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## Paper Degradation: I

*As further proof that I have too much time on my hands, I happened to be thinking about what the average life expectancy is of covers (!). Hoping to find some sort of chart giving the average expected life spans of various paper products, I searched the internet and was surprised to find quite a few studies on the life expectancy of paper. Although none hazarded such a chart (because of the unpredictable variables affecting such), and none dealt with cardboard, in particular, I did learn some things, as well as finding scientific verification of some other observations already known to collectors simply from experience. Mind, I'm assuming here that what the studies say about paper applies cardboard, as well.*

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The American Society for Testing and Materials (ASTM) has administered a five-year research effort into the aging of printing and writing papers.

Paper ages more rapidly in stacks than in single sheets. This appears to be caused by the buildup of acids that are products of decomposition within the stack. These products cannot easily diffuse from the stack, whereas some of them are sufficiently volatile in the free sheets that they can evaporate away from the paper. It is well demonstrated that acid hydrolysis (shortening) of the cellulose fibers is the major cause of paper degradation. Thus the more acidic the paper becomes, the more rapid is its degradation. *[Ed. That would seem to raise the question re the wisdom of keeping covers in tight stacks for long periods (i.e., years). Few, if any collectors, I would think, keep covers in vertical stacks for such long periods, but what about horizontal stacking, as in drawers and trays?—Most of us do that! My own Towns and Zip Code collections immediately come to mind. There are too many of them to house in albumed plastic pages, so I have them stored in trays and boxes. Hmmmmm! Also, while I'd be very surprised if there would be any noticeable damage within my lifetime, what about the preservation of covers for posterity?*

In natural aging, daylight is more damaging than artificial light in the early stages of aging. Additionally in natural aging, all papers reach a limit beyond which loss of optical properties ceases. The papers remain optically stable thereafter.

In a minor way, color and brightness properties of the paper are affected by humidity change. An unexpected finding of the light aging work was that all papers (including those of pure cotton) suffered measurable strength loss over the extended time of natural aging. Almost certainly this was primarily caused by the photochemistry created by incidence of light on the paper surfaces. This finding has significance to libraries and archives that are entrusted with the keeping of valuable documents over very long periods of time. It provides additional emphasis to the need to prevent such papers from exposure to bright light for extended periods.

Even after exposure to the highest concentration of pollutant gases (one thousand times the amount found in an office space in a polluted urban environment), there was only very small loss of paper strength. The most sensitive strength test, fold endurance, was the only parameter which showed this loss of strength.

Color change was another matter. When lignin-containing papers were exposed to oxides of nitrogen, they darkened and turned very yellow.