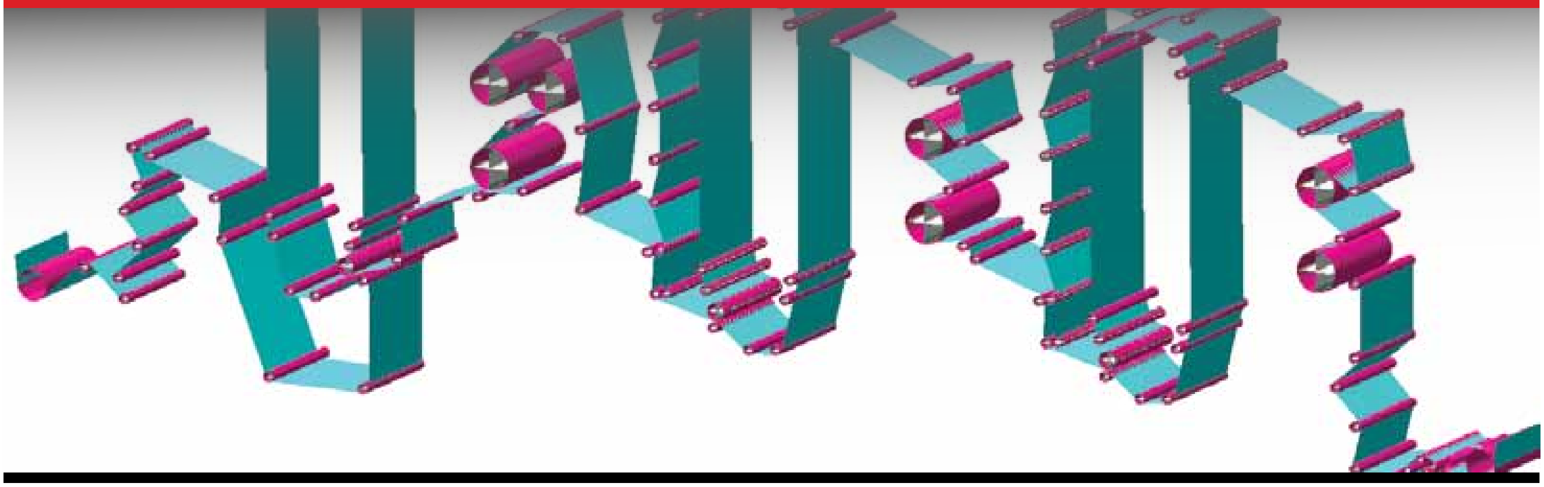
CASE STUDY

MSC Software: Case Study - Armor

Armor Increases Machine Productivity by 20% with MSC Software's Adams and Easy5 Simulations



With sales of 137 million Euros in 2011, Armor is one of the leaders in producing inked ribbon used in thermal transfer printing for product identification and other applications. Ribbon is produced by applying ink to polyethylene terephthalate (PET) film in a web coating process in which the speed, tension and position of the web and other variables must be closely controlled in order to ensure the highest possible quality while maximizing throughput.

Gildas Hubert, project manager for Armor, has simulated many of the company's coating machines with MSC Software's Adams multibody dynamics software and control systems with Easy5 multi-domain modeling and simulation software. "Simulation helped us work out the optimal coating conditions and make engineering changes to our machines," Hubert said. "Over one year we improved productivity by 20% while also increasing quality of the finished film. Simulation is a great way to improve our manufacturing process at a relatively low cost without disrupting production as is required for physical experiments."

Based in Nantes, France, Armor was one of the first companies to manufacture carbon film, introduce ribbon cassettes for typewriters and introduce thermal transfer technology in the early 1980s. The company has over 760 employees worldwide and produces 110,000 thermal transfer film rolls per day at five production sites around the world. Armor is the leading producer in Europe with a 53% market share. The company offers over 12,000 different ribbon configurations.

Key Highlights:

Industry

ARMOR

Industrial Machinery,

Printing Technologies

Challenge

Maximize throughput & increase quality

MSC Software Solutions

Dynamics analysis & controls integration

Adams & Easy5

Benefits

- Increased machine productivity by 20%
- Achieved optimal coating conditions
- Increased quality

"Over a one year period, we improved productivity by 20% while also increasing quality of the finished film"

Gildas Hubert, Process Engineer, Armor

Thermal transfer technology

Thermal transfer printing consists of applying thermofusible ink using a heat source emitted by the printer. The thermal transfer ribbon passes over the thermal print head with the coated side pressed against the label surface. The heat energy produced by each dot causes the pigment to transfer off the carrier film and bond to the surface of the label. The largest application by far for thermal transfer printing is the marking of individual products during manufacturing with information including model number, serial number, use-by-date, composition, price, etc. Other applications include flexible packaging, ticketing, personal identification and plain paper fax machines.

