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THE ADAPTIVE INTELLIGENCE OF MALLORCAN DRY STONE WALLING

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Prologue: *THE DRY STONE WALLS OF MALLORCA*

I was fortunate to have been introduced to stonemasonry in the south of France, in an area replete with stone-built structures: there were houses and barns, outbuildings, boundary walls and retaining walls. Instructive examples of the stonemason's craft, good, very good and not-so-good, were everywhere, and there was plenty of work available transforming ruinous old farmhouses into rustic villas for Parisians and their ilk from elsewhere in Europe who were discovering the charms of life in the French countryside. I lived in a small village and worked as a stonemason for several years.

Then, I visited the island of Mallorca and found myself face to face with walls very unlike those I had been familiar with in France. Not the walls of the houses which were not that different from the walls of French houses, but the many retaining walls forming the agricultural terraces that so articulately modified the stony, hilly landscape. There was something, well, disturbing about these walls, but what, exactly? Eventually it dawned on me: The stones were not at rest!

In France I had learned to build in horizontal courses with jumpers between courses, to place each stone in a stable position, to form a stable mass. There, walls were generally built in this way, house walls or terrace walls, mortared or dry laid.

But in these Mallorcan walls there were no horizontal courses and the individual stones were set on their ends rather than laid on their long sides, placed vertically or diagonally rather than horizontally—except for the corners of the walls and the vertical columns that occurred at regular intervals in the body of the wall like structural parentheses.

If rectangular, the stones were oriented on the diagonal, herring-bone fashion, but the common stone shape was that of a polygon, in the case of fieldstones an irregular, even shaggy, rudimentary hexagon. Imagine, if you will, that roughly hexagonal, individual stones in the wall have the shape of a human torsos (some fat, some skinny.) What might then be referred to as the hips of one stone would be exerting pressure downward diagonally against the shoulders of the two stones immediately below it—just as pressure is being exerted upon it, upon its shoulders, by the hips of the two stones above it.

This is graphically apparent in the regular (or irregular) honeycomb structure of walls constructed with carefully tailored stones, but the principle is at work as well in rougher walls made with un-worked fieldstones that are more like angular ovals than polygons.

All those stones actively wedged together, pushing against each other, create a web of tension throughout the body of the wall. That tension, a cohesive force, infuses the mass of the wall and in so doing forms a stronger bulwark than mass alone against the lateral pressure of the earthen terrace behind it.

The instinctive intelligence at work here deserves respect—more than respect, admiration. Later, when Miguel Ramis made me aware of the interlocking arches built into the fabric of the terrace walls (or *marges* as they are known in Mallorca) and how they function to enhance structural stability, my admiration grew.

EQUILIBRIUM is a state of balance. Stonemasons, it might be said, are agents of structural equilibrium; the lesson this mason took from those Mallorcan terrace walls was that there are two types of structural equilibrium:

STATIC EQUILIBRIUM occurs in well bonded, horizontally coursed masonry with the stones laid in a stable position. It is an effective way to build and is adequate for house walls or free-standing fences where masonry has only to accommodate bearing weight. But when the masonry structure must resist lateral pressure, or is subject to earth movement either through subsidence or seismic upheaval, DYNAMIC EQUILIBRIUM serves best.

In houses and larger buildings, the two are often combined, for instance in the use of arches. A relief arch, incorporated into the fabric of a wall over an opening and deflecting the weight of the wall to the sides of that opening is an excellent example of a dynamic masonry element in a static masonry context.

Inertia, as it relates to construction, is the tendency to resist induced movement. Equilibrium contributes to inertia. Static style masonry accomplishes its work through the inherent inertia of its mass. Dynamic style masonry also possesses inertia, but inertia enhanced by the masonry being in tension.

The antecedents of contemporary Mallorcan builders evolved styles of masonry that served their various needs. In the thousands of kilometers of *marges* interwoven with ramps and roads and watercourses, we see the most ingenious manifestation of their instinctive technological savvy.

Landscape design professionals and contractors, stone masons and those who seriously pursue stonework as an avocation would all benefit from an understanding of Mallorcan style walls. ■

Tomas Lipps

MALLORCA

is the largest island of the Balearic archipelago in the western Mediterranean (at 1,405 square miles it's just slightly larger than Rhode Island, the smallest US state): Due to its strategic location Mallorca has been densely populated throughout its long and colorful history. The successful agriculture-based economy that evolved there made territory an important cultural issue.

