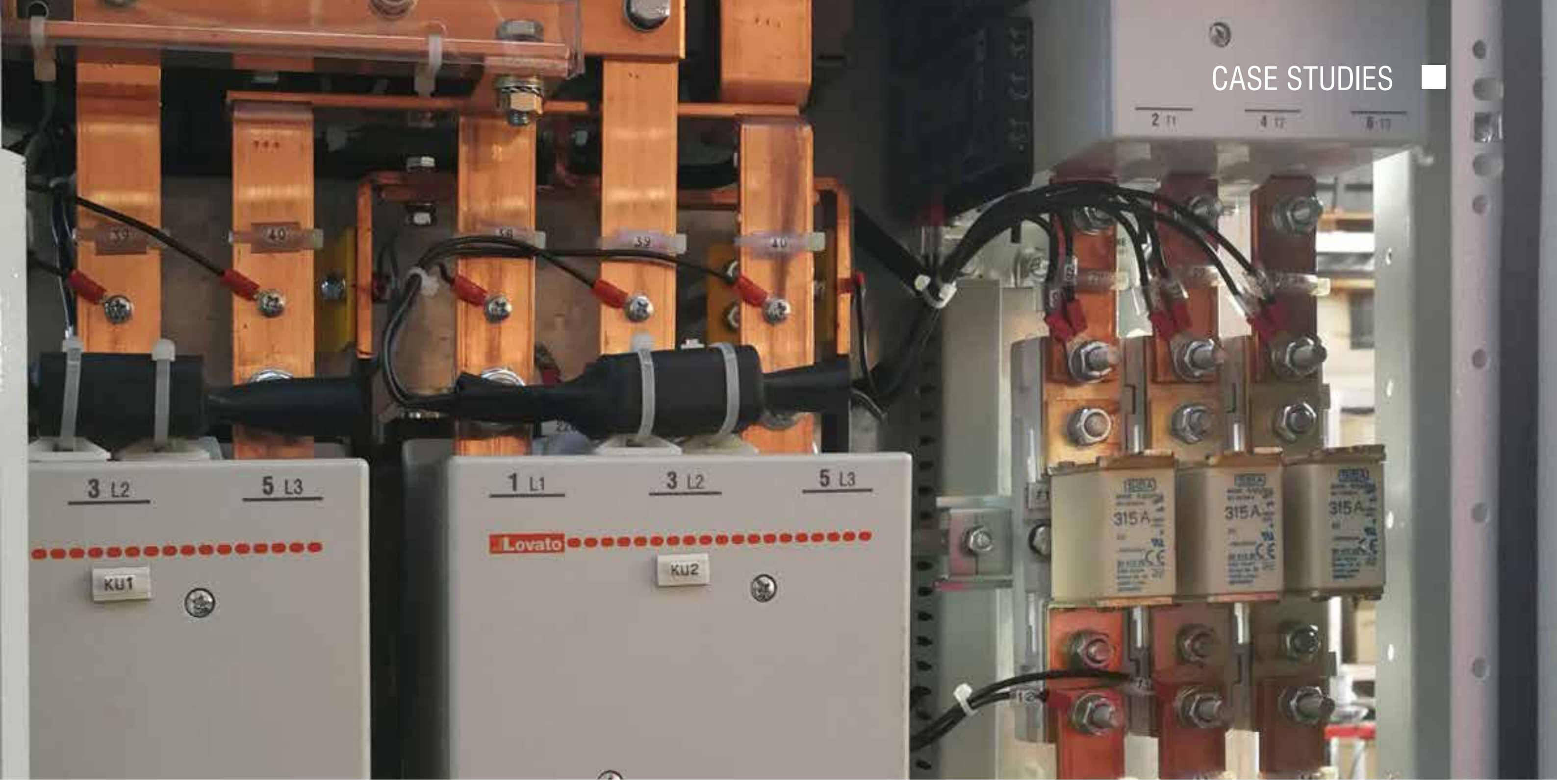


# A multibody simulation of an electric switch disconnector

## Using simulation and validation to build trust in new tools

**By Iacopo Guaiatelli[1] and Gian Marco Colorio[2]**
1. LOVATO Electric, 2. EnginSoft

*Changing the way a company moves from an idea to a physical product is not always an easy task, especially as designers first have to develop trust in the results provided by any new tool. This article describes the multibody simulation of a switch disconnector and its validation with experimental tests, undertaken by LOVATO Electric for the purpose of conducting a detailed evaluation of a potential new tool to design the mechanical part of its electrical devices. This type of "field test" of potential new tools is also valuable for skills and knowledge transfer.*

In order to reduce the time it takes to release a new product, companies are changing their design processes by increasing their use of CAE tools year on year. This is, for example, the strategy that LOVATO Electric is implementing: streamlining its design process through the use of simulation tools from the earliest stages of the design process.

