Early Pigments to Designer Paints

Paints are used for three primary purposes: to protect surfaces, to perform a special function (such as to reflect infrared radiation), and to serve as decoration. The major paint categories we know today can be classed as inorganic or organic. Typical paints have an average film thickness of approximately 50 to 75 microns. Paints can be more durable than some metals having the same thickness.

Caves in France and Spain have paintings dating from 17,000 BC. The earliest known pigments were derived from natural ores such as iron oxides, clays, manganese oxides, and charcoal.

At about 6,000 BC, the Chinese also used natural ore pigments, but supplemented them with calcined (fired) blends of organic pigments and inorganic compounds. They mixed these pigments with binders made from gum arabic, egg white, gelatin, and beeswax.

The Egyptians advanced the art of making paints by using pigments made from a mixture of dyes. They typically used indigo for blue pigment and madder for red.

In Colonial America paint was considered a luxury and a mark of wealth. As the lower and middle class typically lived in unpainted log houses or hand-sawed wooden homes, a painted house denoted an air of richness.

Not until the 18th century did Europeans, using linseed oil, discover that by adding zinc oxide as a pigment a durable white paint was formed. This resulted in an immediate rapid expansion of the paint industry.

Linseed oil was pressed from flaxseed and had the additional benefit of being a "drying oil." Catalysts such as oxides of lead, magnesium, or cobalt were added to heated linseed oil to quicken the hardening and thus were called dryers. The linseed oil was cooked in iron or copper kettles. Much myth surrounded the cooking process, and individual paint makers had their own closely guarded secret for combining the ingredients. The limited knowledge paint makers retained was handed down from generation to generation, usually by word of mouth. For all practical purposes, no technical advancements in the science of paint were made until the mid-19th century.

In 1804 the first white lead paint factory in the U.S. opened in Philadelphia. However, the first ready-mix paint did not appear on the scene until around 1867. These paints were often poor in quality, with variations occurring from batch to batch.

In the early 1900s the paint industry took a radical step and started hiring chemists to investigate how to make a good, robust paint. By 1914 a small group of production engineers and chemists met to exchange knowledge about paint manufacturing. Out of this grew the first high quality development of standards.

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By 1930, paint makers developed quick-drying, resin-emulsion, water-thinned paints. Latex paints were developed in the 1940s for home and industrial use, and the industry rapidly expanded.

The use of synthetic polymers as binders and synthetic pigments in the 20th century spun off a new wave of development. Advances in the understanding of the physics and chemistry of paints allowed manufacturers to target paints for specific applications, such as to aid in preventing pitting corrosion, galvanic corrosion, exfoliation corrosion, stress corrosion, corrosion fatigue, thermal embrittlement, fretting fatigue, oxidation, hydrogen embrittlement, weathering, and fungus growth.

Paint consists of four parts, a binder (commonly called a "vehicle" when used with a solvent), a pigment, a solvent (or thinner), and additives. The binder consists of oil or resins, or a blend of oil and resins, and acts as a vehicle (usually dissolved in a solvent) that dries to a tough film. The binder actually *binds* particles of pigment together to the surface, and has the properties of good adhesion to a substrate and certain mechanical properties such as hardness, flexibility, and toughness.

Pigments are small particles that are inert and insoluble in the vehicle. They may be "hiding" or "non-hiding." Hiding pigment provides paint with its color and usually hides the underlying surface. In addition, it may inhibit corrosion or may function as a fire retardant. Non-hiding pigments, also called extenders, give the paint a decreased permeability, and may act as a bond for additional coats. Solvents typically evaporate after the paint is applied, allowing the film to evolve from a low viscosity liquid to a hard shell—although polyurethane-based paints can be designed to be hard or soft by varying the molecular weight of the polymer.

Additives—including dryers, fungicides, and wetting agents—are used in relatively small proportions to create specific characteristics.

The manufacture of "designer paints" has resulted in a complex technological infrastructure. These designer paints can be targeted for specific applications, and are created by using sophisticated design techniques such as numerical modeling. For example, silicone binders can be custom designed for coating high temperature items, acrylic binders for missiles, and phenolic binders for military bridges.

More conventional uses, such as paints for the centerlines on highways, are also designed for a specific purpose and would be almost useless if used on any other surface. Paints used on highways must dry rapidly, retain their color and be easy to see both in daylight and darkness. In addition to their suitability for asphalt and concrete, they must resist erosion effects of tires, chains, salt, snow, rain, and sun.

The trend toward even more tightly designed paints will likely continue, keeping up with the multifacets of our technological environment and the growing diversity of paint applications. So the lines on the roads and other innovative paints of today may go the way of the past use of linseed oil and beeswax, which no longer satisfy societal needs.

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FOR FURTHER READING: Dean H. Parker, *Principles of Surface Coating Technology* (Interscience Publishers, New York, 1965); and L.A. Tysall, *Industrial Paints: Basic Principles* (Pergamon, New York, 1964).