The flatlands were obviously the most desirable areas and these were possessed by the most important families, the descendants of the noblemen who with King James I defeated the Moors and took control of the island in 1229.

The forests were slowly transformed into cultivated land by the landed gentry and the religious orders, especially the very organized Cistercians. Trees were felled, water channels, mills and cisterns built and the forests physically adapted to suit economic ends. The mountainous areas, with hardly any soil, remained wild. The poor people, called *roters*, (ro-TAIRS) started to establish agreements with the landlords. For the right to inhabit and cultivate a section of hilly terrain they would give the landlord half of what they were able to make the land produce—the practice known elsewhere as share-cropping. The wealthy landlords had nothing to lose, and the poorest people had the opportunity to scratch out a living.

Thus, the hills began to change. Retaining walls, called *marges*, tamed the stony landscape step by built step. Erosion was checked and the soil was held in cultivable terraces on which crops like olives, grape and onions were grown, produce that had been exported since Roman times. The Sierra Tramuntana is a mountain range in the northwest quadrant of the island; in this area alone over 10,000 linear miles of *marges* were built over time.

After generations of hardscrabble life the most resourceful and hard working *roters* had been able to earn the means to buy the land and the territory started to change from large estates to small farms or *fincas*. This social revolution was the by-product of the transformation of the natural landscape.

Once erosion is controlled, agriculture in the mountains becomes possible. Olive trees, fruit trees and viniculture brought a green overlay to the mountains. Greenery attracts rain, and rain abets the development of a successful agricultural economy.

The dry walls are a home for many creatures, snakes, insects, and especially *caracoles*, or snails, which were an important source of protein in the meager diet of the poor folk and are a delicacy still in Mediterranean cuisine. Even today, I remember my excitement, as a small child, putting on rubber boots after the rain and visiting the *marges* to "harvest" snails. Just after dusk is the snails' preferred mealtime and an hour spent patrolling the walls with a lantern could result in a bucketful of tasty food.

A scene from TSF's Dry Stone Walling Workshop in 2007. Mestre (Master) Biel Estela 76 years old, is assisted by workshop instructor Lluc Mir as Michel Giannesini works nearby and Donna Hasbrouck looks on.

Mestre Biel has been working with stone since he was 13 years old and building stone walls like this has become second nature to him. One wonders how conscious he is of the interlocking complex of arches that he is incorporating into the fabric of the wall—or is it instinctual? (See photo, right.).

Note the rudimentary but effective Mallorcan scaffolding which can be easily removed and repositioned. Two stout planks supported by two rebar rods inserted into crevices in the wall (the beer cans are safety measures).

The tightly packed infill of a dry stone wall forms an effective barrier to larger animals such as rats, rabbits and hedgehogs but in the event of a wall swelling or collapsing they can, and will, gain access to the spaces thus created.

One might think that rats and rabbits could happily install themselves below a wall's foundations, but this is seldom so, since a *marge* is essentially a drainage device for the water, therefore a very inconvenient place to establish a permanent home.

The last decades have witnessed an increasing trend for tight stone fitting. This was never traditional in the past. It is nothing a *marger* could not do, but simply illogical in terms of efficiency. Furthermore, smaller joints means the snails would not be able to house in the *marges*, thus blocking the possibility of gathering them.

To clarify: the *marges* we are concerned with here are countryside agricultural terrace walls which are related to, but distinct from tightly fitted walls that date from the XIX century. These were civil works, roadway walls built as specified during the reign of the Queen Isabel II. Those walls started a trend towards a style of construction that is essentially urban.

The Evolution of Skill:

Agriculture has always been a proving ground of the art of the stonemason. Using stone, and stone alone, to build mortarless walls evolved into a traditional building art form, the principles and aesthetics of which were passed from generation to generation of craftsmen capable of conceiving and executing more demanding and technical stonemasonry designs such as roadways, bridges, water channels and reservoirs, livestock enclosures, flooring, pavements and, ultimately, sculpture.

DISTINCT FEATURES OF A MALLORCAN WALL:

Dry Stone Walls, Polygonality and Arches:

In general Mallorcan *marges* are polygonal, comprised of pentagonal and/or hexagonal shaped stones. In rural walls stones are usually placed in the wall as they are found, with little or no shaping so they tend to be only rudimentary pentagons or hexagons. In more urban or formal settings the stones tend to be tailored to form more regular polygonal shapes.