Changing the way a company moves from an idea to a physical product is not always an easy task, especially as designers first have to develop trust in the results provided by any new tool. Before making the decision to adopt RecurDyn as the main tool to design the mechanical part of its electrical devices, LOVATO Electric went through a very detailed evaluation process consisting of the construction of a multibody dynamics (MBD) model of a switch disconnector and its validation by means of experimental tests.

### Switch disconnectors

Switch disconnectors are electrical devices suitable for various applications such as electric equipment, machinery and power distribution, to perform quick-make, quick-break operations in low voltage circuits. These devices convert the potential elastic energy stored in the springs into kinetic energy for the mobile contacts in the poles. A quick-make, quick-break operation lasts about 5 milliseconds, so the velocities involved are extremely high.

An optimal design of the switch disconnector control is critical for high performance. In this type of mechanism, performance is identified as the time it takes to switch from ON to OFF during a break maneuver, as well as robustness and durability (over time, the arc generated during ON-OFF operations damages the copper parts).

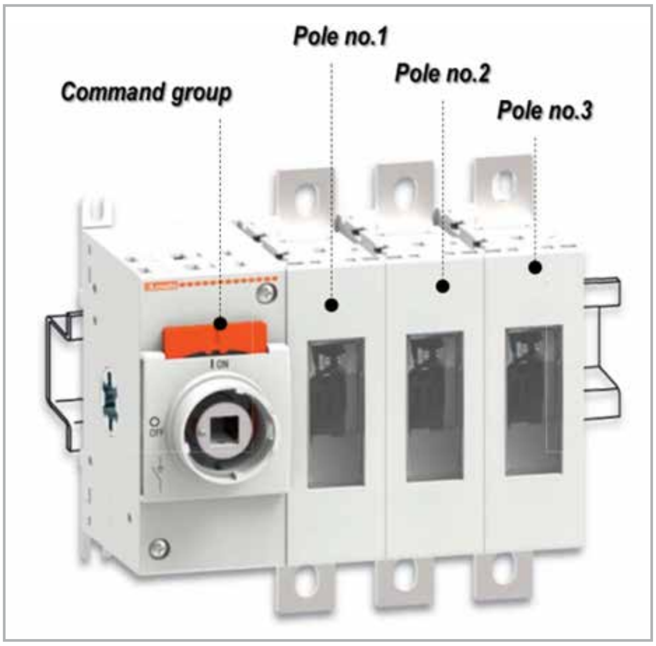


*Fig. 1 - Switch disconnector architecture*

## Why LOVATO Electric chose RecurDyn

To understand how LOVATO Electric has changed the way it designs its products, we need to review the original process. In the past, each new product was the result of a rigid multibody analysis, based on experience gained over the years by designers, and from both mechanical and electrical experimental tests. This method was very expensive in terms of time and resources and sometimes, too many iterations were needed to meet the specifications because of the use of inappropriate engineering tools.

Traditional embedded multibody CAD software lacks the three-dimensionality of the contact and cannot take into account the flexibility of the parts. These aspects make them unsuitable for applications where the contact surfaces are highly processed (such as in the switch control assembly), and the deformation of the body affects the delay with which the quick-break, quick-make operations are carried out.

LOVATO Electric was looking for a tool that could address all these aspects from the beginning of the design process, helping it to reduce the number of prototypes. That was when RecurDyn came into play with its unique features for detailed contact analysis (GeoSurface) and its proprietary technology for Multi Flexible Body Dynamics (FFlex).

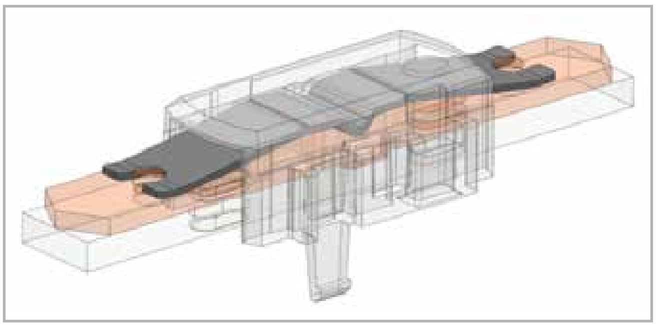

*Fig. 2 - Leaf-springs in the pole mechanism*

***After a period in which LOVATO Electric, shadowed by EnginSoft's multibody team, tested RecurDyn's capabilities, it was able to insert RecurDyn correctly into its product design cycle. LOVATO Electric is now able to predict the dynamics with high accuracy, and to identify the optimal configuration, increasing effectiveness and requiring the use of the laboratory for validation purposes only.***

## Why the FFlex method

The flexibility of certain bodies was fundamental in the switch disconnector that LOVATO Electric decided to analyze to test RecurDyn's capabilities. In particular, there were two leaf-springs under great deformation in the poles (see Fig. 2). Being subject to large deformations and being in contact with other bodies by means of sliding contacts, these springs show non-linear behavior.

