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## IN THIS ISSUE:

- 7** Spotlight: John Massey
- 13** Practical Solutions for Improving Problem Solving
- 21** The Process of Drying and Curing Inks and Coatings
- 31** FESPA Mexico
- 35** Controlling Synthetic Polyester Dye Sublimation and Migration
- 43** Terminology
- 45** Article Index
- 50** Final Thought
- 53** Quote of the Month

### Article Submissions Welcome

Screenprint Magazine is an essential source of knowledgeable information for the screenprinting technologies. Articles are written by industry experts, covering a wide variety of topics of interest to readers.

Submitting articles for Screenprinting Magazine provides an excellent opportunity for exposure to screenprinting globally.

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## OUR MISSION

To relentlessly pursue opportunities to empower our readers with knowledgeable and truthful information that can be trusted.

We see our readers as essential to our existence. We listen to what matters to readers and help them lead a meaningful, healthy life on the reader's terms.

When things get hard, as they do – we will be there to see our readers through.

Our team realizes our responsibilities as problem solvers and connectors. We are passionate about helping others create a voice for our readers' needs.

We harness data, processes, and technology to provide high-quality knowledge to as many needy people as possible. We build relationships to drive positive outcomes for the readers we serve.

## OUR VALUES

**Integrity**—We are true to our readers, acting openly and truthfully in all situations and making ethical choices.

**Grit**—Persevering with courage and resolve to exhibit character in making decisions that positively affect others.

**Faithfulness**—To honor our legacy in staying grounded in what matters and doing the right thing for all concerned.

**Connection**—Creating and conveying trust that genuinely puts our readers first. We champion collaboration, partnership, and community.

**Belonging**—Every team member is involved with the screenprint technologies daily. We each care significantly about others. We stay true to the industries that have provided us with our livelihood.

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G. William Hood  
Publisher

In this issue, we cover time-based issues. First, we have the most profound article (Page 34) on controlling synthetic polyester dye sublimation and migration by Rick Davis, who began his career as a textile screenprinter in 1976. We created a companion podcast specifically for this article, featuring a Deep Dive into the subject, which explains the process in more detail than the article. It can be viewed on YouTube at <https://youtu.be/xeipkistLeQ>. Let us know what you think of the Deep Dive Podcast and if you want to see more.

Be sure not to miss the article The Process of Drying and Curing Inks and Coatings (Page 21). In the article, readers will learn the difference between temperature and thermal energy, which are necessary for a deeper understanding of how to avoid problems of over- and undercuring inks, plus a lot more!

The article Practical Solutions for Improving Problem Solving (Page 13) will assist in finding solutions for almost any problem that is encountered. It is perhaps not surprising that we each make some 30,000 decisions a day. Granted, some are extremely small, such as hitting the snooze button on the alarm or not, and can be quickly resolved. But what about those decisions that cause production or revenue to fall below our expectations?

FESPA de Mexico is approaching, and we are in the last weeks of FREE registration. You will not want to miss this expo, as the cost can be a total write-off on taxes for many owners. We hope to see you at the show September 25-27!

May all your impressions be great!

A handwritten signature in black ink, which appears to read "Bill Hood".

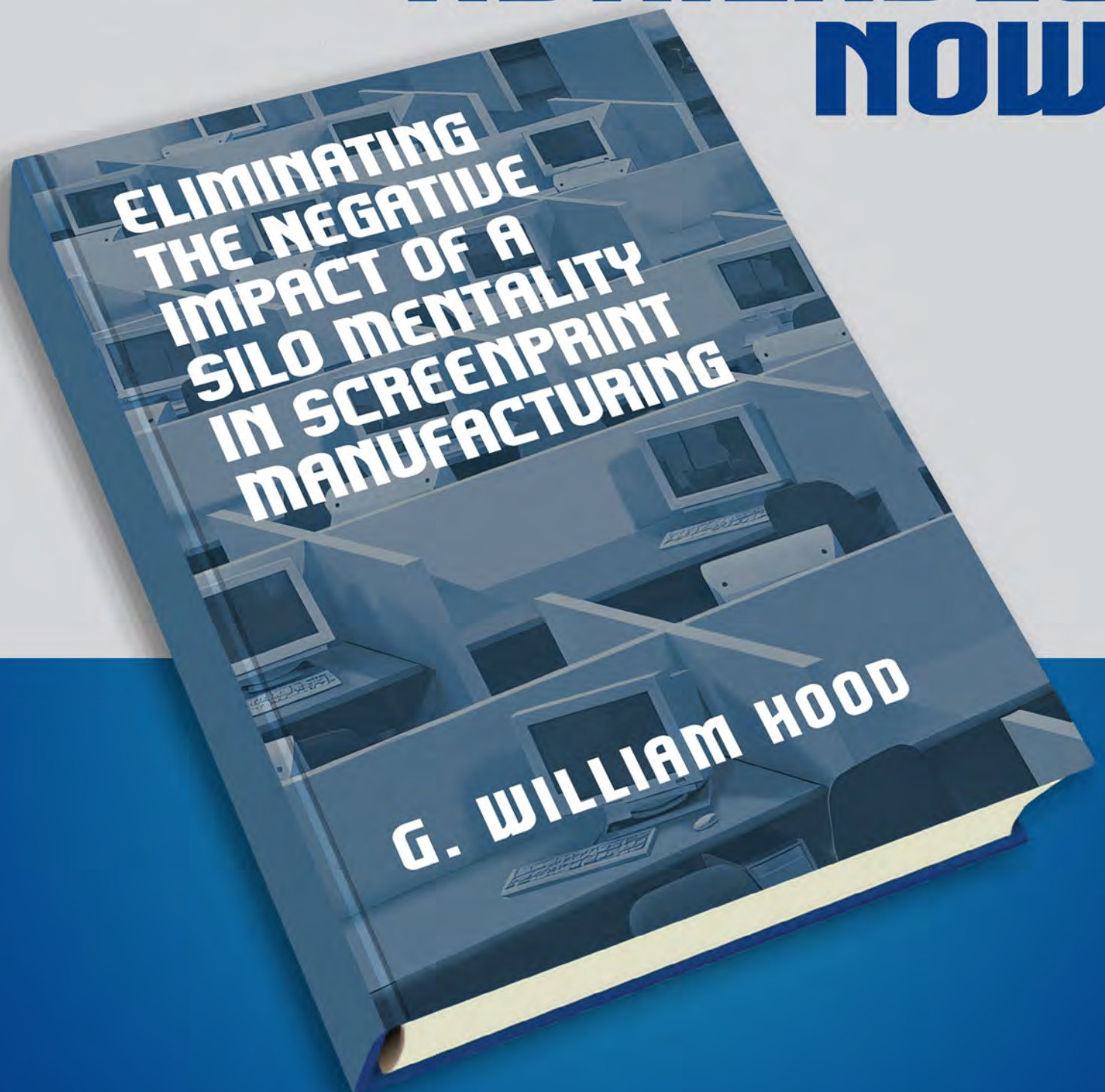
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**John Massey**  
**Designer - Serigrapher**



Poster for Shedd Aquarium, Chicago, 1966

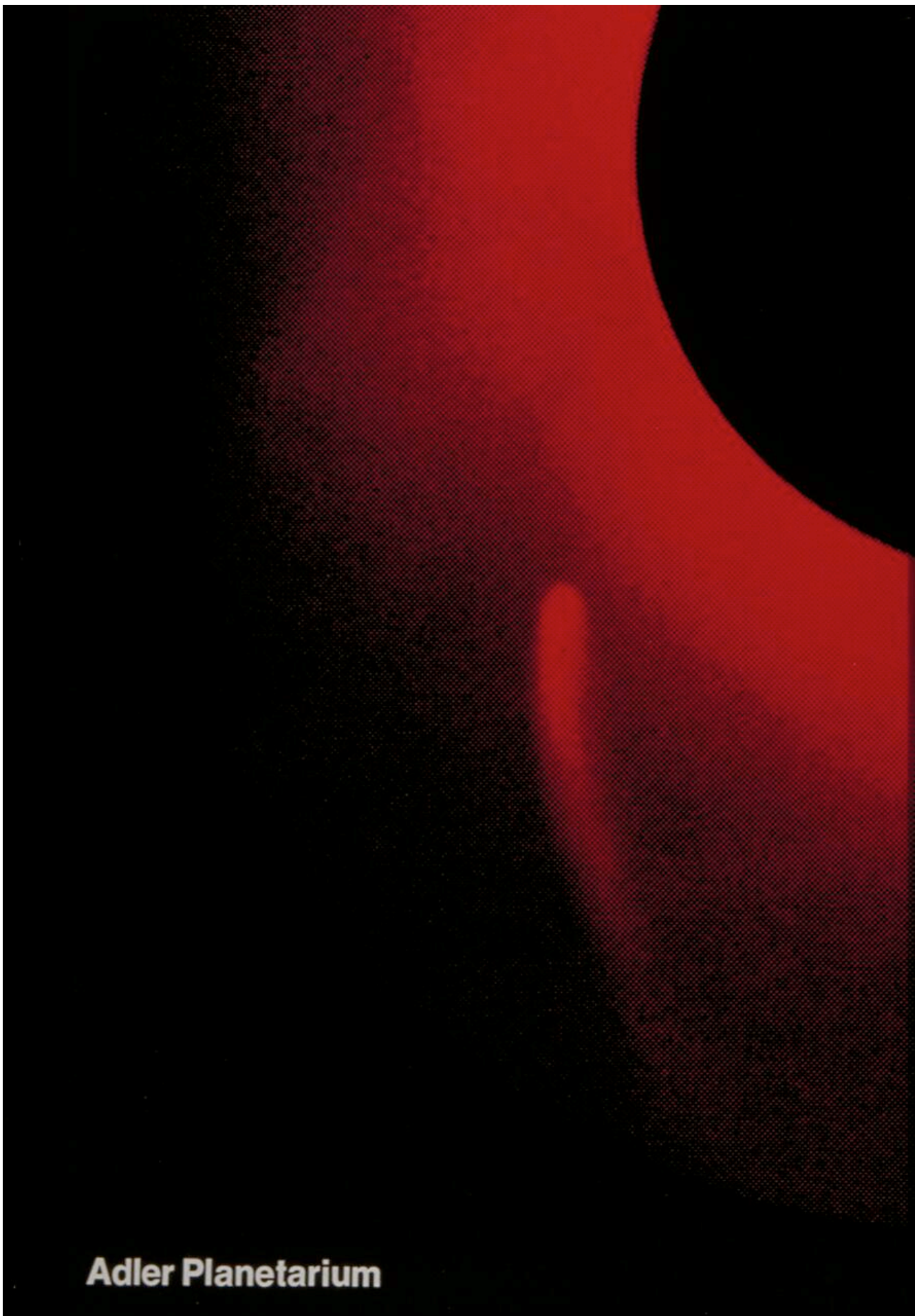
**J**ohn Massey (1931–2019), a Chicago-based graphic designer and serigrapher, significantly influenced modernist design, blending principles of the Bauhaus and Swiss International Style. Massey was born in Chicago, Illinois, in 1931.

After graduating from high school, Massey studied at the Chicago Academy of Fine Arts and received a BFA from the University of Illinois at Urbana-Champaign in 1954. His early

exposure to the young, Basel-based Armin Hofmann and Zurich-based Josef Miiller-Brockmann, whom he met as a student intern at the International Design Conference in Aspen in 1953, profoundly influenced his minimalist modern designs and approach to geometry, abstraction, scale, asymmetry, texture, white space, and the restrained use of modern, sans serif typography.

After graduating from the University of Illinois, Massey found-

ed his design firm in Chicago. Two years later, in 1956, he accepted a job at the University of Illinois Press, where he worked under the direction of Ralph Eckerstrom, co-founder of Unimark International. Eckerstrom became director of design at Container Corporation of America, and he invited Massey to join him there in 1957. Container Corporation of America acquired Massey's practice and established a separate division, the Center for Advanced Research in Design. After Ecker-