As indicated in the detail of the photograph of Mestre Briel and, as can be seen in the other photographs, the Mallorcan *marge* is a complex mesh of many interwoven arches. In a well-built marge, most stones are surmounted by an irregular arch of other stones—and are themselves elements in one or more other arches.

With rectangular coursed stonemasonry, if a stone is taken out of the wall, a natural corbelled arch is formed by the stones in the courses above it. With polygonal masonry, what you get is a true arch formed by three or more stones. The wall would not even notice the missing stone since the arch will be in tension. Because the ground under a wall tends to subside here and there over time, especially after heavy rains, the arches embodied in the wall enter into tension; so a polygonal wall can withstand the movements better than a rectilinear wall due to its inherent tensile strength.

The arch is one of the strongest and most efficient building forms so it is no surprise to discover that they are integral to this walling system.

Non-Horizontal Coursing:

The stones are placed vertically instead of horizontally. In the event of the foundation sinking, the dry laid stones adjust, find new positions, obey gravity, work like wedges. Tensile strength is gained, not lost. In a horizontally coursed wall, a subsiding foundation immediately causes a loss of tensile strength that can never be regained.

It is no wonder in Japan and Peru, areas subject to earthquake, a polygonal wall system evolved. The Mediterranean historically is also a seismic zone, so the technique could well be a universal anti-seismic solution.

Paret en sec versus Paret en verd:

In Majorca there is a clear distinction between the *paret en verd*, a horizontally coursed house wall built with lime and earth mortar and designed to take top-to-bottom bearing weight, and the *marge*, a dry wall with non-horizontal courses designed to withstand the lateral pressure of the earthen terrace behind it.

Capginyas:

The *capginya* is a vertical column of sizable stones placed at regular intervals within the *marge*. This simple and effective design is, in fact, an integral pilaster or in-built corner that in the event of a collapse on one side, limits the damage and sustains the other side until the repair is made.

The Backfill:

The backfilling uses 100% of the spalls, chips, rubble and otherwise worthless stone to occupy the space behind the external face of the marge. So the dry stone wall absorbs all the scraps; nothing is wasted (unused wall stone is removed or neatly stacked nearby for future use.)

The spalls are not just thrown in, but carefully placed, even wedged with a hammer (or with another stone if the hammer is not to hand) in order to create tension throughout.

Here and there at the back of the *marge* a second wall is often built, the braó. This is a way of using the round boulders that would require too much energy to shape. The *braó* ("biceps" in the Catalan language) is a "muscular" reinforcement, a parallel wall section that augments the inertia of the backfilling and helps to withstand the lateral pressure of the terrace being retained.

Coping, Capginyas and Corners:

When the *marger* begins to work, he normally spends a day shaping the stones and placing them in three piles: the larger ones are saved for the corners, capginyes and coping, the largest for use in the first course. Those remaining will be used in the body of the wall. A typical mistake for beginners is to use the stones as they come without saving large stones for the coping or corners. The result is an ugly wall with very small stones at the top and inadequate corners.

There is very practical logic in differentiating stones by size: it is inefficient to lift a big stone higher than hip level. The place for such a stone is at the bottom of the wall, where it is most needed.

Through-Stones:

Ideally the tails of stones should extend deep into the back fill,"length in," as they say in the UK and Ireland. In general, the front face of the stone, which is seen on the outer surface of the wall, should NOT be the largest face. Since this is not always possible, at least one stone in four or five should be a through-stone,

one that extends from the face of the wall well into its body. The increase in the use of mortar to build *marges* is regrettable and has made it possible to break this basic rule and diminishes the integrity of mortared walls.

Freestanding Walls,

These structures, usually perimeter or boundary walls, are generally wider in proportion to their height than *marges*. Why does a freestanding wall need to be so wide if it is not working to retain earth? The answer is utilitarian; the countryside freestanding wall is not just a boundary wall, it is also a way to store stones cleared from the fields. (see *claper* below.) On the neighboring island of Minorca walls are nearly a foot wider than in Mallorca; one reason for that is there is a lot more fieldstone in the soil there. Another reason is that the most common livestock in Mallorca are sheep, but in Minorca there are more cattle and a thinner wall could be damaged by the larger-bodied cows.