With RecurDyn, LOVATO Electric's engineers were able to simulate the correct assembly procedure starting from the springs in undeformed shape and loading them to the assembled position by simulating the actual assembly procedure. After the validation of the leaf-spring model against experimental tests (Fig. 3), using the Extract feature, it was possible to create a subassembly of the pole with the leaf-springs already in their loaded configuration, ready to be implemented in the entire switch disconnector model in as many subassemblies as necessary.

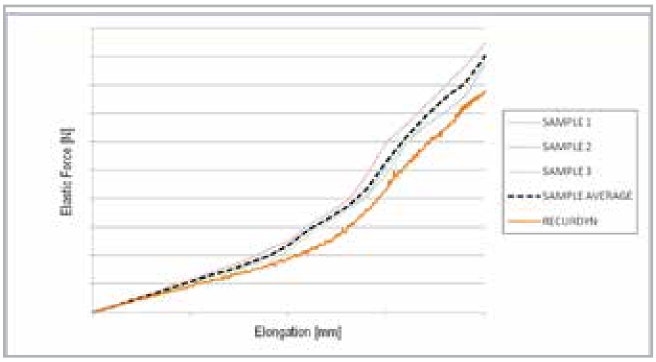


*Fig. 3 - Validation of leaf-springs subsystem*

The FFlex method allows the stress within the components included in the model to be evaluated (even with non-linear material properties), while considering the effects of the deformation of the body. This aspect is crucial to identify structural problems from the early stages of the design.

## Why GeoSurface contact

The switch control assembly is the device required to translate a slow rotation of the handle to a rapid switching of the switch.

At the center of the control unit is a sophisticated cam system involving a central shaft, called the primary shaft, and two other shafts at right angles to it, called secondary shafts.

These three shafts communicate via cam-type surfaces whose shape plays a very important role in performance. This part of the mechanism is impossible to model with a standard joint and it is here that GeoSurface contact was widely used, as it is able to efficiently manage the contacts

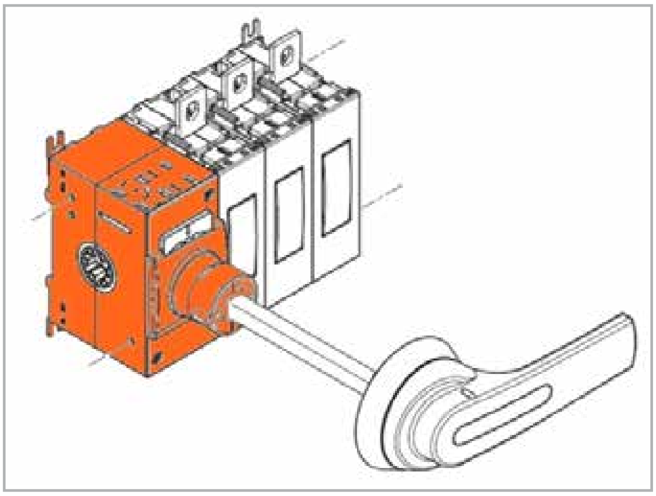

*Fig. 4 - Switch control assembly*

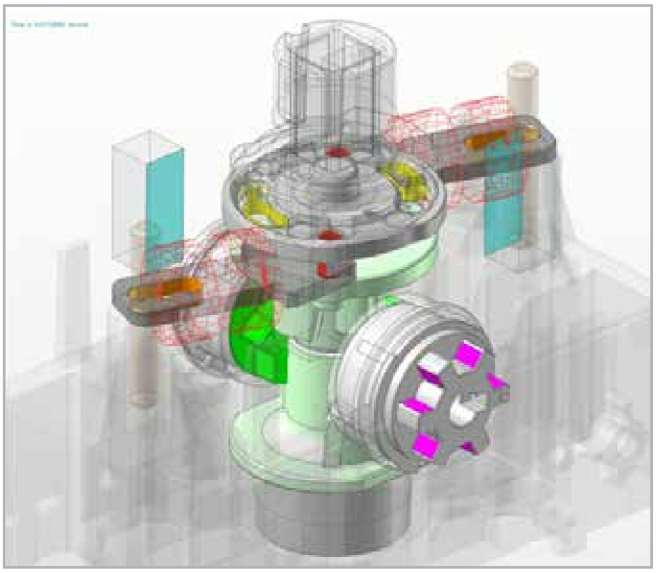

*Fig. 5 - GeoSurface contacts within the switch control assembly*

between complex surfaces characterized by extensive sliding between them.

## Future developments and conclusions

As a next step in this project, LOVATO Electric wishes to remove most of the joints and use contacts instead, in order to take into account the effects of all the clearances. The company also wants to implement RecurDyn and the techniques learned during this study in the design of the dimensions of the next switch disconnector and other products. As a result of this project, in fact, LOVATO Electric has acquired most of the skills necessary to correctly simulate the switch disconnectors using RecurDyn and is now able to use it for its entire range of electromechanical products.

***Visit also www.lovatoelectric.com***

For more information
info@enginsoftusa.com
469-912-0504