known, it is possible to proceed to the verification of these details using the classical methods; no problem for the rivets, for which it is sufficient to know the allowable load, while for the holes it is necessary to be armed with paper, pen and calculator to determine the three stresses that determine the three modes of failure of a lug/eyelet.

18.1.4 The principle of the least necessary mass

In thirty years of experience in the simulation of mechanical assemblies, even complex, I happened to work for and with companies in different sectors (aerospace, railway, plant engineering, motorsport, energy) and in many of these the reduction of masses in the game, in compliance with the requirements of structural strength and stiffness, was, or has become over time, a determining factor at the base of each new project. And perhaps it is almost useless to explain why: the lighter an aircraft, or a spacecraft, is, the higher the payload will be (passengers in the case of commercial aircrafts, armaments in the case of military aircrafts, material to be put into orbit in the case of spacecrafts) all other things being equal; for a competition vehicle, on the other hand, the matter is not so straightforward: reducing the mass to the bare minimum by dropping below the limit stipulated by the regulations allows the ballasts (designed to make the vehicle "legal" again) to be placed in the most suitable positions for better overall balance and to lower the center of gravity of the vehicle itself.

In addition, in the most innovation-conscious sectors, additive manufacturing (better known as "3D printing") is spreading rapidly: this technology enables material to be placed where it is needed, making it possible to obtain shapes that would be unthinkable with classic CNC machining and thus contributing to the achievement of the least necessary mass.

In other areas, on the other hand, mass reduction does not seem to be a need felt by technical departments because "our machines don't move anyway and we've always done it this way". And if this is partly true, i.e. design carried out without paying particular attention to the masses involved does not jeopardize either the functioning or the quality of the product, it is also true that today everything must be conceived with a very careful eye to the ecological aspect. An extra kilo of steel, which is not strictly necessary for safety and functionality, creates a chain closely linked to energy aspects and therefore, ultimately, has an impact on the environment: more energy required to extract the raw materials (iron, alloying elements), more energy required to operate the furnace to produce the steel, more energy required to transport the material to the site of its processing, more energy required to handle the parts during manufacture and assembly, more energy required to transport the completed product to the place of destination and, finally, more energy for its disposal at the end of its life.

Here then that the simulation of the structural behavior of parts or assemblies that until now have been sized by "eye" and usually, to stay in favor of safety, with a generous eye, must today be used to reduce the mass, and consequently the environmental impact, to the minimum even in those sectors where this practice does not seem at first glance to be determinant for the product itself.