Poster for Adler Planetarium, City of Chicago, 1960

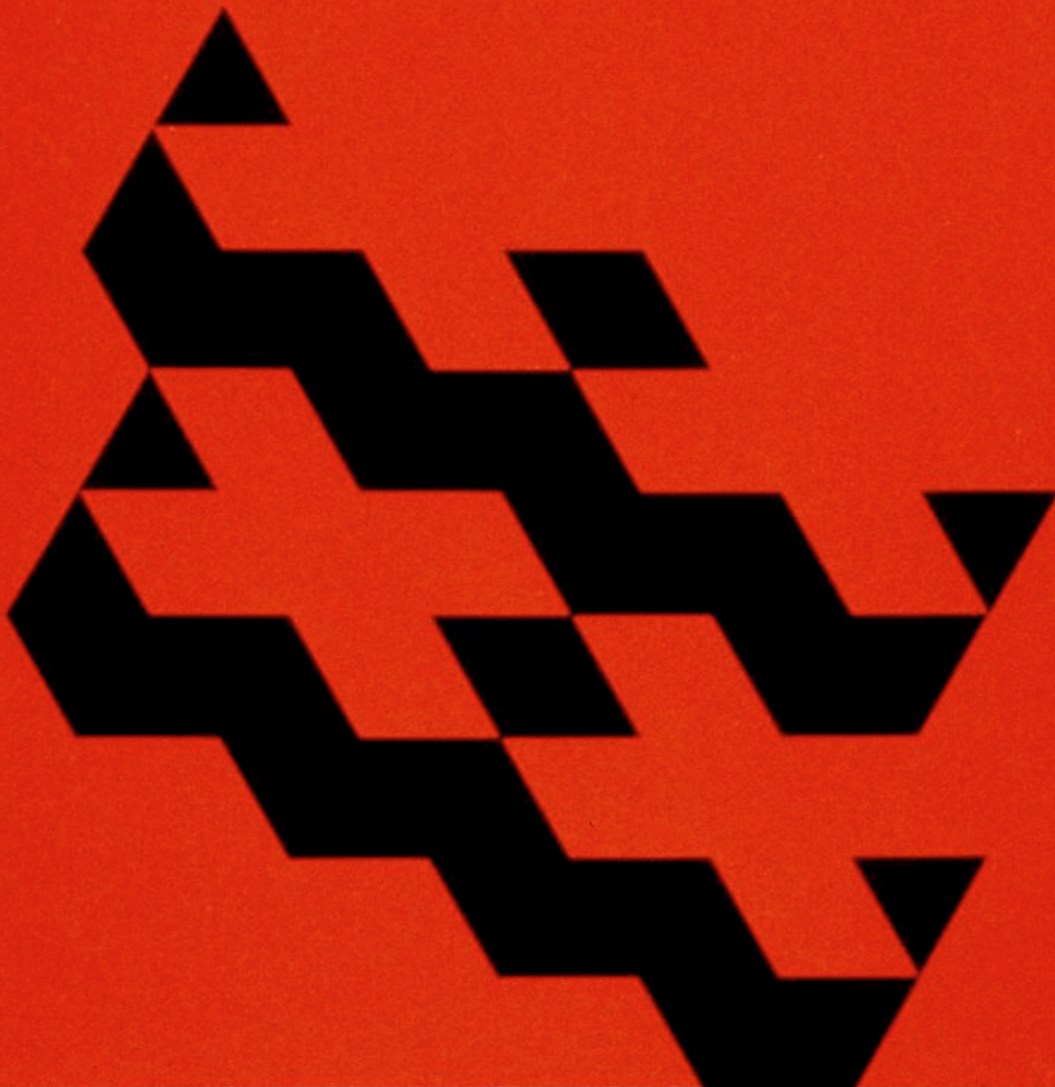


# Careers in Safety and Health: The Occupational Nurse

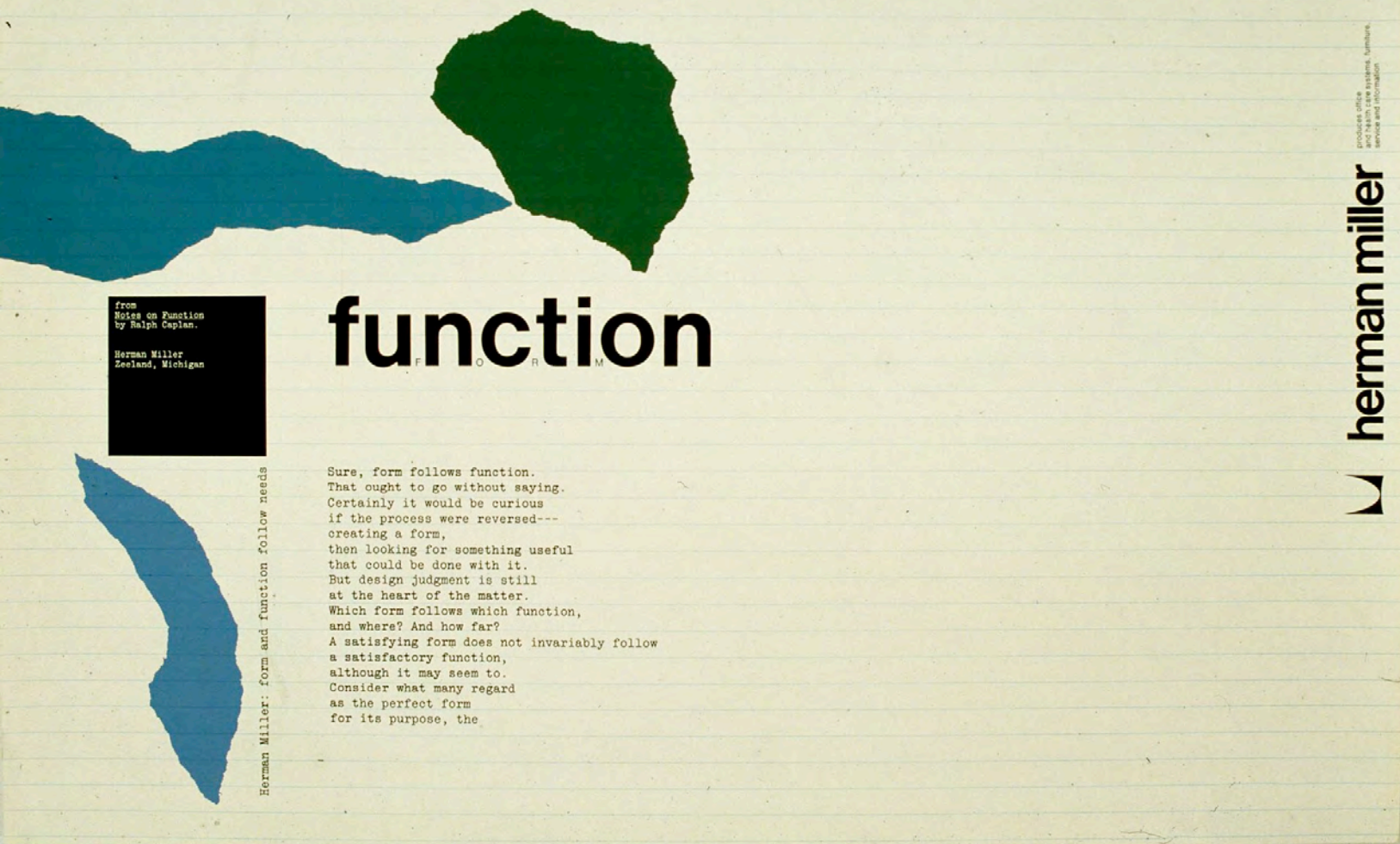


U.S. Department of Labor  
Occupational Safety  
and Health Administration

OSHA 2053



Poster for US Department of Labor, 1973



Poster for Herman Miller, 1975

again started a practice under his name, doing extensive work especially for Herman Miller. He taught at UIC (1984–2000) and received an AIGA Medal in 1994.

In Print magazine, Massey stated, "Graphic design is in a position to influence industry in greater depth than ever before .... Designers concerned with the visual aspects of design mustn't limit themselves solely to the organization, placement of elements, and color within the confines of two dimensions. Increasing the designer's responsibilities is the only way that he can be in a position to evaluate the purposes and objectives of everything he works on. This

kind of approach, I believe, will help reduce the superficial and trite solutions that are often superimposed unthinkingly in many printed messages and will contribute to a greater efficiency in communication between product and consumer."



 herman miller

Equally inspired by the masters of modern art, Massey produced work that combined mathematics and play. It was both practical and artful. "*Massey thinks as artist and designer simultaneously*," wrote Victor Margolin, the founding editor and co-editor of the academic design journal, Design Issues.

# Practical Solutions for Improving Problem Solving

Effective thinking serves as the cornerstone for applying practical solutions to real-world complexities.

To effectively confront the multifaceted challenges that arise in both personal and professional environments, it is essential to develop robust critical thinking skills. However, merely engaging in thought processes is inadequate; the focus must be on refining and enhancing cognitive capabilities to achieve exceptional analytical performance. This article provides a structured framework aimed at significantly improving cognitive abilities, enabling individuals to surpass the performance of at least 90 percent of their peers through a clearly defined, systematic two-step approach.

Daily, various problems necessitate timely and practical solutions, often encountered in a continuous, minute-to-minute

fashion. To function optimally in such a dynamic context, it becomes imperative to address these challenges in a manner that is not only consistent but also predictable and repeatable. Effective thinking serves as the cornerstone for applying practical solutions to real-world complexities. In the following sections, this article will delineate proven methodologies designed to enhance problem-solving skills, distilling intricate concepts into two easily digestible and actionable steps.

It is vital to acknowledge that each individual possesses a distinct cognitive style and approach to problem-solving. This inherent diversity can be advantageous, especially when tackling personal dilemmas, as it allows for varied perspectives

that foster creativity and innovation. However, in a corporate or organizational setting, the ability to collaborate effectively with team members becomes paramount. A cooperative and synchronized approach is essential to resolve work-related issues effectively.

Consider the common scenario within a conference room where ten individuals endeavor to reach a consensus regarding even a straightforward issue. Each participant represents a unique communication style and problem-solving preference. For instance, one individual may advocate for an in-depth discussion, meticulously examining all angles of the issue. At the same time, another may opt for visual techniques, such as sketches or diagrams



on a whiteboard, to elucidate their ideas. At the same time, a third participant might engage in rigorous analytical questioning or reach out to external colleagues for additional insights and expertise.

Amidst these varied approaches, there may be a team member who appears disengaged, distractedly gazing out the window, seemingly waiting for a spark of inspiration or clarity. As time progresses, minutes stretch into hours, and anxiety mounts within the group. Despite numerous contributions and perspectives shared, no concrete resolution is achieved. This situation can breed frustration and a sense of ineffectiveness among participants, even as they grapple with what

seems to be an obvious question at hand.

Fortunately, there is a more structured and effective methodology available for framing questions and uncovering solutions during such critical discussions.

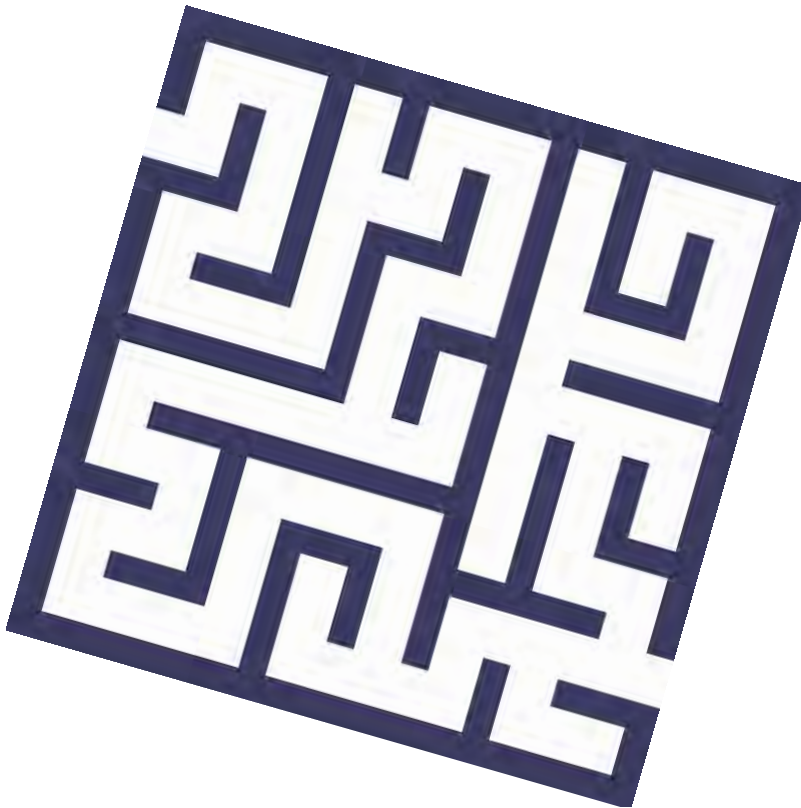
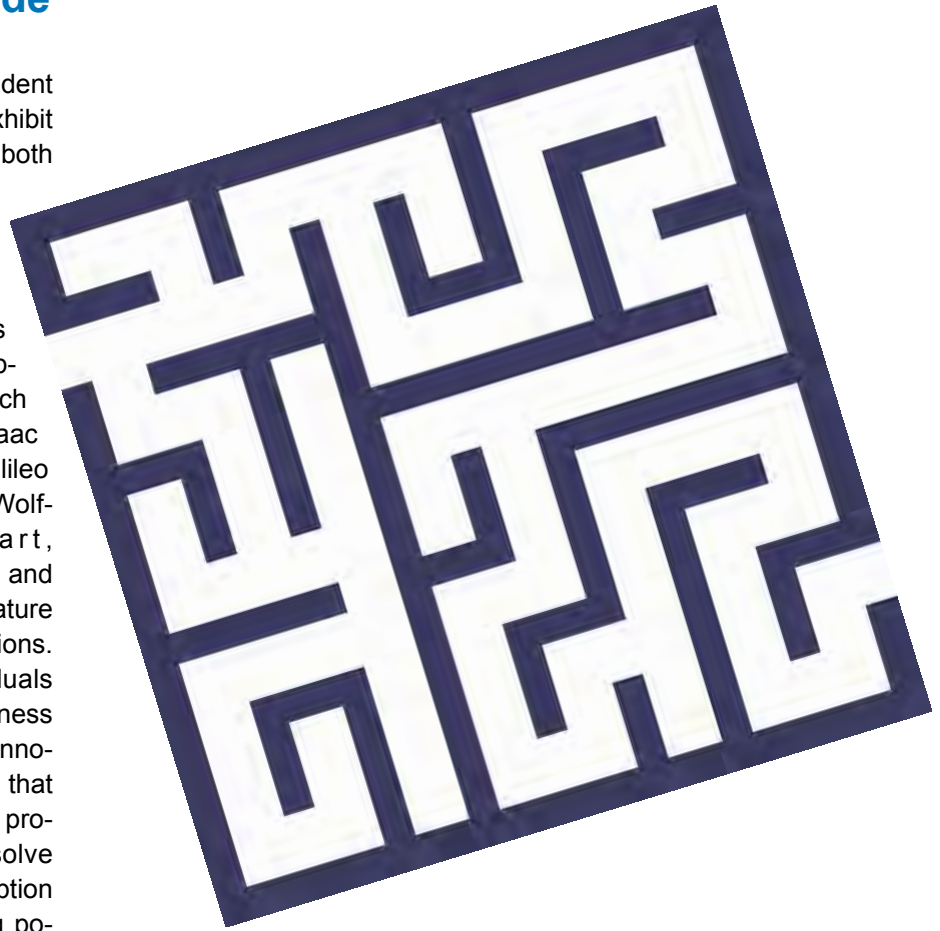
Approximately thirty years ago, an illuminating article identified a compelling commonality among many of history's most esteemed thinkers. These individuals possessed distinctive methodologies for engaging with complex topics, demonstrating an extraordinary ability to distill convoluted ideas to their most fundamental elements. This simplification enhances comprehension and fosters innovative problem-solving capacities.

Drawing from these insights, similar practices were incorporated into problem-solving frameworks, yielding remarkably effective results. Over time, these methods were synthesized into nine actionable steps that culminated in the creation of the Problem Solving Pyramid. This visual representation, prominently displayed, has proven to be an invaluable tool for addressing diverse challenges—both personal and professional—and has facilitated numerous clients in navigating their obstacles.

The nine steps of the Problem Solving Pyramid encourage individuals to harness the same methodologies employed by some of the greatest minds throughout history.

