**The Italian engineer Paulo Nervi started his experiments with ferrocement in the early 1940's and continued his experimentation after WW II and during the 1950's. When he published his ideas during the 1950's interest in "ferrocimento" became widespread.**

**Builders that use the Nervi method to make a ferrocement structure start by making a "basket" or "form" of small diameter steel rods. They then tie several layers of steel mesh to each other and to the rods to complete an armature of steel reinforcement. When the armature is complete cement mortar is forced through the densely packed mesh. When the mortar has cured the object is ready for surface finishing. This traditional method of building in ferrocement is highly labor intensive and unless very carefully supervised is likely to produce a structure in which the reinforcement is not completely encapsulated. The latter problem is due to difficulties in getting the cement mortar through several layers of tightly tied steel mesh.**

**During the late 1960's Martin Iorns and his business partner Lou Watkins, developed and patented (1972) the procedures that are now known as laminated ferrocement (LFC). This method uses an approach opposite to the Nervi method of building the ferrocement structure. In LFC a mold is made to embody the shape of the product. Cement mortar is placed on the mold. Each individual layer of the steel reinforcement is then pushed,layer by layer,into the soft mortar to embed the mesh. As each layer is embedded, pushed, into the soft mortar it is covered with additional mortar. No ties are used. The steel reinforcement is all mesh. Reinforcement rods are normally not used in the structure unless specifically required (at edges for instance) by the structural design. The process is rapid and difficulties with encapsulation disappear. .**

**Iorns' and Watson's own business,which was located in West Sacramento, California, focused on marine related structures, boats, dry docks, pontoons, barges. Their patent pertained to marine related structures only. However, the LFC technique has been used on land as well as on water, and has also been used in both industrialized and less industrialized parts of the world. The most recent notable example of the use of LFC wss in the fabrication of the "leaves" for the ceiling of the Menil Family Art Collection building in Houston, Texas.**

**LFC requires: 1) a mold on which to spread the cement mortar that will be the matrix for the reinforcement; 2) a release agent on the surface of the mold; 3) a mortar that will become water impervious and so protect the reinforcement; 4) steel mesh reinforcement material; 5) tools to push the steel mesh into the mortar and to spread and smooth the mortar over the final layer of reinforcement. The mortar may be spread by hand or by using spraying equipment. Curing procedures are the same as the earlier ferrocement curing procedures.**

**The advantages of using the lamination technique are:**

**1) radical reduction in the amount of labor involved in fabrication by the elimination of tying together multiple layers of steel mesh**

**2) simplification of quality control issues by placing each individual layer of steel mesh into the wet mortar instead of forcing wet mortar through multiple layers of mesh**

**3) reduction in weight of the product due to the reduction of the thickness of the product. This is a consequence of the elimination of the rods needed to support the reinforcement mesh during fabrication**

**4) the amount and location of steel reinforcement can be varied to precisely meet the stresses anticipated in the design. No allowance is needed for structure to**

support the mesh during fabrication

5) the lamination technique allows the builder to construct separate subunits of the final structure then join them with laminations into a unified whole.

Strength in ferrocement is closely related to the volume of steel reinforcement in a given volume of the product. By using the LFC technique, which defines the shape of the product with a mold instead of with rods,a structure can be built in which the steel reinforcement will be used most efficiently.

Use of reinforcement rod in a ferrocement structure can have a negative effect on the strength of the structure. Stresses in the structure get concentrated along the rods, which leads to cracking and failure of the mortar along the line of the rods. More effective use of the weight of the rod can be achieved by adding an equivalent weight of steel mesh to the structure. Conversely, the structure may be made significantly lighter but of equal strength by eliminating the rods and the mortar necessary to cover them. The weight savings cascade throughout the design.

Because LFC was developed under the protection of United States patents, knowledge of this procedure is not widespread. Iorns' and Watson's patent applied to marine related structures only. The United States patent office noted that prior art eliminated the patenting of terrestrial uses of LFC. In any case, that patent has now expired and should no longer serve as a deterrent to using the lamination technique.