Claper

This is another type of dry stone structure, a circular, sometimes oval, dome-like cairn of stacked field stones. Its purpose is to clear the arable land and it is designed to occupy the smallest possible amount of soil. The *marger*, usually the land owner/farmer, incorporates empty spaces within the *clapers* and tunneled entries which invite rabbits to make dwellings inside, thereby providing another source of protein by hunting or snaring them in the future.

In places endowed with an excessive amount of stones, instead of domes the *clapers* are made like irregular stone vaults, about 12 inches high, weaving between the olive trees, one of the few plants able to thrive where soil is scarce. The *claper* then acts to moisten the earth, condensing the dew and the mists and preventing the moisture from evaporating into the air. At the same time this insulates the roots beneath the stones, preventing them from being overheated by the sun.

Rutló:

The *rutló*, an indented space that interrupts the plane of a marge that is a good example of the "savvy" of the farmer/dry stone waller. As any agriculturist knows, a tree that is "born" naturally is always stronger and grows quicker that another planted by man. That is because seeds thrive only at places where the conditions are the best. So when the *marger* builds a wall and finds a small tree, instead of unrooting it, he modifies the design of the *marge* by creating a *rutló*, a semicircular "cove" that interrupts the wall plane order to give it a better chance. The stones will retain the moisture and, in winter, capture the solar heat to warm the soil.

At other times the *marger* incorporates a *rutló* in the wall because has spotted a deposit of fertile earth which, if covered by the *marge*, would be unproductive. The *rutló* enables the marger to plant a tree here and at the same time avoid an unstable foundation as the softer earth might subside beneath the weight of the wall and lead to its collapse.

A capginya, that has successfully fulfilled its function.

Dry stone ramps bridging levels of dry stone terrace walls

The Stone:

The types of stone available are crucial to the development of dry wall technique. The Balearic Isles are home to several varieties of excellent limestone of moderate hardness (5.5-6.5 on the Mohs scale) which respond truly to the tools. There is no need for carbide tools, good carbon steel is enough.

There are other even more workable stones available; in the southern part of the island there is a type of sandstone called *marés* that is so malleable it can be shaped with an axe or sawn.

There are no "beautiful" or "ugly" walls in a well-crafted traditional wall, just different designs answering to different environments and materials. Traditional stone walls have to be considered within their context and are generally the most clever, evolved, appropiate local answer possible.

The Mallorcan Hammer

is the local answer to the Swiss knife design, a versatile tool that makes hammer-and chisel work unnecessary. The shape of the Majorcan hammer is an untouched Roman design, 2000 years old.

Its most distinctive features are a square head at one head with a concave depression in the center and—at the other end, a point. These effectively transform the hammer into an array of several tools.

Instead of a hammer head, what you have in fact are four chisels or, better said, four hand-sets. Using only one hand (or two if a stronger blow is required) the *marger* strikes the stones with precision using either left and right sides of the hammer face, or the bottom or top edges. Striking the top edge of the stone with bottom edge of the hammer endangers one's fingers and requires some care, as one quickly learns when doing this.

The other end of the hammer does the work of a point chisel. Its curved shape follows the arm's natural swing movement, hitting inward towards you like an adze, instead of the outward movement of the pointer and chisel work.