## Adopt a New Mode of Thinking

It becomes increasingly evident that specific individuals exhibit extraordinary capabilities in both critical and creative thinking, effectively distinguishing themselves from others. While compiling a definitive list of history's greatest thinkers can be subjective, notable figures such as Leonardo da Vinci, Isaac Newton, Albert Einstein, Galileo Galilei, Plato, Aristotle, Wolfgang Amadeus Mozart, Archimedes, Nikola Tesla, and Michelangelo frequently feature prominently in such discussions. These exceptional individuals achieved remarkable greatness by utilizing distinctive and innovative modes of thinking that enabled them to navigate profound questions and resolve intricate problems—the adoption of similar modes of thinking po-

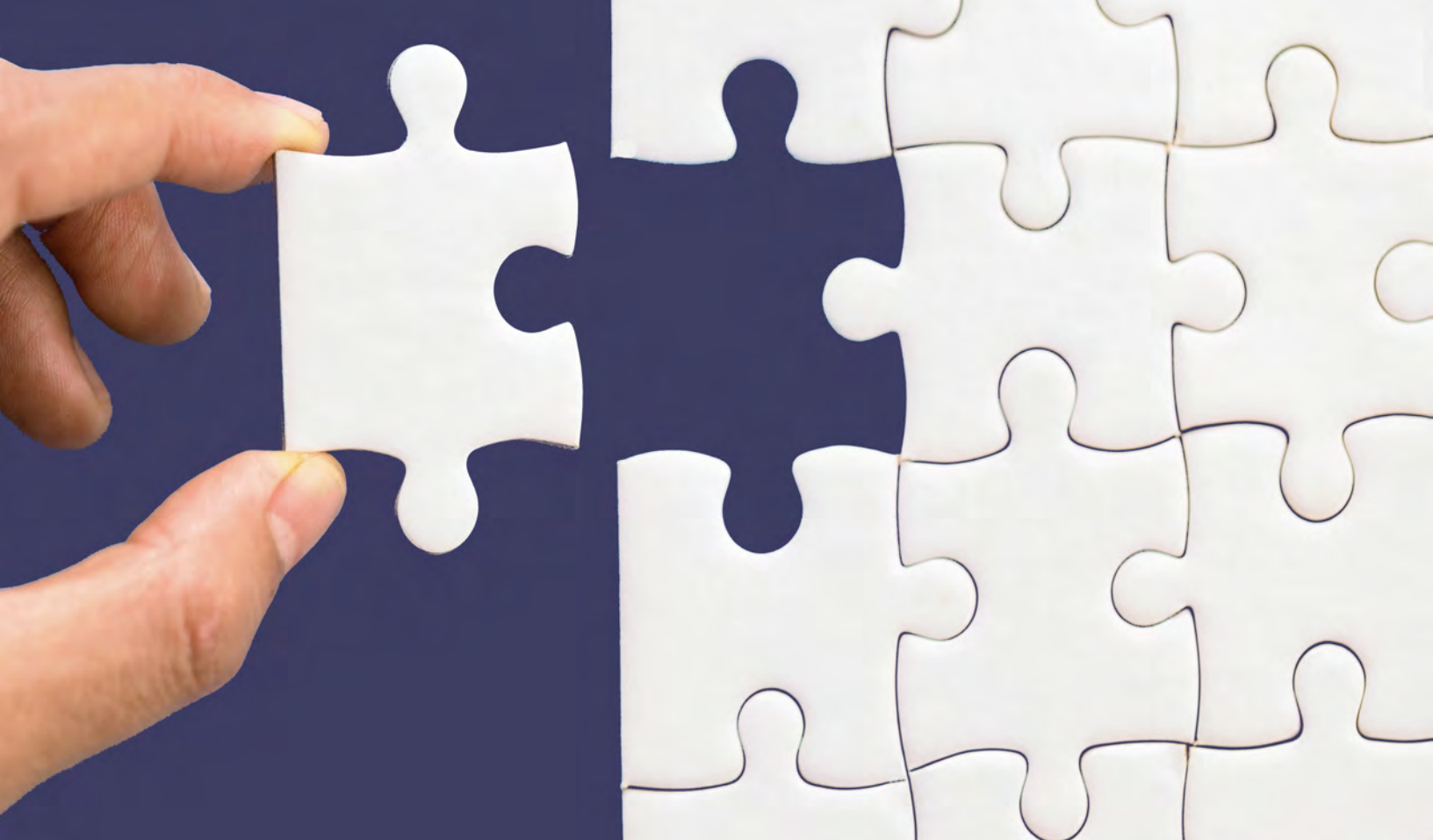


sitions individuals favorably for attaining greater intellectual and professional achievements.

In many instances, individuals confront a problem, rapidly formulate a solution based on initial intuition, and proceed with implementation. Should findings appear to yield favorable results, success may be declared. However, there are numerous occasions when questions arise regarding the reasoning behind specific approaches.

### 1. Defining the Problem

The initial and perhaps most critical step in effective problem-solving involves carefully and precisely defining the problem at



hand. This intelligent approach necessitates a thorough deconstruction of the issue, rendering it into its simplest form to ensure clarity and comprehension. Articulating the problem in unequivocal terms is imperative. If there is difficulty in conveying the essence of the issue, it indicates a potential gap in understanding that must be addressed. A thorough grasp of the problem significantly enhances the likelihood of identifying an effective resolution. Allocating adequate time for a comprehensive examination of the challenge before initiating brainstorming sessions for potential solutions is advisable. This diligence empowers individuals to develop informed and accurate conclusions.

To navigate the complexities of a problem effectively, consider reformulating the initial question. This involves breaking down the

query into smaller, more manageable components and expressing it in a detailed yet accessible manner. A well-articulated question, one that is specific and clear, significantly enhances the chances of finding nuanced and insightful answers. Precision in inquiry allows for focused research and exploration, increasing the likelihood of uncovering valuable insights that might otherwise go unnoticed.

## **2. Research the Problem**

Before drawing any hasty conclusions, the significance of conducting thorough research must be recognized. Effectively addressing a problem becomes exceedingly challenging without a comprehensive investigation. Maintaining a healthy level of skepticism regarding whether an

effective solution already exists is critical. Engaging in meticulous research may yield valuable insights, including seemingly applicable hypotheses that address the problem at hand. Such discoveries should be viewed as initial stepping stones in the analytical process. A rigorous evaluation of the validity of any hypothesis is equally essential, as it is often the case that a more innovative and customized solution may emerge. Embracing an exploratory mindset encourages deeper inquiry into various perspectives and strategies, ensuring that one is well-equipped to solidify the final approach.

After simplifying the question for clarity, conducting thorough research, and accumulating knowledge, brainstorming potential solutions becomes essential. In this creative phase, a free flow of thought encourages



exploration of various angles, possibilities, and innovative ideas that could address the issue at hand. Diverse thinking promotes the generation of numerous ideas without immediate judgment, which can lead to unexpected solutions and open up new avenues for investigation.

### **3. Learn About the Subject of Inquiry**

Upon recognizing that existing attempts to resolve the problem have been insufficient or inaccurate, it is imperative to embark on an in-depth exploration of the subject matter. This entails gathering extensive facts, theories, historical data, contextual insights, and diverse perspectives that pertain to the issue. Engaging with primary and secondary sources, conducting interviews with subject matter experts, and reviewing relevant literature are key strategies in this phase. The accumulation of knowledge serves as a robust

foundation; the more intricate and detailed the understanding acquired, the better equipped one becomes to formulate a credible hypothesis aimed at addressing the underlying problem effectively.

If the research indicates that the question remains unanswered, it is crucial to immerse oneself in learning about the subject. This learning process includes reaching out to experts in the field, participating in workshops, attending seminars, and utilizing a diverse array of learning materials. Engaging critically with content leads to a deeper understanding of the underlying principles, theories, and debates that inform the topic. The depth of knowledge gained during this phase will serve as a robust foundation for effectively tackling the problem.

### **4. Generate a Hypothesis**

In the pursuit of success, cultivating a unique and innovative mindset is paramount. Many individuals approach problem-solving by asking a question, formulating a hypothesis to address that inquiry, and quickly sharing findings without a second thought. However, a crucial step is often overlooked in this process: the essential verification of whether the hypothesis is accurate and reliable. This step is fundamental to ensuring that proposed solutions are not only plausible but truly compelling.

In the pursuit of identifying potential solutions, it is essential to acknowledge the boundaries of feasibility inherent in the problem area. This understanding will guide the process of generating plausible hypotheses. During this phase, critical thinking is required to explore various angles and possibilities. Once a potential solution is identified, it



is crucial not to accept the first feasible option without further scrutiny. Instead, engage in a thorough evaluation of the idea, considering its implications, potential impacts, and the assumptions underlying it. This may involve conducting preliminary assessments or thought experiments to ascertain the plausibility and relevance of the hypothesis before moving forward.

## 5. Rigorously Test the Idea

The next critical step involves designing a comprehensive testing framework for the proposed idea that encompasses a range of scenarios, including both minor and major scales. Testing should be structured to assess the idea's functionality, effectiveness, and applicability across different contexts. This multifaceted approach not only

helps validate the solution but also uncovers any limitations or unintended consequences associated with its implementation. It is essential to maintain an open mind; the idea may not provide a complete resolution to the problem, but it could significantly alleviate some aspects. The objective in this phase is to rigorously assess the validity of the concept through extensive experimentation, data collection, and analysis. If evidence fails to substantiate its efficacy on both minor and major scales, the hypothesis lacks validation and must undergo further refinement.

Upon identifying a promising solution, it is vital not to accept it as valid prematurely. Instead, a commitment to a rigorous testing process is required, involving exploration of various methodologies to assess the

solution's validity deeply. This phase may include designing experiments, conducting surveys, or employing statistical analyses, depending on the nature of the solution. Documenting each stage of testing meticulously allows for tracking progress, identifying patterns, and adjusting the approach as necessary.

Challenges may arise in confirming the effectiveness of the solution across different scales—whether small or large—the solution's legitimacy must be scrutinized. A thorough evaluation of every idea is vital, observing how each component holds up under various conditions. This assessment phase not only helps confirm sound ideas but also highlights potential weaknesses or unforeseen variables that may influence outcomes. Time must be taken

to reflect and reassess the data collected during testing to ensure a comprehensive understanding of the solution's performance.

## **6. Test Again Until**

### **Accurate**

Once the initial testing yields positive results, it is advisable to undertake additional tests using various methodologies to confirm that the findings are reliable and consistent. This might include altering variables, changing the testing environment, or employing different analytical tools. If subsequent tests yield results that differ from the initial findings, it is indicative that the hypothesis's validity requires reevaluation and potential reworking. The rigorous testing process should continue iteratively until a consensus is reached on the idea's validity across different scales and contexts, ensuring comprehensive accuracy and reliability in all respects.

Following initial tests that yield positive outcomes, engaging in further testing using slightly different approaches or contexts is crucial. This iterative process enhances understanding of the solution's effectiveness. Significant variations in results during subsequent tests signify the need for re-evaluation of the idea's validity and exploration of potential modifications. Continuous testing and refinement strengthen the solution and enhance analytical capabilities and critical thinking skills.

Before delving deeper into exploration, engaging in comprehensive research to uncover

whether a valid hypothesis addressing the question already exists is imperative. This step involves exploring academic journals, industry reports, books, and reputable online resources. Approaching the inquiry with an open mind acknowledges that established answers may already be available. Doing so not only saves valuable time but also enriches understanding and contextualizes the approach within existing knowledge.

## **7. Master Extrapolation**

The concept of extrapolation involves the ability to identify and interpret patterns observed in small-scale scenarios and accurately predict their potential ramifications as they scale over time. For instance, if it is noted that specific projects consistently miss their deadlines, it would be prudent to investigate whether similar delays have occurred previously and their frequency. Conducting meticulous research may reveal statistics that indicate a significant percentage of projects are habitually delivered late, potentially by 30 minutes to an hour. By identifying contributing factors—such as resource bottlenecks, communication breakdowns, or workflow inefficiencies—and implementing corrective measures, it becomes possible to not only rectify the immediate issue but also enhance overall productivity. Attentiveness to small-scale patterns and their implications can provide valuable insights that yield substantial organizational benefits.

When analyzing findings on a smaller scale, it is logical and beneficial to extrapolate observations to broader contexts over time. Extrapolation serves as a systematic tool to estimate the relevance of findings beyond immediate circumstances. This practice helps determine whether observed effects apply to other related areas or situations, allowing for deeper insights and informed predictions regarding potential impacts in various contexts.

## **8. See Greater Depths of Detail**

Achieving a profound understanding of any issue requires an unwavering commitment to detailed inquiry. This encompasses meticulous question formulation, extensive information gathering, thorough examination of the subject matter, and rigorous hypothesis development and testing. The depth of knowledge gleaned is directly related to the careful attention placed on details and intricate interactions. It is equally important to maintain awareness of the broader context while meticulously examining specifics; this holistic perspective can be cultivated by applying new cognitive strategies alongside the process of extrapolation. The difference between success and failure often hinges on critical details. Exhaustive documentation of observations and findings significantly enhances the likelihood of achieving successful outcomes, while many failures can be traced back to inadequacies in information. Individuals who achieve excellence tend to possess a sharp understanding of the broader implications of their

work, coupled with a focused attention on essential details, gained through rigorous scrutiny and ongoing questioning.

The richness of inquiry, thoroughness of research, depth of understanding, and intricacy of idea generation and testing processes significantly enhance overall knowledge of the topic. A comprehensive and detailed approach leads to a more profound and multifaceted understanding. Engaging with material at various levels—conceptual, practical, and theoretical—results in a holistic grasp of the subject.

## 9. Draw Accurate Conclusions

The capability to draw accurate conclusions in complex situations necessitates a systematic approach that adheres to the initial eight steps outlined previously. It is crucial to achieve clarity regarding how conclusions were reached, ensuring that the reasoning is straightforward and well-articulated. The methodology for developing effective thinking strategies can be distilled into four fundamental steps, underscoring the importance of simplification in en-

hancing comprehension and retention of knowledge. One must be equipped to convey the subject matter in a manner that is accessible and relatable; should this capability be lacking, it may warrant dedicating additional time to refining the problem definition, conducting more thorough research, or enhancing overall understanding.

Finally, once the complexities of research and testing have been navigated, distilling findings into clear and concise conclusions is essential. Synthesizing information in a manner that captures the essence of learned content ensures accessibility and understandability. Clarity of expression communicates not just the results of inquiry but also the insights gleaned and implications for future exploration. Articulating conclusions in straightforward language allows findings to contribute meaningfully to ongoing discussions in the field.

## Conclusion

In alignment with the goal of simplification, the comprehensive nine-step process for developing effective thinking strategies can be succinctly

summarized into two essential steps:

Step 1: Rigorously evaluate and test every proposed idea through thorough validation and exploration of its implications.

Step 2: Analyze the intricate details within a broader context to foster a deeper understanding and insight that can lead to informed decision-making.

There is a 30-inch x 40-inch, colorful poster of the Problem Solving Pyramid, which can be printed out at any size and hung on the wall. It is available at:

<http://screenprintbooks.com/downloads/problem-solving-poster>



### About the Author

G. William Hood was born into the screenprinting technologies as the son of a screenprint shop owner. Hood is a leading, international specialist in screenprinting, across all segments. Hood operates Bill Hood Consulting International, which trains, troubleshoots, problem-solves, and enhances the performance of screenprinting operations worldwide.

