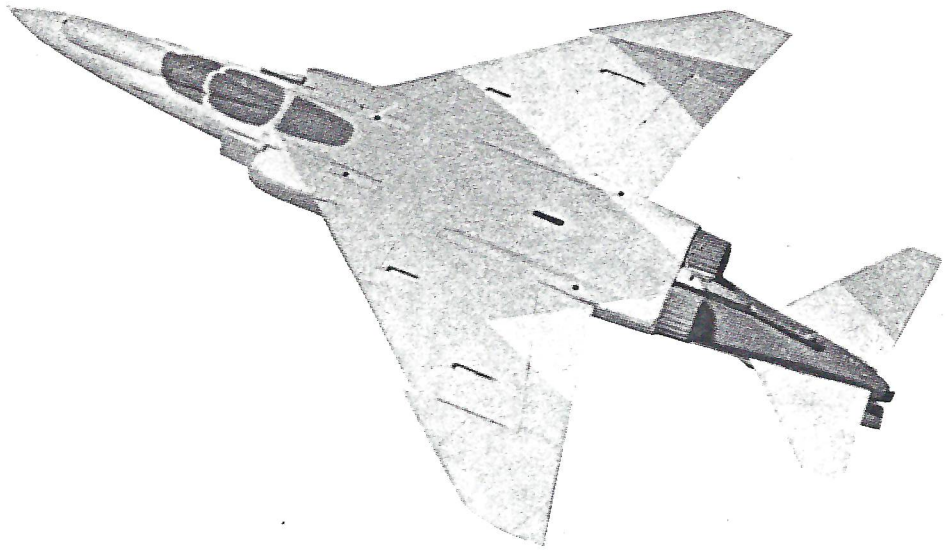
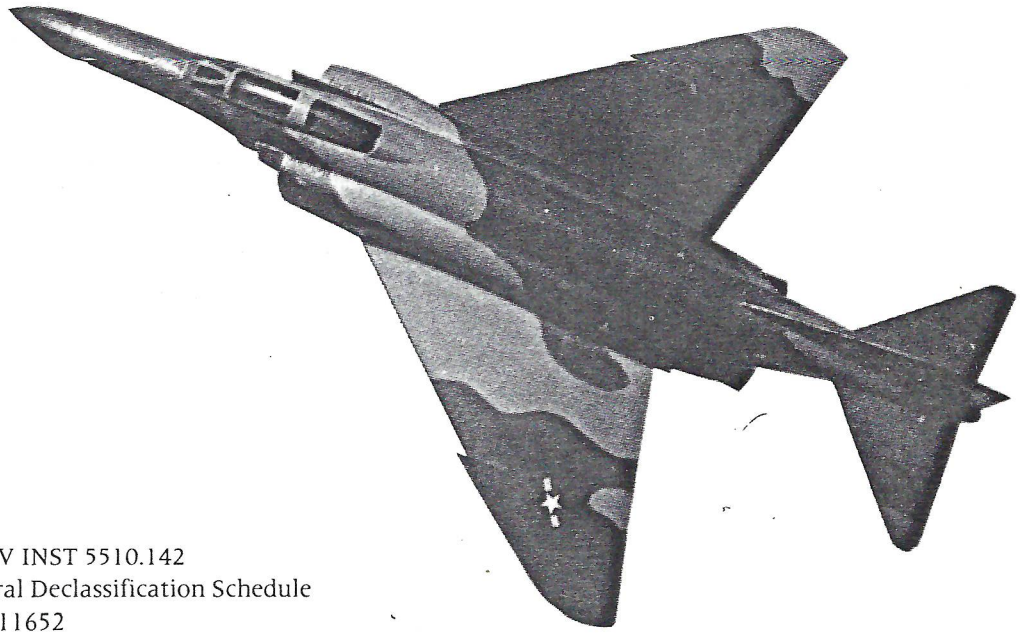
TOPGUN JOURNAL (U)

