First off, it should be said that Portland cement can be a wonderful material. Often, particularly in the preservation community, Portland cement is described as an evil material and the world would be a better place if only lime were used. Of course, lime is a wonderful building material, one that offers numerous benefits for the environment and for historic preservation, but many of our great buildings of today could not have been realized if not for the use of Portland cement. However, for the context of historic preservation and for buildings that were built with lime mortars with no cement, Portland cement can be a harmful and dangerous material.

Portland cement was patented in England in 1824 by a bricklayer named Joseph Aspdin, who named it based on its resemblance in color to the stone from the Isle of Portland. The process (although more controlled and standardized today) remains in essence the same. Limestone and clay are mixed together, pulverized, and burned to form a clinker. This clinker is then ground to a powder to make cement. The first known shipment of English Portland Cement was in 1868; however, shortly thereafter David O. Saylor began producing American Portland cements in Copley, PA. So, if your building was built prior to 1868, you can guarantee it was a traditional mortar, and prior to the 1880-1890s there is a strong chance that it was built without Portland cement. Between 1880 and 1920 you may find various combinations of lime and this early cement, and after 1920 you begin to see, ever increasingly, more mortars that are very comparable to what we use today. Having said that, you can also find buildings built into the 1950s and 1960s with traditional lime mortars with no cement additions whatsoever. Another material that should be mentioned as well is the Natural Cements that were produced throughout the United States in the 19th century. Natural Cements in a way combined these two technologies. These cements were produced by taking limestone that was infiltrated with aluminates and silicates (much like Natural Hydraulic Lime) and burning this raw stone in a kiln to produce a highly hydraulic clinker that would not slake. Therefore, the resultant “quicklime” was ground to a powder to produce cement. There is still Natural Cement production in the world today. In fact, the Vicat factory near Grenoble, France produces their Natural Cement “Vicat Prompt” in the same kilns from the 1870s.

Now that we’ve got our history lesson out of the way, and you’ve got a better understanding of how these materials came into use. Let’s talk about why they should not be used to repair over traditional masonry built with pure lime mortars. The first issue to discuss is the inability of cement to transfer moisture throughout historic masonry. Historic buildings built with lime mortars were built with multiple wythes (or layers) of brick. The porous nature of the masonry allowed moisture and water to come in, but due to the sheer mass of the masonry, the moisture would not make it all the way through the wall. If by chance it did, the breathability of the lime plaster and traditional paints would filter this water into the structure in the form of vapor. When moisture travels through masonry, it travels through the path of least resistance, which would commonly be the mortar joint. When that path of least resistance is closed (as is the case with Portland cement repointing over lime mortar) two things can happen. First, is that the moisture will look for a new mode of transportation, which is often the brick themselves. The brick begin to retain this moisture and puts the masonry in a less stable state, one that can be venues for soluble salt formations and/or freeze thaw issues. Both of these situations can

cause deterioration of the brick or stone causing accelerated and irrevocable decay. Second, the original mortar retains moisture which causes damage to the mortars integrity. One of the benefits of lime is its ability to "heal itself" or its property of autogenously healing. If a traditional lime mortar develops small cracks over time, water enters the crack and the "free lime" goes into solution. This lime is then drawn to the surface and is deposited where it carbonates, healing the fissure. However, when a traditional lime mortar has a more modern impermeable surface pointing (or stucco, paint, etc.), problems arise.

Moisture is going to find its way into the building, whether through the foundation below grade or the softer masonry units themselves. When this water enters, it can't find its way out, which often leads to saturation of the wall's interior. The free lime then goes into solution and begins to migrate outwards. This leaves a far weaker mortar holding the building together, and, in most cases, the mortar will have deteriorated to the point of failure. Often when you remove a piece of Portland cement repointing from a historic structure, the interior mortar appears to be only aggregate or sand, and one can only think, "What kind of mortar is that!". But if you were to scrape past the "sand" you will frequently find that the mortar behind is in relatively good shape. To fix this problem, remove any deleterious material and re-point with a traditional lime mortar.

In the 1990s a group in England comprising of Jeanne Marie Teutonico, Iain McCaig, Colin Burns, and John Ashurst did a series of mortar trials of various mixes and published their findings in "The Smeaton Project: Factors Affecting the Properties of Lime-Based Mortars." Among their findings was that even a small amount of Portland cement (less than 25%) can have a negative effect on the mortar's strength and durability. Although mixes with more Portland cement (greater than 25%) do offer increased durability and strengths, its decreased permeability of water vapor, hardness, and other properties render them inadequate for use on historic properties. In essence, what happens is that even though you may get an early initial set with adding a small amount of Portland cement to your mix, the dense hydraulic matrix of the OPC (Ordinary Portland Cement) cuts off the natural carbonation that gives lime mortar its strength, resulting in a weaker, less durable material. Because of the lack of carbonation that takes place, the mix (whether in the form of mortar or stucco) will not absorb the same amount of carbon dioxide, which is important when trying to "build green."

When working with traditional lime mortars it is possible to have a whole range of strengths, set times, etc. by using lime putty or hot mixed mortars, natural hydraulic limes, and in cases where high strength is needed, Natural Cements. It is unnecessary to feel the need to add Portland cement to the mix. If the mortars have worked for over 6,000 years, they should work for you too.