He is a Fellow of the Screenprint Process Technical Research Center, a Lifetime Member of the Speciality Graphic Imaging Association and a recipient of the prestigious Swormstedt Award for technical writing and the Joe Clarke Innovator in Screenprinting Award. Hood is an inductee into the Academy of Screen & Digital Print Technologies (ASDPT).

He may be contacted through <http://billhoodconsulting.com> online.



# The Process of Drying and Curing Inks and Coatings

A thorough understanding of the drying and curing processes is essential for enhancing the efficiency of drying systems.

A thorough understanding of the drying and curing processes is essential for enhancing the efficiency of drying systems. The primary ink categories utilized include evaporative inks and cross-linking inks. Evaporative inks cure or dry by releasing volatile compounds, which results in the formation of a solidified mass; most water-based inks belong to this group. In contrast, cross-linking inks require an external application of energy to trigger the curing process. During this intricate transformation, the liquid ink structure undergoes substantial rearrangement, leading to cross-linking and polymerization that ultimately form a solid mass, often without emitting harmful fumes. Plastisols serve as a prime example of cross-linking inks that find

widespread application in various industries.

Water-based inks generally require a careful combination of both drying methods, radiation and convection, for optimal performance. Initially, the volatiles within the ink are evaporated from the printed substrate, followed by the application of additional heat necessary to set the inks effectively. This two-step approach ensures that the finished substrate not only reaches proper curing but also possesses the resilience needed to withstand cleaning processes and regular wear without compromising its structural integrity or aesthetic appearance.

The curing process emphasizes the need for reliability and uni-

formity achievable through high-quality drying systems, underscoring their importance in industrial applications.

A comprehensive examination of conveyor dryers necessitates an understanding of the foundational concepts of temperature and heat. While these terms are frequently employed interchangeably in everyday discourse, they represent distinct scientific principles. Temperature is quantitatively defined as a measure of how hot or cold an object is at any given moment. It is expressed in degrees Fahrenheit (°F) or Celsius (°C) and accurately measured using a thermometer, an instrument designed to gauge thermal conditions.



Heat, in contrast, refers to the total thermal energy present in the particles of an object. This energy is measured in joules (J) by utilizing a joulemeter, which is specifically engineered to quantify energy in physical systems. Thermal energy represents the kinetic activity of particles within matter; when matter is subjected to heating, its particles gain energy, resulting in increased vibrational and movement rates. Consequently, the flow of thermal energy, when transferred from one body to another, is classified as heat energy, a critical factor in processes such as curing inks, coatings, and adhesives in conveyor dryers.

The transfer of heat energy occurs through three primary mechanisms: conduction, convection, and radiation. This transfer process typically moves from regions of lower temperature to those of higher temperature, abiding by the principles of

thermodynamics, which dictate that heat migrates from colder areas to warmer ones in pursuit of thermal equilibrium.

## Ink Setting Process

This setting process is energy-dependent, wherein the application of greater energy levels, without damaging the substrate, leads to improved results.

Radiant energy has demonstrated particular effectiveness for this application, as it is capable of transmitting high energy levels in a brief duration, significantly facilitating the setting process. After the solvents (the volatiles) have been eliminated, there is no requirement to elevate the printed material to boiling temperature, thus allowing radiant energy to be utilized more effectively. Notably, only a limited amount of radiant energy is necessary for this purpose.

In a jet system, the volume of air being utilized is sufficiently substantial that exhausting the entirety of it is not necessary; only a portion needs to be disposed of. This facilitates the remaining air to be adequately clean to absorb additional moisture, enhancing overall efficiency, with an estimated 80% of the air being recirculated. In scenarios involving the processing of cross-linking materials such as high solids acrylic or plastisol inks, it may not be necessary to exhaust any air at all. Achieving the required high airflow velocity demands considerable horsepower; for example, a dryer with dimensions of 3 x 1.2 meters typically necessitates a robust 2-horsepower motor. Despite the seemingly large size of this motor for the relatively compact area, a well-functioning jet system needs to generate adequate pressure above the air knives. The recirculated air enters the blower through heating elements, while a separate

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blower, regulated by a damper, is employed for exhaust. Although this configuration may entail higher costs, it provides the benefit of preventing disturbances to the pressure side of the blower, which is critical for maintaining the necessary velocity for efficient jet drying.

## Methods of Heat Transfer

### Conduction

Conduction is defined as the transfer of thermal energy that occurs within a solid material or between solids in direct contact. This process exemplifies the direct transfer of heat through physical interaction, and its efficiency is closely tied to the thermal conductivity of the materials involved. This property indicates how readily heat can pass through a substance. A standard illustration of conduction can be found in heat presses equipped with electric platens. In this context, the heated platen makes direct contact with the substrate, facilitating thermal energy transfer across the entire surface. This conduction raises the substrate's temperature, thereby promoting the curing of inks and materials contained therein.

### Convection

Conversely, convection involves the movement and transfer of heat via the circulation of fluids, including gases or liquids. Heated air, for instance, ascends, transferring thermal energy to adjacent materials. A salient application of convection can be observed in a conventional conveyor oven. In this configuration, heating elements elevate the temperature of the air within the

oven chamber, which, in turn, raises the temperature of the inks, coatings, or adhesives placed inside. This method parallels forced-air heating systems, where warm air is circulated throughout an interior space to enhance ambient temperature and ensure the comfort of occupants and protection of sensitive materials.

### Jet Air System

The jet air system represents a highly effective convection-based drying method. This approach was initially recognized by screen printers, who acknowledged that jet drying was the most efficient method for curing or drying evaporative-type inks. In the textile industry, the majority of water-based inks are categorized as evaporative inks exhibiting unique cross-linking properties. This cross-linking process occurs rapidly; upon reaching the requisite temperature, the ink undergoes a precise transition from a liquid state to a solid form. This transition involves two crucial phases: the initial drying process followed by the curing phase.

Within the jet air system, high-velocity airstreams are directed over the printed garment, thereby effectively eliminating solvents embedded within the ink. Increasing the temperature of the airstream enhances moisture absorption capabilities. As the high-velocity air becomes turbulent, it generates small voids or vacuum pockets. These pockets draw in surrounding volatiles, selectively extracting moisture from the fabric. It is essential to expel moisture-laden air from the system efficiently; failure to do so may re-

sult in the rewetting of garments, which could compromise the overall drying process.

Historically, jet dryers employed plates with small orifices to facilitate the creation of jets of air. However, this design occasionally resulted in moisture returning to the garment due to a persistent moisture cloud trapped beneath the plate. By utilizing an innovative knife-like design at the jet outlet, this moisture cloud can be effectively eliminated through the application of negative pressure, thereby preventing any potential rewetting issues.

Jet dryers are distinguished by their superior temperature control, providing uniform temperature distribution across the entire air mass. This precision stands in contrast to radiant systems, which may exhibit less accuracy in temperature management.

### Jet/Radiant System Configuration

The radiant drying component is strategically positioned downstream from the jet section. This arrangement is imperative, as adequate curing of the material cannot transpire until all volatiles have been thoroughly removed, a task that is optimally achieved through the jet drying mechanism.

Upon the removal of volatiles, radiant drying can commence, incorporating essential principles such as precise temperature control, panel height adjustment, and belt speed regulation. Temperature management within the jet section is distinct from that within the radiant pan-

el section. The effectiveness of the jet portion relies on the temperature of the air itself, which is monitored explicitly in that segment of the dryer.

Conversely, regulating the temperature of the radiant panel is the optimal method for controlling radiant energy. It is common for more petite heat strips to function effectively only in convection systems; these strips absorb radiant energy differently than the garment or ink, potentially leading to inaccurate representations of the heat influencing either. Consequently, controlling radiant energy presents significant challenges due to these thermal management issues, underscoring the importance of managing the temperature of the panel itself.

Three specific applications relevant to this process are outlined below:

1. **\*\*Utilization of Water-Based Inks:\*\*** Following the removal of volatiles, the radiant panel applies sufficient heat to induce the cross-linking of the remaining mass, ensuring optimal adhesion and durability.
2. **\*\*Application of High Solids Acrylic or Plastisol Inks:\*\*** For these inks, which do not pose volatile issues, the jet system operates efficiently. The curing temperature of these inks relies not on the duration of exposure but instead on achieving the requisite thermal energy for the cross-linking of the ink molecules.
3. In cases where the ink achieves the necessary thermal energy but the substrate does not, the substrate functions as a

heat sink, absorbing heat away and obstructing the ink from properly cross-linking.

By meticulously managing these various parameters, the overall efficiency and effectiveness of the ink cross-linking process can be significantly enhanced, leading to superior printing outcomes and improved product quality.

## Control Features

Insulation is a critical component in the functionality of convective-type ovens. Such ovens, which rely solely on hot-air heat, can attain dangerously high surface temperatures. For instance, an uninsulated oven operating at a temperature of 260°C (500°F) poses significant safety risks. A recommended safety feature includes an airflow switch that automatically shuts off the heating element in the event of blower failure. The absence of such a device can result in excessive heating, potentially causing damage to the equipment.

Another limitation of convective systems lies in their dependence on a singular heat source. In infrared systems, lamps can be readily replaced; should one lamp fail, the overall heat output remains largely unaffected. Conversely, a hot air dryer—whether powered by gas or electricity—relies on a single heat source; if this source fails, the entire system ceases to operate, resulting in significant replacement costs.

The implementation of a high-level temperature cutout switch is likewise imperative. If the ambient temperature within the

oven exceeds the designated threshold, such as between 230 - 260°C (450 - 500°F), the system must be equipped to shut down safely. A malfunctioning limit switch could potentially lead to unregulated temperature increases, underscoring the necessity of a reliable cutout mechanism.

When procuring drying equipment, attention to the required voltage specifications is often insufficient. Various systems are available across a wide range of voltages, including 208, 220, 230, 240, 440, and 480 volts, with options for both single-phase and three-phase systems. Typically, an electric meter will indicate the voltage available within a facility. It is essential to distinguish between single-phase and three-phase systems, as three-phase systems are generally categorized as delta loads.

## Convection-Type Ovens

Convection ovens are designed with specific characteristics that optimize their performance in curing applications. Typically, these ovens feature a single heating element and occupy a footprint approximately 1.2 meters wide by 3 meters long, commonly operating at a power level near 40 kilowatts. The design of convection ovens emphasizes thermal efficiency; notable features include enhanced insulation that minimizes temperature cycling and reduces energy consumption while preventing material scorching. Unlike conventional gas or electric convection ovens that use recirculating hot air, convection

ovens do not impart direct radiant heat onto substrates. Instead, they maintain precise temperature control; for instance, when set to 260°C (500°F), the enclosed chamber consistently upholds this temperature, compensating for any variations due to the movement of fabrics or substrates.

It is essential to note that adjustments to the belt speed in a convection oven should not adversely affect the curing process or the structural integrity of the substrates undergoing treatment. The defining characteristic of a convection oven includes its ability to utilize recirculating hot air; generally, approximately 20% of the air within the chamber is exhausted, while around 80% is recirculated, enhancing energy efficiency. This recirculation process is particularly beneficial when employing environmentally friendly inks, such as high solids acrylic (HSA), plastisol, or water-based inks.

Moreover, convection ovens can be classified as "color-blind" concerning curing performance, whereby both light and dark colors cure at comparable rates regardless of the material characteristics involved. In contrast, infrared curing systems are sensitive to color variations, as different ink colors exhibit varying responses to infrared heat. Darker hues typically absorb more infrared radiation, which may necessitate longer exposure times for lighter colors to achieve complete curing, potentially leading to over-curing issues for darker shades.

Despite the numerous advantages presented by convection ovens, a significant considera-

tion for prospective buyers remains their relatively high purchase cost. This financial aspect often plays a decisive role in equipment selection, particularly for businesses aiming to balance performance parameters with budgetary constraints. Ultimately, an in-depth understanding of temperature principles, heat transfer mechanics, and the operational characteristics of convection ovens can significantly enhance operational efficiencies and the quality of the final products.

## Radiation

Radiation is widely recognized as the most straightforward and most efficient mode of heat transfer. Heat is generated within an object through the direct transfer of infrared radiation through open space. Unlike conduction and convection, the movement of air currents does not affect or alter infrared radiation.

Within the domain of drying techniques, the goal of a pure radiant drying system is to apply enough heat energy to effectively vaporize the liquid content that is present in the substrate. A specific time/temperature relationship exists for effective drying with radiant heat; for instance, water reaches its boiling point at 100°C (212°F). Introducing excessive heat beyond this point does not enhance the drying process and can have detrimental effects. However, as additional heat accumulates within the fabric, the risk of reaching the scorch point escalates, potentially damaging the printed surface before adequate drying occurs.

This challenge is further complicated in infrared or radiant systems. As the heat source temperature increases, its spectral output can shift, leading to selective heating of certain areas rather than even distribution across the substrate. Effective heat transfer occurs most successfully when the spectral production aligns with the specific heat absorption characteristics of the garment. Ideally, maintaining the temperature of the heat source between 427°C and 462°C (800°F to 900°F) facilitates a relatively flat spectral output. This promotes more uniform heating of both the ink and the fabric, ensuring thorough and effective curing.

Experienced screen printers recognize that maintaining lower operating temperatures can sometimes lead to more muted color effects within a radiant environment. Additionally, the inherent complexities of controlling temperatures within a radiant system necessitate diligent oversight of the heat source itself to ensure precise management. Such careful control is essential for achieving consistent and desirable results.

In screen printing, radiant heat is primarily used for curing inks, exceptionally high solids acrylic, plastisol, and some water-based inks, and for drying prints. The two main types of radiant heat sources used are infrared (IR) panels and quartz bulbs. Infrared panels are commonly used in flash dryers, which are used in both manual and automatic screen printing presses. Quartz bulbs, found in quartz flash curing units, offer faster heating and cooling compared

to infrared panels, potentially saving time and energy.

**Infrared (IR) Panels:** These are commonly used for curing inks in screen printing. They provide a consistent and even heat distribution across the printed area.

**Quartz Bulbs:** Quartz flash curing units use quartz bulbs to generate heat, offering faster heating and cooling times compared to infrared panels. This can lead to faster production times and potentially lower energy consumption.

## Infrared Radiation

Given its efficiency and versatility, infrared radiation warrants a thorough examination. In the realm of physical science, infrared radiation occupies a position within the electromagnetic spectrum between radio waves and visible light. Upon interaction with a substance, infrared rays increase the temperature of that substance. It is critical to acknowledge that any object above absolute zero emits some degree of radiation.

Contrary to prevalent misconceptions, no infrared ray penetrates deeper than approximately 50 microns (0.002 inches). More than half of the solar energy reaching the Earth is emitted in the form of infrared radiation. Infrared radiation exhibits the same fundamental characteristics of light; it can be focused, directed, and reflected, and it travels at the remarkable speed of 299,792 kilometers per second (186,300 miles per second).