During the manufacturing process, a transparent PET film is unwound as a single or several layers of ink are applied on one side and a protective layer called the backcoating is applied on the other side. The PET film used as the carrier has a thickness of 3.2 to 5.0 μm, high resistance to tearing, good thermal conductivity and very good heat resistance. The backcoating protects the printhead as the ribbon unwinds, provides high thermal conductivity to transfer heat to the print medium and reduces the formation of static electricity. A range of different inks are used including wax, wax-resin and resin types. A rubber coated metering roll feeds the ink to a gravure roll which in turn feeds the ink to a format transfer roll onto the web. The coating weight is controlled by the velocity of the rolls and the footprint between the metering roll and the gravure roll. All rolls are heated with thermo oil. A jumbo roll 20 kilometers long is coated and then the jumbo roll is unwound onto smaller rolls as required for customer applications.

Moving from physical experiments to simulation

"We have always been concerned with eliminating defects to ensure a positive experience to our customers while at the same time increasing the productivity of our web coating process," Hubert said. "In the past the primary method of improving operations was with physical experiments. But there were several problems with this approach. First of all utilizing coating machines to run physical experiments disrupts our production operations. The limited time available for and high cost of physical experiments greatly reduces the number of different conditions that we can evaluate. Physical experiments also provide only a very limited amount of diagnostic information. The number of physical measurements that can be captured during these experiments is limited by the difficulty of instrumenting the coating machines."

Armor has long been interested in using simulation to evaluate a much larger number of different process conditions while reducing the need to disruption production operations. But in the past the company found it difficult to model the complicated mechanisms and motion control systems involved in roll coating. This challenge was overcome with the use of Adams and Easy5 which enable controls systems to be integrated into mechanical systems simulations to optimize systems performance. Adams, the world's most widely used multibody dynamics simulation software, automatically formulates and solves the equations of motion for kinematic, static, quasi-static and dynamic simulations. Easy5 is a graphics-based software tool used to model multi-domain dynamics systems characterized by differential, difference and algebraic equations such as digital and analog control systems. Integration is accomplished with the Adams interface block in an Easy5 model that provides inputs from Easy5 into Adams and vice versa.

Optimizing roll coating performance

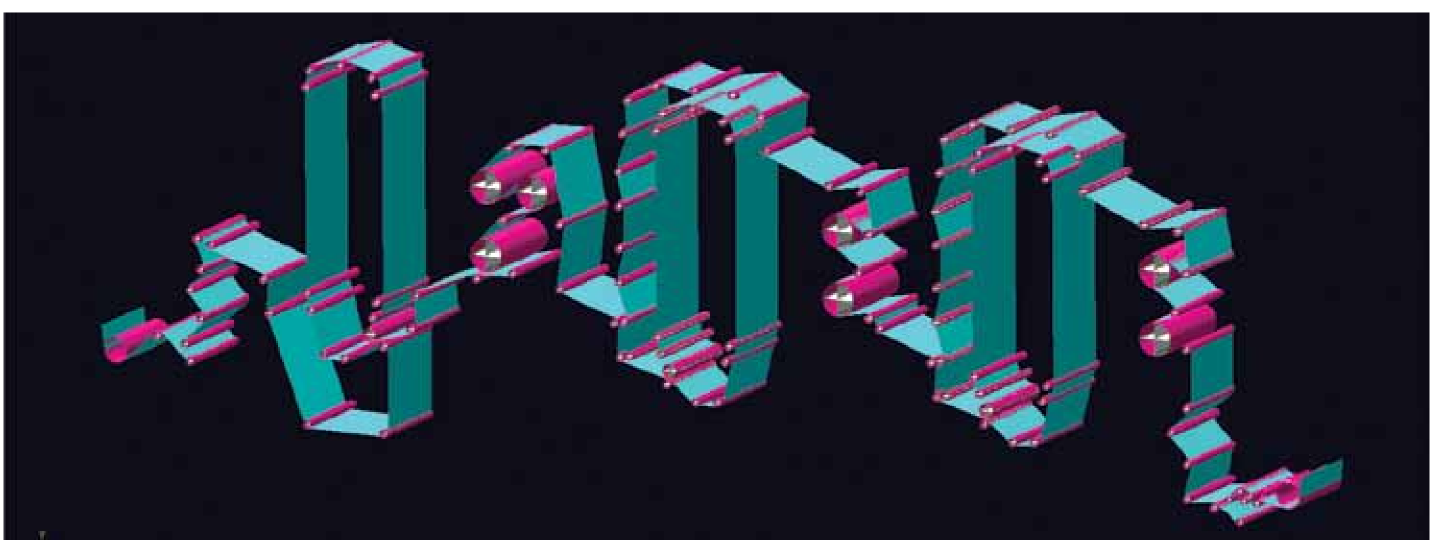
Hubert constructed an Adams model of the machine. He defined the rolls as cylinders and added connections between them to represent the gearing in the machine. He defined the material properties of the PET web and entered the friction between the web and the rolls based on physical measurements. Easy5 is used to simulate the proportional–integral–derivative (PID) closed loop motion controller. "I found it very easy to define both the physical and control model with Adams and Easy5," Hubert said. Hubert began his simulation efforts on a machine whose performance he felt left considerable room for improvement. The machine required continually adjustments in order to avoid defects. He began by simulating the machine's current operating conditions. Comparing the simulation results with physical measurements, particularly of web tension, showed that the simulation accurately represented the machine performance.

