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On the Interest of Research in Building Materials

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For a private company like Lafarge, the first question to be asked is whether research in building materials is necessary. Past experience shows that innovation is probably one of the slowest processes compared to other businesses, due to the public's conservative attitudes (an old building is always perceived better than a new one), from the prescriptors (remember the joke about the civil engineer for whom two plus two must at least make five), or even from a legal point of view (if a problem occurs in a building containing a different material, the material should be blamed).

Not only is innovation slow due to conservative attitudes, but it cannot be incremented only by a building materials company. The full chain of business has to be convinced: the owner, the user, the prescriptor, the contracting firm, the professional bodies and institutions, the qualifying laboratories, and in the end the building materials company. The manpower involved has to be trained, and the sensitivity to external parameters, like temperature, moisture, local aggregates, and local practice has to be controlled.

The investment for a private company appears to be enormous, mainly because of the time of return and the increasing budget needed as each step is achieved. It may seem far easier to develop a follower strategy and to wait for the patent rights to extinguish as a significant business may take this time to develop. For this reason, many have stopped doing research and only carry out technical survey.

However, we believe there are three ways for research to be successful and improve the business of building materials:

1. Improve the existing products by "troubleshooting." One good example of improvement is the rheological behavior of concrete. The user's demand is fairly simple: to obtain a good flowability, stable with time before setting occurs. This means consistency, no bleeding, no stiffening (or very little stiffening) with time. It also means easy adaptation to the mixing and placing conditions.

   This work involves research in rheology definition (slump test is only descriptive and doesn't tell of the controlling action), particle size distribution, optimization, and admixture formulation. These parameters have to be controlled to limit the effect of temperature, moisture, mixing, and curing conditions.

   Also these parameters should be studied to assess their influence on the performances of the concrete and its durability. In the field of strength, a great improvement has been achieved over the last 20 years, the concrete design strength rising slowly from 25–30 MPa to 60–65 MPa in civil engineering work. The route followed is the "continuous" route on the path relating strength to porosity.

   Yet some question the durability, not of the concrete itself but of the structures, like "fume silica reacts with Portlandite to form further CSH, lowering the buffering effect of Portlandite for steel passivation," or "the more compact the concrete, the more brittle its behavior as cracks are not stopped in porosity as before." On everyday commonplace concrete—and this is our present business matter—there is still a lot to be done, in research as well as in technology. This route can be called the "homogeneity" route, as its purpose is to make a concrete containing as few defects as possible. For laboratory concrete, this route has already been successfully traveled with compression strength as high as 600 MPa . . . but on a very small volume only.
2. Recent research was organized at ACBM about new products with cross-breeding materials: the MDF, made of calcium aluminate and polymer is one good example of a breakthrough as the ratio flexural strength to compressive strength is now close to one. The oriented fibers in a dense matrix

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are another example of a breakthrough as the product shows nonbrittle properties, and a toughness regarded as an order of magnitude better.

This laboratory work has to be pursued, with a very long-term view as it will take time to find actual uses on the market. The research work has to focus on the product tolerance, by gradually making bigger samples and starting durability studies and qualification tests by technologists as soon as it appears possible. This second route, which could be called the breakthrough one, is appealing as it has a revolution within itself, and might bring everyone to reconsider building engineering. But it is like looking for the jackpot only. The "breakthrough" route cannot be sustained by one company alone, but has to be shared for better efficiency between the various possible actors, like it is done with the ACBM memberships, and yet has also to be subsidized by public resources.

3. The third route is to create in partnership a new solution to specific needs. Here the best example can be given by the French project, "New Ways for Concrete" led by Yves Malier (ENS Cachan) which brought together in 1986 30 partners from four owners, four firms in the material industry, five contracting firms, seven laboratories, two professional bodies and institutions, and two scientific associations. The objective was defined within its title, with four main ideas: (1) to ensure the best possible continuity between fundamental research, applied research, experimental structures, codes and development; (2) to associate the various aspects of new buildings/techniques/materials, designs, and construction methods; (3) to show the importance of "high performance" instead of "high strength," by improving ductibility, permeability, abrasion and impact resistance, resistance to frost, pumpability on long distance, etc.; and (4) to stress the fact that using high-performance concrete leads to improved durability.

   This project led to the construction of the Joigny experimental bridge, to study the Civeaux nuclear plant, and to create prestressed structures, a university building, another bridge (Ré), airport runways, and reinforced drainage networks. Such a network makes each partner progress by exchanging ideas from very different points of view, and can lead in time to true innovation, as nowadays innovation lies at the crossing point of different sciences and technologies.

As a provisional conclusion, it is obvious that tangible improvements, on a continuous basis or by breakthrough can be made, but still necessitate an important and steady effort, both financial as well as structural, to be able to make the most of the partnerships. This structural effort, of course, applies to academics as well as industries, and can be considered as the challenge of the future.