However, several disadvantages are associated with the use of

infrared bulbs for drying or curing applications. Notable issues include their fragility and the difficulty in accurately measuring the temperature of the heated product. Up to 25% of the energy consumed can be lost as light emissions, contributing to inefficiencies. Frequent replacements due to burnout or breakage may be necessary, resulting in downtime, increased labor costs, and uncured inventory—all factors that adversely impact production timelines and overall expenses. Similar limitations apply to quartz tubes, which also exhibit extreme fragility and pose challenges related to temperature control, often resulting in unwanted light emissions.

With a solid bed, infrared heat functions as an effective convective drying system. Unlike radiation-type drying, which operates independently of any enclosure and relies solely on radiant heat, an efficient production-rate dryer utilizing convection must be significantly longer in design. This requirement can present practical challenges for many facilities seeking to optimize their operational space and workflow.

## Types of Infrared Lamps

A diverse selection of infrared lamps is available in the marketplace, including shortwave infrared and medium-wave infrared varieties, each characterized by distinct attributes that make them suitable for particular applications. Shortwave infrared lamps, for example, are recognized for their high luminous efficiency and exceptional penetration capabilities, thus making them ideal for quick dry-

ing processes involving inks, coatings, and adhesives. The design of these lamps allows for the delivery of intense heat rapidly, significantly reducing curing times without compromising quality.

In an infrared drying system, the lamps are designed for straightforward replacement, ensuring that the failure of an individual lamp does not substantially affect the overall heat output or functionality of the system. This modular design contributes to maintaining continuous operational efficiency.

## Dry Clime Lamp

The dry clime lamp represents a specialized category of infrared heating technology, which is instrumental in the drying or curing of various materials, including inks, coatings, and adhesives. This term is not only applicable to the lamp itself but also pertains to the innovative organization behind its development—Dry Clime Lamp Corp. This company is distinguished in the industry for its expertise in designing and manufacturing advanced ovens and systems that frequently employ proprietary infrared lamps tailored for a range of drying and curing applications across diverse sectors.

The construction of these infrared lamps utilizes high-quality ceramics, within which a cadmium rod is embedded. This design choice not only enhances the durability of the product but also contributes to a notably low replacement cost. The functioning of these lamps is based on their ability to deliver concentrated heat through a parabolic



reflector that effectively focuses infrared radiation onto the targeted substrates. For optimal performance, these lamps should be positioned approximately 10 to 12 inches (25 to 30 centimeters) above the conveyor belt, ensuring that the heat is efficiently applied. Continuous infrared radiation is essential for achieving the desired results; if exhaust is routed through the top of the oven, it may present challenges in maintaining uniform spacing among sections to guarantee consistent exhaust flow. An average dry clime system typically measures about 10 feet (3 meters) in length and 48 inches (1.2 meters) in width, operating at a robust power rating of approximately 48 kilowatts, thus rendering it suitable for industrial applications.

### ***Infrared Drying/Curing***

Infrared lamps emit a significant form of radiation that falls within the spectrum of electromagnetic energy. This radiation can be

readily absorbed by various materials, resulting in a rapid increase in temperature. In the context of paint applications, this swift heating process is critical in expediting the drying and curing times, thereby ensuring that surfaces are adequately prepared for subsequent processing promptly. The efficiency of this process has a direct impact on production timelines and overall product quality.

### ***Key Features***

These infrared lamps are equipped with a range of user-oriented features designed to enhance operational efficiency, convenience, and safety during use. Adjustable lamp heights and heads enable customization according to specific heat application needs. Integrated timers contribute to precise control over drying or curing cycles, ensuring consistent and reliable processes. Additionally, the inclusion of casters allows for enhanced maneuverability, facili-

tating easy repositioning within various work environments. The systems often incorporate essential safety features, such as overheat protection, to diminish the risk of material damage and to ensure the safe operation of the equipment.

## **System Controls**

The infrared drying or curing systems must encompass essential controls that enable optimal functionality and adaptability to varying production requirements. Typically, these systems are equipped with adjustable temperature controls, variable belt speed settings, and sophisticated exhaust systems. In infrared systems, it is particularly critical to have adjustable elevations for the heat source above the substrate to achieve the desired results without causing potential damage.

Among the various control mechanisms, the percentage timer is one of the fundamental

tools for regulating temperature during operations. This timer functions analogously to conventional clocks, with a cyclical span of 30 seconds that can repeat multiple times within a minute or condense into shorter intervals, such as 15 seconds. For instance, when configured to operate at 50%, the units will alternate between periods of activation and deactivation, providing an efficient method for temperature management.

The utilization of a percentage timer offers various advantages, including reliability and compatibility with a wide range of substrates. This control mechanism proves particularly effective in industrial applications where there is a heightened risk of substrate burning, such as in the curing of enamels, lacquer finishes, or harder coatings.

However, it is essential to recognize that the percentage timer may not be the most suitable solution for textile processing applications, where sensitivity to changes in heat may vary significantly. While the percentage timer serves as a reliable tool, it is imperative to incorporate flexibility and adaptability to meet specific operational conditions effectively.

Adjustable lamp heights are crucial for achieving optimal results in infrared curing systems. Due to the concentrated heat delivered by these systems, improper positioning can lead to either overbaking or underbaking at varying belt speeds throughout the coating application process. Moreover, a significant amount of convective heat can accumulate within the drying system, even when direct

infrared curing is the primary method employed. Observational data suggests that with the percentage timer in operation, an increased number of substrates in the system correlates with rising temperatures. This phenomenon occurs because the infrared heat elevates the temperature of substrates, particularly those with darker surfaces, which subsequently radiate convective heat, thereby increasing the temperatures of adjacent substrates. The timer's mechanism does not account for this additional heat increase, potentially impacting overall product quality.

To effectively manage this circumstance, the implementation of a sophisticated temperature control system may become necessary. These temperature controllers utilize heat probes to measure the ambient temperature within the oven's enclosure. It is essential to acknowledge that a probe should not be positioned merely beneath an infrared lamp; infrared heat primarily measures the substrate temperature rather than the ambient air temperature. For optimal heat management, the oven must be entirely enclosed, constructed with a solid steel bottom, continuous solid sides, and designated entry and exit points to facilitate material movement. The temperature controller will autonomously adjust the operational parameters based on color variations and changes in ambient room temperature.

Furthermore, the oven's bottom should incorporate a well-engineered exhaust system that effectively expels air from either the top or bottom. Given that hot

air rises, this design approach simplifies the removal of warm ambient air through the integration of a low-profile blower. However, in instances where air is vented from the bottom of the oven, a more powerful blower is required to maintain consistent temperature and airflow dynamics, thereby ensuring that optimal curing conditions are consistently achieved.

The exhaust system must be meticulously designed and strategically positioned to prevent any interference with the infrared units, which rely on precise focusing for maximum effectiveness. Each infrared lamp in the system is engineered to emit concentrated heat within a specific range, creating an overlap with neighboring lamps. This overlap is crucial for ensuring uniform heating, as improper spacing between lamps can lead to the formation of thermal inconsistencies. When substrates move through the drying process, they risk exposure to contrasting hot and cold spots that can negatively affect curing quality. If the system employs a top exhaust, any misalignment in the oven's elevation with respect to the focused length of the infrared source can create a cold spot at the center of the oven. This situation can lead to serious repercussions; for instance, if a temperature probe is inadvertently placed over this cold spot or if a lamp fails unnoticed while positioned far from the probe, multiple substrates may sustain damage well before any problem becomes apparent, resulting in costly waste and prolonged downtime.

In most heating systems utilized in an industrial context, the importance of an efficient exhaust system cannot be overstated. It plays a vital role in maintaining optimal operating conditions by cooling the infrared lamps after they have worked extensively. Furthermore, an effective exhaust system is essential for upholding the warranty on many heating units, as manufacturers often stipulate that proper ventilation must be implemented. Without adequate exhaust, ambient heat can build up inside the system, disrupting the delicate equilibrium necessary for effective temperature control and potentially leading to overheating, which can damage equipment or compromise performance.

## Belt Speed

The speed at which the conveyor belt operates is a critical factor influencing the overall performance and efficiency of the drying process. In situations where the heat controller lacks high precision or accuracy, belt speed becomes a crucial variable that significantly impacts the curing of various inks, coatings, and adhesives. Infrared heating technology provides targeted thermal energy; how-

ever, if the substrate moves through the dryer at a slower pace than intended, it risks being exposed to an excess of infrared radiation. Such excessive thermal exposure can lead to a dangerous rise in ambient temperature, possibly causing the substrate to melt or suffer irreparable damage.

For operators using homemade or customized systems, the ability to precisely adjust both the belt speed and the temperature settings is paramount for achieving optimal curing results. It is essential to understand that effective adjustments for speed and temperature cannot simply rely on a single control setting. A prevalent misconception among users is that running the unit at maximum capacity—100%—will consistently yield the desired curing results; however, this assumption is fundamentally flawed. Achieving successful outcomes relies on ensuring that both adequate time under the heat source and appropriate thermal exposure are carefully calibrated. For high solids acrylic or plastisol inks, excessively high temperatures within the system can pose significant risks, including potentially scorched fabric or irreversible damage.

Adjustable lamp height is another essential feature that plays a critical role in optimizing results. The infrared system generates focused heat that can result in either overbaking or undercuring of substrates, depending on the varying belt speeds. For example, if an infrared lamp is focused at a distance of 10 inches (25 cm) from the substrate, and the substrate measures between 2 and 3 inches thick (5 and 7 cm). In that case, the top edges are particularly susceptible to scorching. The capacity to either raise or lower the lamp height above the substrate allows for significant mitigation of this issue by promoting more even heat distribution.

In summary, maintaining precise control over an oven used for drying or curing requires a careful balance of several interrelated factors, including accurate temperature regulation, appropriate belt speed, a fully functioning exhaust system, and adjustable lamp height to guarantee optimal results.

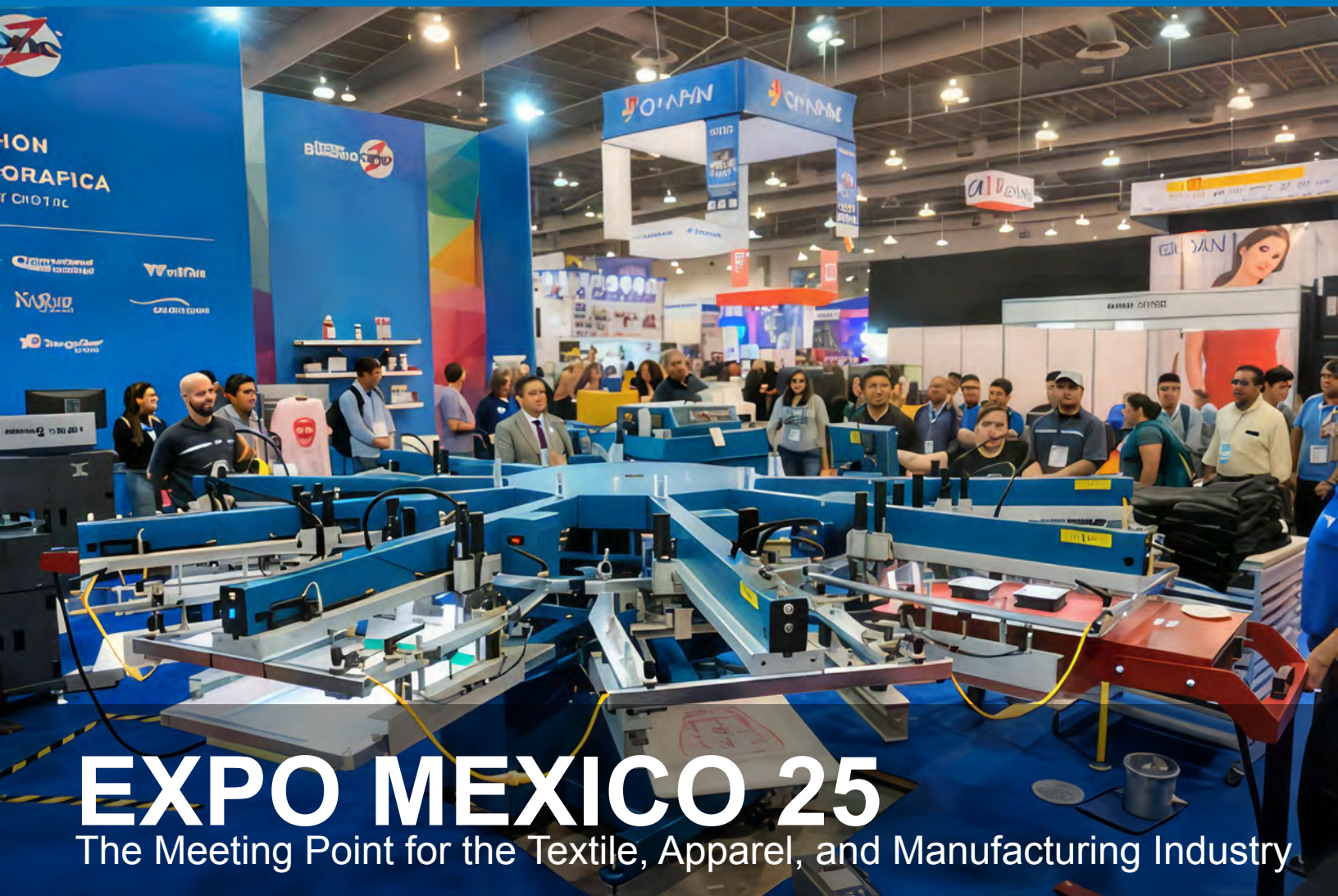


### About the Author

G. William Hood was born into the screenprinting technologies as the son of a screenprint shop owner. Hood is a leading, international specialist in screenprinting, across all segments. Hood operates Bill Hood Consulting International, which trains, troubleshoots, problem-solves, and enhances the performance of screenprinting operations worldwide.

He is a Fellow of the Screenprint Process Technical Research Center, a Lifetime Member of the Speciality Graphic Imaging Association and a recipient of the prestigious Swormstedt Award for technical writing and the Joe Clarke Innovator in Screenprinting Award. Hood is an inductee into the Academy of Screen & Digital Print Technologies (ASDPT).

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# EXPO MEXICO 25

The Meeting Point for the Textile, Apparel, and Manufacturing Industry

Expo México 2025: The Meeting Point for the Textile, Apparel, and Manufacturing Industry

- There are more than 19,000 active economic units in the apparel industry, which directly employ nearly 300,000 people according to INEGI (National Institute of Statistics and Geography).
- The World Bank reports fluctuations in the cost of industrial energy in Latin America, forcing companies to adopt cleaner and more efficient technologies.