The simulation results showed that a small change in operating conditions could cause the machine to produce defects. Hubert evaluated changing the operating conditions, particularly the PID control values. He modified the model and re-ran the simulation multiple times, seeking to move the machine to a point where small changes in operating conditions would have no impact on quality. In the end, he discovered more robust operating conditions that substantially improved throughput of the machine by reducing downtime required for adjusting operating conditions.

Based on this success, Hubert turned his attention to other machines that were seemingly operating well to see if improvements could be made in either throughput or quality. During this process, he discovered the importance of accurately determining the friction between the web and the rolls in order to provide accurate simulation results. He evaluated more of the company's machines in order to identify optimal operating conditions. He evaluated a range of different products with varying film thicknesses on each machine. For each product he evaluated different PID control values in order to identify values that provided stable operating conditions without defects. During this process, he optimized the control values for each film thickness. This required far more simulation runs than would have been possible with physical experiments. Running virtual experiments with Adams and Easy5 also eliminated the cost of downtime on production machines.

By optimizing control values, Armor was able to increase throughput of its coating machines collectively by about 20% over a one year period. The primary improvement came from increasing machine reliability and stability so that less time was required for repairs or adjustment. Web speed improvements were also achieved on many machines. "We are now able to set the PID values much more precisely to optimize the performance of the machine for specific products," Hubert said. "We have made other improvements with simulation such as increasing the throughput of a cutting machine by 8%. We have plans to apply simulation to additional processes such as our rewinding machines. We are looking to improve the precision of our models by integrated process related thermal phenomena into the analysis loop. Finally, we also see the potential for simulation to improve the quality of our labeling machines."

"Our goal was to improve the coating process, notably by controlling the tension of the film on to which the ink is deposited," Hubert concluded. "Coupling Adams, MSC's multibody simulation solution, with Easy5 turned out to be the ideal way to model our roll machines and control systems. By simulating the operation of our machine we were able to determine the ideal parameters for operating them over a broad range of products. These calculations make it possible to run each machine at the optimal coating conditions. The end result was that we improved quality while at the same time making substantial improvements in productivity."



About MSC Software

MSC Software is one of the ten original software companies and the worldwide leader in multidiscipline simulation. As a trusted partner, MSC Software helps companies improve quality, save time and reduce costs associated with design and test of manufactured products. Academic institutions, researchers, and students employ MSC technology to expand individual knowledge as well as expand the horizon of simulation. MSC Software employs 1,000 professionals in 20 countries. For additional information about MSC Software's products and services, please visit www.mscsoftware.com.

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About Adams

Multibody Dynamics Simulation

Adams is the most widely used multibody dynamics and motion analysis software in the world. Adams helps engineers to study the dynamics of moving parts, how loads and forces are distributed throughout mechanical systems, and to improve and optimize the performance of their products.

Traditional "build and test" design methods are expensive, time consuming, and impossible to do sometimes. CAD-based tools help to evaluate things like interference between parts, and basic kinematic motion, but neglect the true physics-based dynamics of complex mechanical systems. FEA is suited for studying linear vibration and transient dynamics, but inefficient at analyzing large rotations and other highly nonlinear motion of full mechanical systems.

Adams multibody dynamics software enables engineers to easily create and test virtual prototypes of mechanical systems in a fraction of the time and cost required for physical build and test. Unlike most CAD embedded tools, Adams incorporates real physics by simultaneously solving equations for kinematics, statics, quasi-statics, and dynamics.

Utilizing multibody dynamics solution technology, Adams runs nonlinear dynamics in a fraction of the time required by FEA solutions. Loads and forces computed by Adams simulations improve the accuracy of FEA by providing better assessment of how they vary throughout a full range of motion and operating environments.

Optional modules available with Adams allow users to integrate mechanical components, pneumatics, hydraulics, electronics, and control systems technologies to build and test virtual prototypes that accurately account for the interactions between these subsystems.

About Easy5

Advanced Controls & Systems Simulation

Easy5 is a graphics-based software tool used to model, simulate, and design multi-domain dynamic systems characterized by differential, difference, and algebraic equations. The systems that can be analyzed using Easy5 include mechanical, electrical, hydraulic, pneumatic, thermal, gas dynamics, powertrain, vehicle dynamics, digital/analog control systems and much more.

Models may be assembled graphically from special pre-built, ready-to-use multi-domain system-level blocks such as valves, actuators, heat exchangers, gears, clutches, engines, pneumatics, flight dynamics, and many more, or from primitive functional blocks, such as summers, dividers, lead-lag filters, and integrators. The building blocks are packaged in easily accessible application libraries. Users can also create custom libraries for reuse and sharing across the enterprise. An open architecture provides an interface to a broad set of software and hardware tools used in computer-aided engineering (CAE), including Adams®, MSC Nastran®, Simulink®, and other CAE software tools.

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