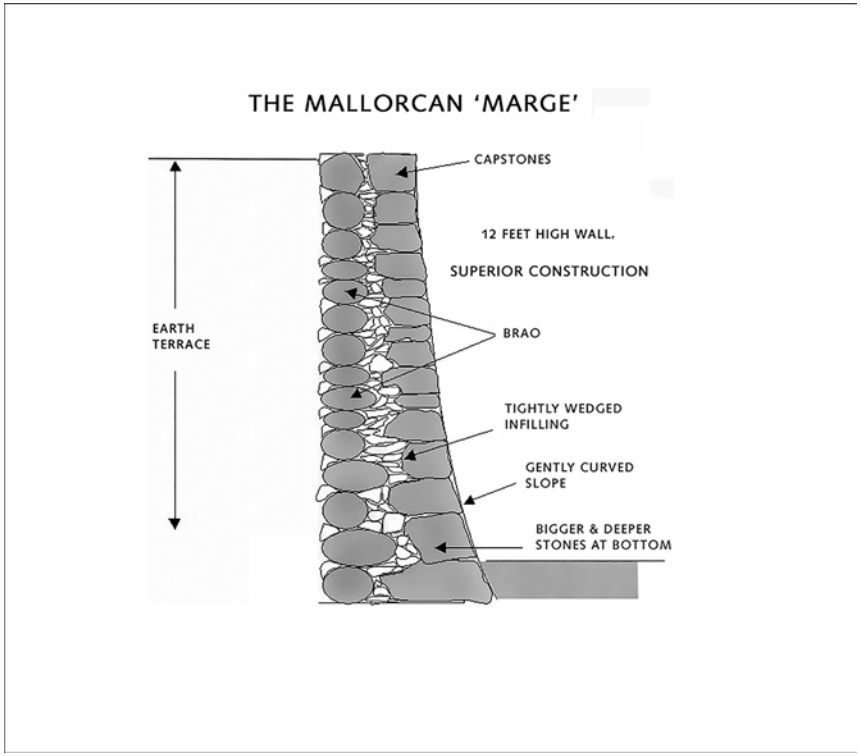
The weight of the hammer is more important than the strength of the arm wielding it. The arm remains relaxed, using only enough energy to lift and launch the blow. Mass and momentum do the work.

If you study the depictions of medieval stonemasons you realize that almost all work (including mouldings) was done with picks and pointed hammers. The hammer and chisel technique was used more for detailed sculpture carving.

Our traditional Mallorcan tools, which evolved from Roman designs, follow this rule. The curved saw with the backwards orientation of the teeth allows you to cut wood by pulling instead of pushing, using the weight of the body. Other traditional Mallorcan tools utilize the same principle: the curved sickle to cut the grass, the adze of the boat-maker, the triangular shovel/hoe used to move earth and rubble. The reason is that you work more efficiently with biceps and pectoral than with shoulder and triceps. The use of these muscles allows you to work longer and tires you less.

Visualization:

The most important tools for any stonemason or waller are a sense of spacial visualization, and an awareness of the relationship of forms and the disposition of force.



The Energy Equation

In terms of results gained from energy expended, the *marge* is a very practical enterprise.

A rustic *marge* can be built at a rate of nine or ten square feet per day and it will last a minimum of 50 years without any maintenance work.

A collapsed section of a wall is normally twelve to seventeen feet wide at most, which means that it can be rebuilt in one or two days since the stones are already shaped and on site. Walls typically collapse in winter, in the rainy season, a time when the farmer conveniently has no urgent jobs to do.

So, as a matter of agricultural routine each generation dedicates a couple of months per year to the building and repairing of dry walls, usually in the winter. It was in essence a part-time job for the farmer and something a shepherd could do 'on the side' as the sheep grazed.

Economy of Style. . .

The less the stones are "tailored" (from the French, *tailler* 'to cut'), the more natural the wall appears. On a Mallorcan building site, an old experienced master waller, even if not seen, can be recognized by the quieter sound of his smaller and rarely-heard hammer causing minor adjustments. He visualizes the stone needed to fill a space in the wall, then locates it in the pile. He finds rather than "makes" the stone. Less effort, quicker work.

Muscularity. . .

The dissipation of muscular strength during the life of a *marger* can be ameliorated by a more efficient use of force. An old master can easily keep up with a younger *marger* even above the age of 60-70 years. Those who participated in the 2007 dry stone walling workshop know this from watching the 76 year old "Mestre" Biel at work. (see photo page X.)

The Team. . .

The ideal team is comprised of 3 persons, a master, a younger master and an apprentice/helper. The master directs the job and, with or without words, teaches the young master the different subtle ways of facing each technical problem. The young master lifts and places the stones; the master only fits them. The young apprentice breaks the stones, brings them to the wall to be placed and provides the backing. The young master does the hard job, the apprentice the hardest. The master does the lightest work, but he is the one able to speed up the job by selecting the right stones at each moment.

An old dry stone waller once told me "every stone is useful." For a basic dry stone wall you hardly need to shape any stone. There's a place for every stone and a stone for every place if you have "the eye." It is a pity to spend time and energy shaping a stone when one that would work is there to be found.

There are lessons to be learned when dealing with vernacular building techniques; purposeful reasons underlay traditional procedures. Attentively considering these will make better artisans of us, proud, conscious and appreciative of this great gift—the heritage of the old masters. ■

Edited for clarity — T L