Mexico City, July 31, 2025 – With a comprehensive view of the challenges and opportunities

facing the textile and apparel industry, Expo México 2025 is consolidating itself as the most relevant event for the sector in the country, bringing together the main players in the production chain: from machinery manufacturers and input suppliers to brands, designers, and smart manufacturing specialists.

The next edition will be held from September 25 to 27 at the Banamex Center in Mexico City, in a strategic alliance with FES-PA Mexico 2025. This collaboration will allow attendees to access an expanded platform of technological and commercial solutions in a single space.

## A new chapter for the textile and apparel industry

Mexico is at a key moment to redefine its competitiveness in the textile and manufacturing sectors. According to data from INEGI (National Institute of Statistics and Geography), the country has more than 19,000 active economic units in the apparel industry, which directly employ nearly 300,000 people. This sector has maintained a steady recovery after the pandemic, thanks to the reactivation of regional production chains, the relocation of operations



(nearshoring), and the integration of new technologies.

In this context, Expo México 2025 presents itself as a strategic opportunity

to drive the transformation of production models and generate new business synergies in areas such as sportswear, fashion, uniforms, technical textiles, home textiles, industrial embroidery, process automation, and more.

### **Technology and solutions for an evolving market**

One of the Expo's main differentiators is its technological focus.

Visitors will be able to experience firsthand state-of-the-art machinery, industrial digitalization solutions, automated cutting

equipment, management and traceability software, robotics, advanced sublimation techniques, 3D design tools, and platforms that optimize response times while reducing waste.

In addition, the event will feature the participation of leading global brands and suppliers who will present innovations designed to respond to current challenges: increased production speeds, customized batches, integration with e-commerce platforms, and new consumer demands.

In the textile industry, sublimation remains one of the most popular and cost-effective methods for product customization. This process has evolved significantly thanks to the introduction of new high-speed

equipment and more sustainable dispersion inks, reducing environmental impact and improving color fidelity. Industry professionals continuously seek training in advanced quality control techniques, color profiling, and material handling to remain competitive in the face of the growing demand for customized products.

### **A space for strategic connection**

Beyond the trade show, Expo México 2025 will be a forum for dialogue between industry leaders, associations, and international experts. The event will offer conferences, panels, and interactive demonstrations addressing topics such as consumer trends, digital transforma-



tion, functional design, sewing automation, color management, quality control, and smart supply chains.

This edition will mark a milestone for its ability to connect complementary markets and create new opportunities at a time of regional reconfiguration, as David Audrain, CEO of Expo Mexico, explained: "We are fully committed as joint entities to the success of the event. It is a full partnership, with concrete benefits for both sectors."

## A unique platform in the heart of Latin America

The alliance with FESPA Mexico will allow visitors to explore not only Expo Mexico manufacturing and apparel solutions, but

also the most advanced innovations in digital printing, sublimation, textile printing, cutting and engraving, packaging, and labels.

This synergy responds to the growing convergence between the two industries. Companies that were previously located in separate segments now share technological needs, design platforms, materials, and market objectives. The integration of both events enhances the exploration and innovation capacity of their visitors.


Expo Mexico 2025 will take place from September 25 to 27 at the Banamex Center in Mexico City. Admission is free with online registration: <https://bit.ly/4IHZIB6> before August 31. The event will bring together more than 250 exhibiting brands and

thousands of professionals from across Latin America in an environment designed to discover the latest machinery, processes, solutions, and global trends in apparel and textiles.

## About the Expo

Expo Mexico is a specialized event for the apparel, textile, and manufacturing sectors in Mexico.

Since 2013, it has offered a business, innovation, and technology platform for the entire value chain. It is organized by Exposition Development Company, a firm with over 55 years of experience in the development and operation of professional exhibitions, and which has been co-organized in partnership with FESPA since 2025. More information at: [www.ExpoProduccion.mx](http://www.ExpoProduccion.mx)



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# Controlling Synthetic Polyester Dye Sublimation and Migration

A thorough understanding of the drying and curing processes is essential for enhancing the efficiency of drying systems.

Since the first day synthetic fabrics entered the screen printing industry, printers have faced the issue of dye sublimation and migration. However, technological advancements in dyestuffs, dyeing techniques, and bleed-resistant printing inks have significantly reduced these issues. Despite advancements in textile printing inks, flash units, and curing technology, dye migration and sublimation continue to plague the textile screen printer. To fully understand the solutions to controlling the problem, one must first understand the characteristics of the components involved.

As with any aspect of textile screen printing, the variables involved in the scenarios are

enormous. The elements that must be taken into consideration when dealing with synthetic dye sublimation and migration are:

- Characteristics of synthetic dye sublimation.
- Characteristics of synthetic dye migration.
- Synthetic fabric content of the substrate.
- Synthetic dye type.
- Fabric dyeing and rinsing processes.
- Heat sensitivity of the fabric and dyes involved.
- Bleed resistance of the ink.
- Printing techniques.

This section will review the aspects of each of these variables and the role each one plays in synthetic dye sublimation and migration.

## Sublimation Defined

Synthetic dye sublimation is an interaction between the dyes employed in the coloration of synthetic fibers and heat. Regardless of the dyeing processes, most if not all, synthetic dyestuffs will sublime (change from a solid state to a gaseous state) at a given temperature. The temperature at which a given dye will sublime is dependent on the types of synthetic dyestuffs, dyeing processes, and synthetic fibers that were incorporated into a given substrate.



Photo 1

## Migration Defined

Dye migration takes place as an interaction between the petroleum-based polyester dyestuffs and the petroleum-based plasticizer employed in plastisol screen printing inks. The petroleum-based plasticizer in plastisol inks devolves the residual petroleum-based polyester dyes, which allows the dyes to travel through the residual plasticizer network within the plastisol ink film until the dyes reach the surface of the ink film and appear as migration. **Photo #1** shows an area of a print where the dye migration process has begun due to insufficient cure. The lighter area within the ink film indicates synthetic dyes that are starting to migrate into the ink film.

## Synthetic Fabric Content Of The Substrate

In most cases, the possibility of polyester dye migration is directly proportional to the polyester content of the fabric. Garment manufacturers have employed polyester as a 100% fabric or as a blend for some advantages that polyester offers.

1. Polyester fabrics are resistant to shrinkage as opposed to cotton, which can shrink as much as 5% or more. Incorporating medium to high polyester contents into a fabric diminishes the need to "overcut" a garment to allow for the mentioned shrinkage.

2. Polyester maintains a greater color strength via superior wash fastness and light fastness as opposed to cotton.

3. Polyester is relatively inexpensive compared to cotton, which lowers both the manufacturing materials cost and the end-user cost.

As the issue of synthetic dye migration becomes more and more apparent to garment manufacturers, manufacturers are offering garments (particularly fleece) with decreased polyester dye content. You can now find garments on the market with all combinations of polyester content as opposed to the standard 50/50 cotton/polyester blend. A preferred blend for many textile

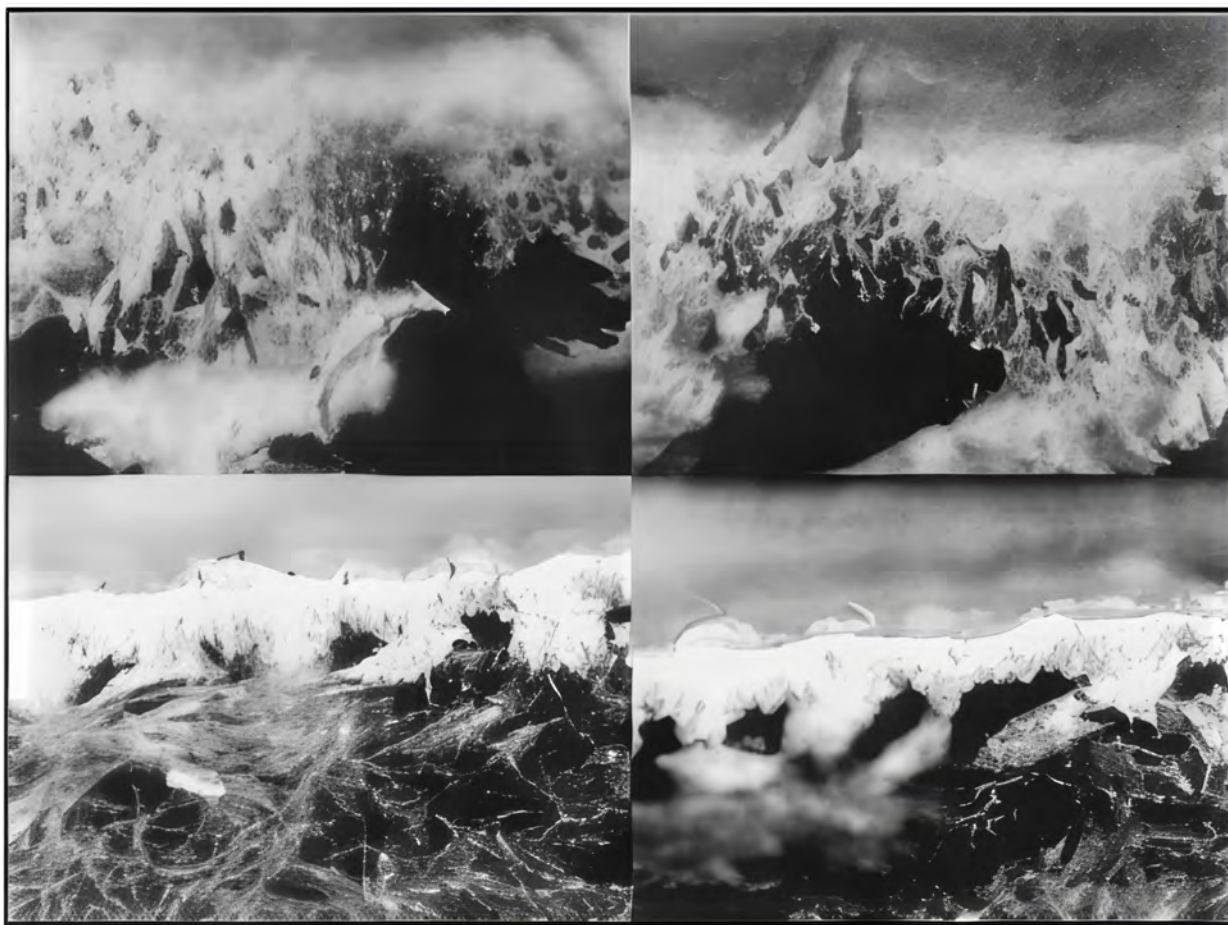


Photo 2

printers is the 95/5 cotton - polyester blend fleece. A fabric of this type offers all the advantages of printing on 100% cotton while maintaining the shrinkage resistance of polyester.

Some manufacturers have also made progress in knitting processes wherein the fleece garment can contain a 50/50 blend of cotton and yet have the cotton portion of the fabric on the printing surface of the garment, while the polyester portion is on the inside of the fabric. The advantage of a fabric such as this is that the ink will only be printed onto the cotton dyed portion of the fabric and be separated from the polyester...thus dimin-

ishing the probability of migration.

## Synthetic Dye Types And Dyeing Processes

Although there are numerous dye types employed in the dyeing of synthetic fibers, dispersed dyes are the primary dyes that are used in the processing of most 50/50 tees and fleece products.

Dispersed dyes are primarily employed for most polyester fabrics in the T-shirt industry. These dyes are set into the polyester under strict conditions, which allow the polyester fiber to swell during the dyeing process

and absorb the dyes into the fiber. These dyes are usually dyed at 70°C (160°F) and pressurized during the dyeing process. Once these dyes are set into the fiber, they are resistant to thermal dye sublimation to 182°C (360°F). It is for this reason that many printers suffer from synthetic dye migration when they heat the fibers beyond the 182°C point and release the (gaseous) dyes into the ink film. Once this occurs, the sublimated dyes can solidify within the ink film and begin the dye migration process.

Cationic dyestuffs are another type of dyestuff that holds particular interest for the textile screen printer, as they allow for

## Gas Dryer Heat Profile

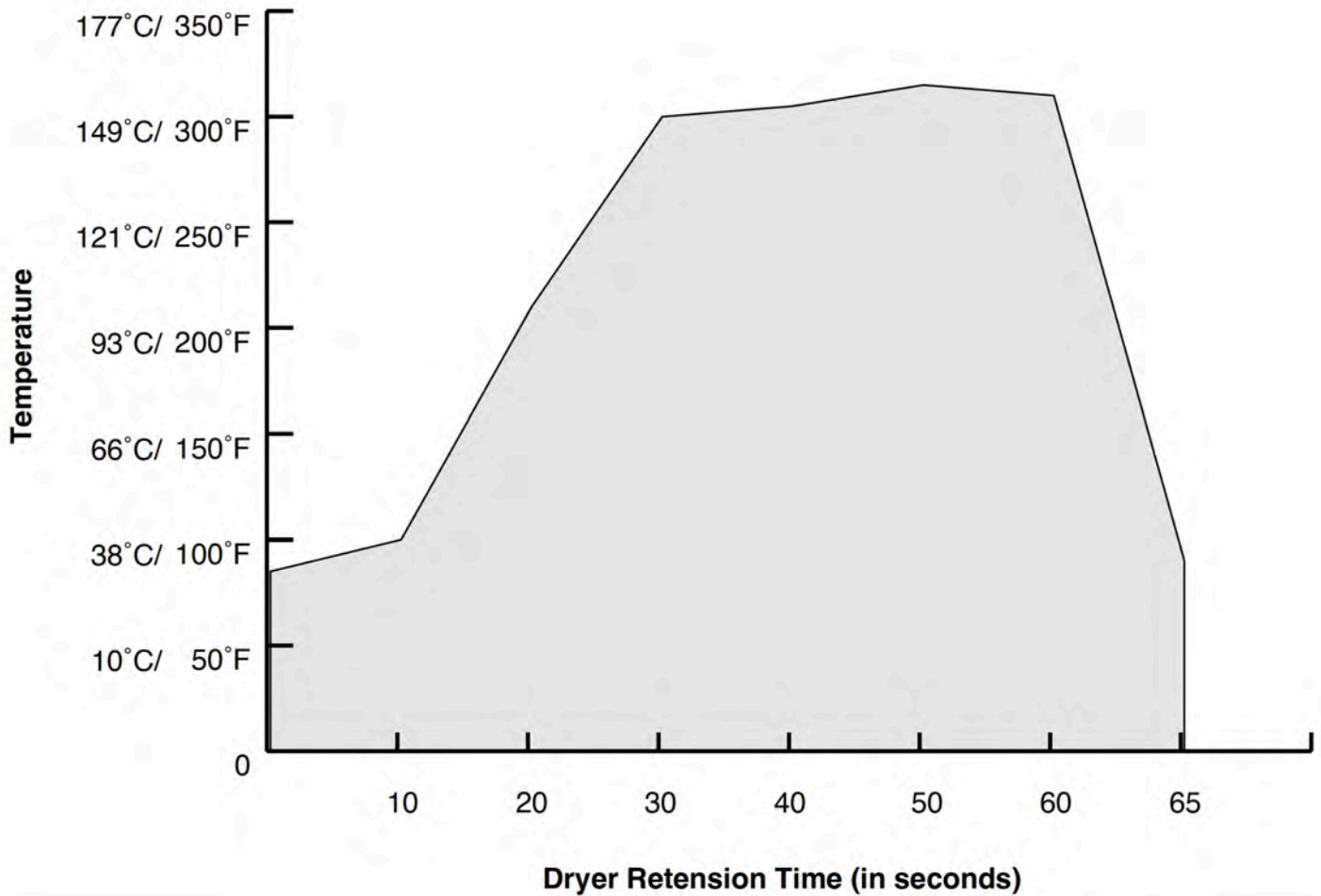


Figure 1: Showing the typical rise and fall of heat in a gas dryer. Astute readers will note that the heat is held over a long period of time, which allows for an increase in production.

printing on fabrics that have been processed with cationic dyes, which are pretty resistant to dye migration. Cationic dyes require specially prepared polyester or acrylic fibers, which allow themselves to be locked into the fiber during the thermosetting process. The downside to this option is that cationic polyester or acrylic typically carries a higher price due to the specialized processing required for dyeing.

## Fabric Dyeing And Rinsing

From the standpoint of the fabric, two primary aspects of the fabric dyeing process are essential to the degree to which the fabric is likely to migrate or sublimate. First is the amount of dye being applied to the polyester fibers. During the dyeing of the polyester fibers, the fabric is heated to 82°C to 127°C (180°F to 260°F), at which point the polyester dye sites expand and allow for the absorption of the dyes. Once the polyester fibers have been dyed, residual

dyes can be left on the surface of the fabric. It is these dyes that are susceptible to dye migration. The second is the rinsing process, which is employed to remove those residual dyes from the surface of the fabric. Should a fabric have a sufficient dye content and an insufficient rinse process, the fabric will have a greater probability of migrating. Another aspect to consider is the weight of the fabric—a 6 oz. A 50/50 fleece will not contain the dye content of a 9 oz. 50/50 fleece is used because it has less polyester by weight. A heavier-weight fabric

## Radiant Dryer Heat Profile

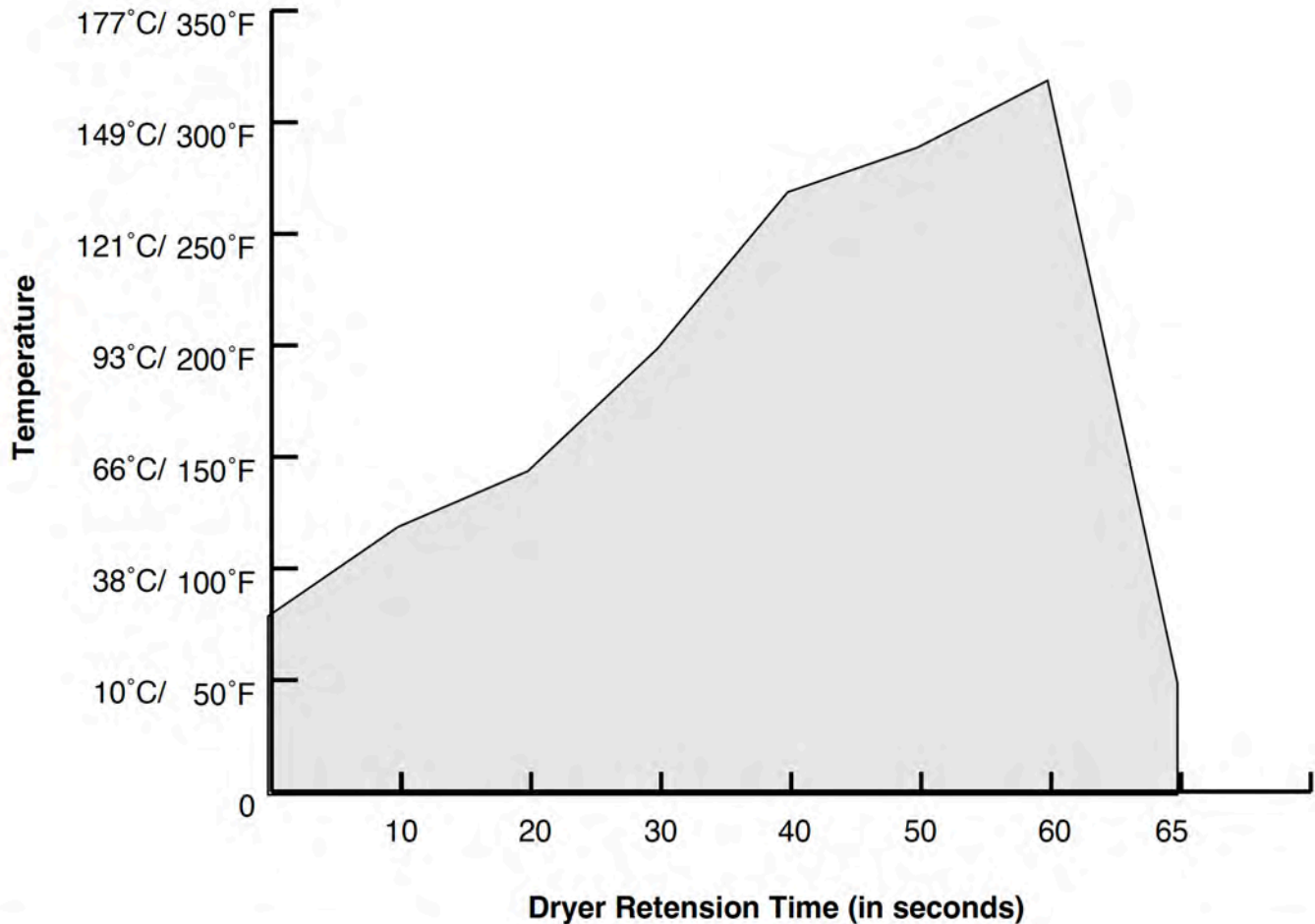


Figure 2: Note the sharp spike of full cure which is an extremely small window of opportunity, which is why so many opt for a gas dryer over infrared curing systems.

requires more dye than a lighter-weight fabric, and thus necessitates a greater amount of rinse during processing to remove residual dyes.

### Heat Sensitivity Of The Fabrics/Dyes

Although the dyes in most commercial polyesters are heat-set to retain excellent color fastness, most polyester dyes used in T-shirts and fleece can withstand temperatures up to 182°C (360°F). It is at this point that the polyesters sublime into a gaseous state and penetrate the

plastisol ink film. In most quality dyed fabrics, it is the residual polyester dyes on the surface of the fabric that sublimate and not the dyes within the fibers. The value of knowing this fact is understanding the reaction between the dyes in the polyester fabric and the heating process during flashing and curing. Most dye sublimation takes place during the flashing while the fabric is exposed to 482°C to 538°C (900°F to 1000°F) from the flash unit. It is this fact that dictates that printers need to print at slower speeds with the flash unit temperature decreased, as op-

posed to super-heating the ink and garment in the name of productivity.

### Bleed Resistant Plastisols

As the textile screen printing industry has evolved to higher quality printing through high tension, thinner ink films, and softer prints, the ink manufacturers have been charged with improving the bleed resistance of plastisols to deter dye migration while printing under these conditions. The products employed today range from bleaches to organic

# CONTROLLING SYNTHETIC POLYESTER DYE SUBLIMATION AND MIGRATION

By Rick Davis

From the August 2025 Issue of Screenprint Magazine

<http://screenprintmag.com>



Click the illustration above to listen to the podcast for a more Deep Dive version of this article.

peroxides. As OSHA and the EPA have invoked stricter guidelines on the manufacturing of plastisols products, many manufacturers have moved away from bleaches to organic peroxides. Plastisol manufacturers also employ fillers, which increase opacity and assist the dye blockers in dye migration.

The degree to which a plastisol will deter synthetic dye migration is dependent on the type and amount of dye blocking agent employed in the ink formulation. Unlike the offset printing industry, which uses SWOP (Standard Web Offset Printing) inks, the textile printing industry lacks standards for plastisol manufacturers to follow. This is partially due to the wide range of substrates on which a plastisol must perform. Due to this fact, it is up to the textile printer

to determine which product performs best on the fabrics that they print. Since no two batches of plastisol or two lots of polyester dyed fabrics are the same, it pays to print-test random lots of inks and fabrics regularly to ensure that the products are going to perform up to the required quality standards.

The level of cure, which is bleed-resistant, is also crucial in deterring dye migration. As the plastisol cures, the PVC resin in the plastisol swells under the heat and absorbs the liquid plasticizer to solidify the ink film. If all the available plasticizer is not absorbed, the residual plasticizer will solvate the available dyes on the fabric, allowing them to migrate through the plasticizer network until they reach the surface of the ink film. This can take place within 2 hours to 6

weeks. Due to this fact, if a plastisol requires 160°C (320°F) to cure properly, the entire ink film thickness must reach that temperature to remedy and deter dye migration adequately.

## Printing Techniques And Fusion Parameters

Knowing that the dye migration is caused by a solvating interaction between the plasticizers in the plastisol and the residual polyester dyes on the fabric, the logical solution is to minimize the contact between the ink and the fabric. High-tension printing allows the ink film to be deposited on the surface of the fabric as opposed to pressing the ink into the fabric from the excessive squeegee pressure required by low-tension mesh. **Photo #2** shows a cross-section of the same fabric with the ink deposited into the fabric under low ten-

# THE FOUR WAY TEST

of the things we think, say, or do

## First

Is it the TRUTH?

## Second

Is it FAIR to all concerned?

## Third

Will it build GOOD WILL and  
BETTER FRIENDSHIPS?

## Fourth

Will it be BENEFICIAL to all  
concerned?

sion printing conditions and the ink deposited onto the fabric under high tension printing conditions.

Having the ink pressed into the fabric allows the garment to act as an insulator for the ink and will thus require additional time and temperature to achieve a proper cure. Retensionable printing frames should be employed when printing on synthetic or combination fabrics to minimize the ink/fabric interface. In addition to reducing the ink/fabric interface, high-tension screens will deposit a thinner and more opaque ink film onto the surface of the fabric. The thinner ink film will require less time and temperature during flashing and curing process; in turn, minimizing the probability of thermal dye sublimation.

From the standpoint of dye sublimation within the printing process, the key to controlling the process is to minimize the amount of heat to which the fabric and ink are exposed during the flashing process. Although many printers feel that their fabric temperature does not reach 182°C (360°F) while flashing, please consider the surface temperature of the flash panel

and the proximity of the fabric to that panel. Should the flash panel be running at 482°C to 538°C, the amount of time it will take for the polyester to reach 182°C will be scant seconds. Although the garment remains under the flash unit for only a matter of seconds, the difference in dye stability and sublimation can be as little as a half-second. It is advantageous to decrease the heat of the flash unit and slightly decrease the cycle time during the flashing process if you suspect sublimation as a contributing factor in any migration issues that might be experienced.

It becomes apparent at this point that the thermal window textile screen printers must work within a relatively small thermal window. Since most plastisol screen printing inks require 160°C (320°F) of heat to cure properly, while keeping the polyester fibers from reaching 182°C (360°F), great care must be taken in the amount of heat to which the fabric and ink are exposed, not only in the flashing process but also in the curing process. Among the available curing units today, forced-air gas dryers offer the most significant amount of heat control com-

pared to conventional radiant heat dryers. Forced air - gas dryers rapidly raise the ink film temperature to 160°C and plateau for a given period, as opposed to radiant dryers.

Standard radiant heat dryers will slowly heat the ink until the ink film reaches 320 degrees. In most cases, this point is reached just before the garment exits the dryer.

Although radiant dryers can plateau around 160°C (320°F), their plateaus are often erratic because many models rely on thermostats or percentage timers.

## Conclusion

Synthetic/thermal dye sublimation and migration are manageable issues as long as there is a clear understanding of the interactions between the artificial dyes, inks, and heat exposure. Once you have identified the potential for migration issues within a given fabric, the appropriate safeguards and procedures can be put in place to address the problem.



**Rick Davis** began his career running a 4-color Hydraulic Precision Oval in 1976 for Tee Formations (in a barn) in Tipp City, Ohio. He would go on to become a plant manager. He worked as a Sourcing Manager for Levi Strauss & Company with their Latin American Division. Later, he served as an Application Specialist for Flexible Products and would later become the Quality Assurance/Contract Manager for Hanes Licensed Products.

Since then, Rick has enjoyed a background in Production Management, Artwork Engineering, and as an industry consultant. He is the author of many outstanding technical articles for the screenprinting industry and was a frequent speaker at industry trade shows.

Rick is a past winner of the SGIA Golden Image Award (Golden Squeegee). And has been nominated three times for the Swormstedt Award for outstanding technical writing. Rick is a 1998 inductee into the Academy of Screen and Digital Print Technologies (ASDPT).



# **WORDS MATTER**

**Change the course of life  
by simply increasing  
vocabulary and knowledge.**

**Compliance colors (non-toxic colors):** inks that conform to US governmental regulations by not containing any of the banned heavy metal salts.

**Compliance date:** the date that a business is required to meet applicable pollution control requirements (US).

**Component:** an ingredient in a formulation; a part of the whole.

**Composing stick:** a hand tool where foundry type is assembled and justified.

**Composite:** (1) an art layout where all color separations are shown in one piece of copy, usually black and white; (2) a homogeneous material created by the synthetic assembly of two or more materials to obtain specific characteristics and properties.

**Composite film:** Graphic arts films made by combining two or more images.

**Composite proof:** Proof of color separations in position with graphics and type.

**Composition:** Text matter set in type.

**Compound:** (1) a combination of elements in a stable molecular arrangement; (2) to mix pure vinyl with plasticizers, stabilizers, lubricants, colorants, or other ingredients before it can be properly processed.

**Comprehensive dummy:** Complete simulation of a printed piece. When produced on a promotional product, comps are often called “spec samples”.

**Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA):** a US federal program enacted and designed to cleanup identified environmentally damaged sites, commonly referred to as the Superfund Program.

**Comprehensive or comp:** A preliminary version of a design, often created for client input or ap-

proval; a comp (short for comprehensive) dummy. When produced on a promotional product, comps are often called “spec samples”.

**Compression:** the process of removing irrelevant information and reducing unneeded space from a file in order to make the file smaller. Compression can cause losses and distortion, depending on the method, also reducing the size of a file through an alternate encoding process.

**Compression molding:** plastic molding process where the molding material is liquefied in the mold, shaped, and cured under pressure before being ejected, typically used with thermoset plastics.

**Compressive strength:** the maximum ability of a solid material to withstand a compressive load; resistance to crushing or shattering.

**Computer Aided Design (CAD) or Graphics (CAG):** system used to generate and reproduce full-color designs, artwork, photographs, etc., through use of a computer, plotter, printer, keyboard, etc.

**Computer graphics:** the interactive production and layout of graphic material, text and images, by means of computer keyboard, light pen, digitizer, mouse, and other hardware/software integration.

**Conc:** abbreviation for concentrated.

**Concentrated solution:** a solution containing a large amount of solute in proportion to the solvent; See dilute solution.

**Concentration:** the amount by percentage of a solute contained in a given amount of solution.

**Concept Proof:** Color proof (printout) from desktop color PostScript™ printer. The concept proof is used to preview for design, layout, text positioning and color selection. Used by service provider, printer or decorator to give to a client for project approval.



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- Pushing Profit Margins
- The Tension Meter
- Squeegee Concave Effect
- Controlling Humidity
- Plain Versus Twill Weave

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- The Fill Blade
- Interface Pressure and Soft Tops of Platens
- Printing 1-2-3
- Terminology: Words Matter

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- Time and Temperature
- The Real Costs of Flashing
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- How to Calculate Downtime Production Losses
- Thermocouple and Donut Probe
- Power Interruptions and Brownouts
- Increasing Production Through Dryer Placement
- Terminology: Words Matter

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- Maximum Image Size
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- The Decisions We Make
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- Reader's Feedback
- Registration Systems
- Tension Controls Color Hue
- Small Particles of Plastisol Ink in Mesh
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- Registration Targets
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- ScreenJet Computer to Screen
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- Rapid Tensioning Method
- The Problem With Coating Low-Tensioned Mesh
- Mesh Elongation
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- An Analysis of a One-Second Slowdown
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- Tension Meter Measurement Area
- Thermal Imaging Devices
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- The Problem with a One-Dimensional Mind in a Three-Dimensional World
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- Inexpensive Off-Contact Gauge
- Using the Power of the Internet To Find Almost Anything
- Terminology—Words Matter

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- Monitor Calibration
- Color Choice
- The Problem of Matching Color on Press
- Color Terminology

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- The Beginning of a Screenprinting Myth
- Wifi Temperature Monitoring
- Capillary Film
- Leaving Money on the Table
- Terminology—Words Matter

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- Nothing is Constant Except Change
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- Approximately 80 percent of All Stencils are Underexposed
- WiFi Digital Microscope
- Argument of Lack of Evidence
- Terminology—Words Matter
- Article Index

## April 2023 Issue

- A Closer Look at Mesh: Its Properties and Parameters
- The Importance of Choosing Color Systems Based on Usage
- Reducing Waste To Lower Costs and Increase Margins
- Mastering Factors Affecting Ink Deposit
- Illustrating Mesh to Determine Correct Ink Deposit
- Press Calibration Test
- Fimor Edge Polisher
- What's in Your Toolbox?
- Terminology—Words Matter
- Article Index

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- Artificial Intelligence: Rudimentary Reconstruction of the Observed Thought
- Screenprinting's Historical Role in Artificial Intelligence
- Achieving Accuracy in Setting of Proper Pressure
- Better Methods of Finding Factual Information Online
- Artificial Intelligence for Serious Researchers, Technical Authors, or Professional Printers
- Dry or Liquid Filled Pressure Gauges
- 30 Changes For Improvement
- What's in Your Toolbox?
- Terminology—Words Matter
- Article Index

## June 2023 Issue

- George Dempsey Legh-Page Jr. (Mar 20, 1948–May 21, 2023)
- Frank Kozik (Jan 9, 1962 - May 6, 2023)
- The Value of Protecting International Intellectual Property Rights
- Business Agility through Knowledge Innovation
- Pros and Cons of Using High Pressure in Screenmaking
- AWT Seri-Vac Aluminum Nozzle
- Variable Analysis of Stencil Preparation
- Drying Emulsion
- Terminology - Words Matter
- Article Index

## July 2023 Issue

- Celebrating Guru Purnima
- The Cost of Making Poor Snap Decisions
- We Don't Have Time!
- Know Your Cost Per Impression
- Investing in Business Analytics for Better Use of Time
- Exposure Reflector Shape and Distance
- Never Use This Type of Brush When Cleaning Mesh
- Use Proper Reclaiming Chemicals to Save Time and Money
- Terminology - Words Matter
- Article Index

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- Looking Beyond the Hype of Accelerated Growth
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- Understanding the Cause and Effect of Recessions and Their Impact on Screenprinting
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- Take Printing to the Next Level with a Viscometer
- Sheer Stress of Inks and Coatings in Screenprinting
- The Ever-Changing Squeegee: Extending the Lifespan
- Terminology—Words Matter
- Article Index

## September 2023 Issue

- Critical Thinking in the Screenprinting Process
- Asset Management of Screens and Mesh
- Looking Beyond Perception
- The Valuation of Labor, Inventory, Material, and Energy Losses in Screenprinting
- Stand-Out Presentations that Convey and Inform
- Finding Air leaks with a Gauge
- Off-Contact Plane
- The Inverse-Square Law
- Terminology—Words Matter
- Article Index

## October 2023 Issue

- Basic Best Practices for the Ideal Stencil
- Dryer Adjustments with Temperature and Humidity Changes
- Mythconceptions About White Ink
- Initiating a Change Process
- Frame Transportation Devices
- Quote of the Month
- Software for Accurately Determining Ink Usage
- Shore A Squeegee Hardness
- Terminology - Words Matter
- Article Index

## November 2023 Issue

- The Interdependencies of Rheology in the Screenprint Process
- Dramatic Efficiency Improvements with a Counting Scale
- Benefits of Retaining a Mentor
- The Filter Bubble Phenomenon
- Fluid Mechanics of Screenprinting White Ink
- Quote of the Month
- Designing for the Masses
- Organizing Orders / Shop Communication
- Cease Replacing Pressure Washers
- Terminology - Words Matter
- Article Index

## December 2023 Issue

- Investing in Quality Screenprinting Tools
- Investing in Vernier Beam Calipers
- Removing the Off-Contact and Peel Confusion
- Return on Investment of Retensionable Frames
- Controlling Ink Transfer with Tension
- Quote of the Month
- Tagless Adhesive Mask for Decorated Apparelists
- Transparency and Darkness of Film-Positive
- Tools to Budget for 2024
- Terminology - Words Matter
- Article Index

## January 2024 Issue

- Increase Production by Eliminating Chaos in Pre-Press
- Mesh as a Metering Tool
- Stereopsis and the Geometric Parallax Effect
- The Three Dimensionality of the Stencil
- How Small Changes Can Make a Huge Difference
- Quote of the Month
- Designing for the Masses
- Organizing Orders / Shop Communication
- Cease Replacing Pressure Washers
- Terminology
- Article Index

## February 2024 Issue

- An Analysis of the Frame System in Screenprinting
- Making Happy Clients
- Achieving Maximum Opacity
- Screenprint Manufacturing Goal Improvements
- Quote of the Month
- The Problem with Word-of-Mouth Advertising
- Squeegee Placement and Off-Contact Affect Quality Stencil Requirements
- Thickness Gauge
- Terminology
- Article Index

## March 2024 Issue

- Developing a Profit Per Employee Plan
- Reducing Labor and Overtime Costs
- Use QR Codes in Screenprinting to Avoid Chaos
- Moving From Mediocre to Wisdom
- The Psychology of Discount Pricing That Wreaks Havoc on Business
- Quote of the Month
- Choosing an Emulsion
- Ink Deposit Thickness
- Terminology—Words Matter
- Article Index

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## June 2024 Issue

- More Color With Less Screens
- Project Management Simplified
- Steps To Avoid Pinholes
- Achieving Resolution with Coarse Mesh
- Control of Dot Gain in Inkjet Films
- Hydrochromic Effect
- Seven Rules for Printing Blue Ink
- Using a Fan to Dry Emulsion is a Myth
- Terminology
- Article Index
- Quote of the Month

## July 2024 Issue

- Why Inkjet Ink Sticks to Emulsion During Exposure
- Path to Higher Impact and Results
- Anthony E. Velonis: Reinventing Screenprinting
- Growth Factors in Screenprinting
- Reframing the Question
- Terminology
- Article Index
- Quote of the Month

## August 2024

- Division Within Screenprinting
- Print Inefficiency Resolved
- Smart Growth for Business
- Expanding or Relocating a Business
- Growing the Business Using an Outside-In Strategy
- How the Four-Way Test Saved a Company from Bankruptcy
- Quote of the Month
- Terminology
- Article Index

## September 2024

- Quality Is a Habit, Not an Action
- Seven Steps to Achieving Goals
- Increasing Productivity
- Six Ways to Reduce Office Waste
- Best Practices for Reducing Spoilage Cost
- Creating an Ink Specification Record
- Quote of the Month
- Terminology
- Article Index

## October 2024

- The Ultimate Arbiter of Superior Print Results
- Perfecting Vector to Raster Image Export
- Resolving Fibrillation on Textiles
- Industrial Screenprinting Market Analysis
- What We Learned About Labor in the 20th Century
- Quote of the Month
- Terminology
- Article Index

## November 2024

- Avoiding Becoming a Victim of Email Phishing
- Feedback is Key to Becoming Successful
- Achieving Great Stencils With Good Practices
- Doubling Manual Production
- Common Mistakes Most Business Owners Make
- Quote of the Month
- Terminology
- Article Index

## December 2024

- A Primer on Surface Energy: Understanding Dyne Level
- Linearization in Screenprinting
- Safety Spring Covers
- Looking into 2025
- The Impossible Task of Matching Color
- Terminology
- Article Index
- Quote of the Month

## July 2025

- Building a Successful Marketing Strategy
- Don Newman: The Man Who Tuned Screen Printing to Perfection
- The Water-Based Ink Mindset
- FESPA Mexico
- The Paradox Between Statements and Predictability
- Terminology
- Article Index
- Final Thought
- Quote of the Month

## August 2025

- Spotlight: John Massey
- Practical Solutions for Improving Problem Solving
- The Process of Drying and Curing Inks and Coatings
- FESPA Mexico
- Controlling Synthetic Polyester Dye Sublimation and Migration
- Terminology
- Article Index
- Final Thought
- Quote of the Month

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Consider what  
you might  
accomplish if  
you could not  
make excuses  
for your  
behavior.



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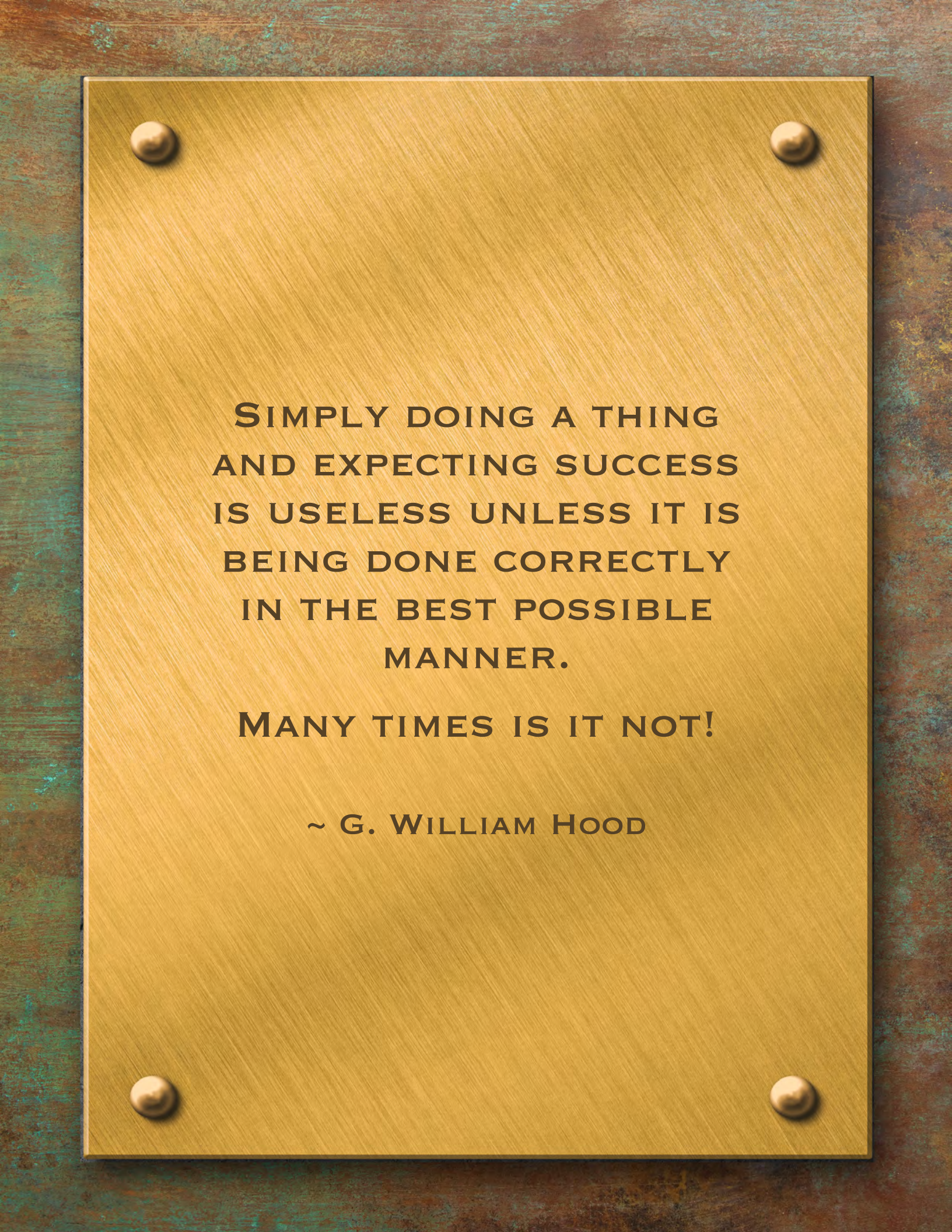
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**SIMPLY DOING A THING  
AND EXPECTING SUCCESS  
IS USELESS UNLESS IT IS  
BEING DONE CORRECTLY  
IN THE BEST POSSIBLE  
MANNER.**

**MANY TIMES IS IT NOT!**

**~ G. WILLIAM HOOD**