VOLUME 1, NUMBER 2 SPRING, 1976





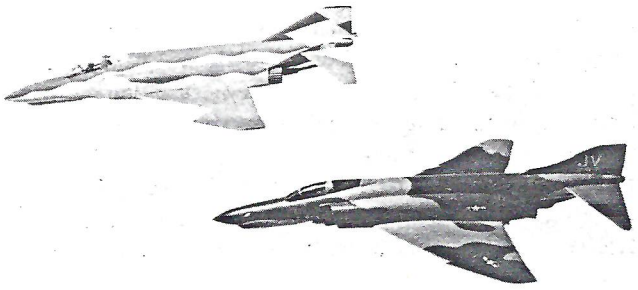
The Keith Ferris Deceptive Aircraft Paint System: Another *Nickel on the Grass*?

Morris Plains, New Jersey

(U) My friend Moody Suter, former chief of the air-to-air section of the 414th Fighter Weapons Squadron at Nellis AFB, once told me "Beating the ——— out of dirt is for the technicians. . . . Air Fighting is for the artists!" As an artist who has spent the better part of twenty-five years documenting military aviation with paint and brush, I agree with Moody. Air-to-air *is* for artists.

(C) Now that air-to-air has become the primary mission for many lucky airmen, new aircraft designed expressly to fulfill that mission are entering service or being developed for the Navy and Air Force. Camouflage optimized for the air-to-air mission is being considered.

(U) I have not seen any of the studies for new camou-

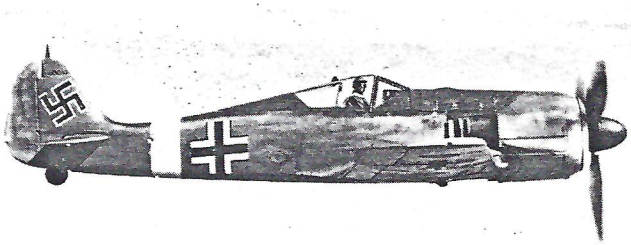


flage schemes, so they will not influence what I say here. I have seen excellent color slides of *Topgun* aircraft as well as those of 64th FWS (Aggressor Squadron) based at Nellis. I understand that the paint schemes of those are used to simulate a broad spectrum of typical threat aircraft. *Topgun's* A-4s, F-5Es, and T-38s, and the USAF T-38s of the 64th FWS appear in paint schemes whose descriptions might range all the way from Easter Egg through Yuk and modified Zebra to Air Superiority Blue.

(C) Camouflage schemes for aircraft of all nations historically appear to have shown more concern for disguise against features of the earth's surface than for concealment against cloud, sky, or the more distant earth of the patrolling fighter. The past decade has seen USAF tactical aircraft painted as though for concealment while parked or working down among the trees. In an air-to-air engagement this scheme presents an almost constant dark silhouette to an opponent and remains visible at great distances.

(U) Since the days of the Red Baron there have been occasional exceptions. Some of those show evidence of completely different concepts. The major exception is the camouflage scheme worn by aircraft of the German *Luftwaffe* fighter arm of World War II.

(C) German fighter camouflage is of particular interest during current efforts to optimize U.S. air-to-air paint schemes. The primary mission of the *Luftwaffe* fighter force remained the destruction of opposing air forces for the duration of the conflict. Its aircraft entered the war in a paint scheme shared by almost all categories of *Luftwaffe*

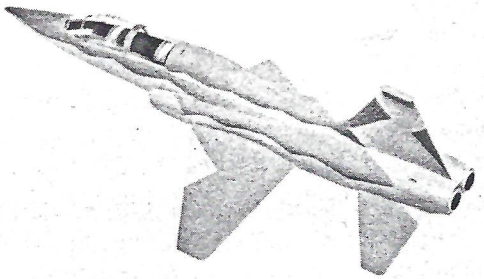


combat aircraft. This obviously was tailored to surface and low-altitude concealment. Air combat experience quickly led to field modifications which evolved into an officially directed specialized air-to-air paint scheme.

(U) The initial World War II *Luftwaffe* camouflage scheme consisted of a splinter pattern of two very dark brownish-greens (World War II *Luftwaffe* Color Standards 70 and 71) covering the entire airframe seen from sides or above. The undersurface of wings, fuselage, and hori-

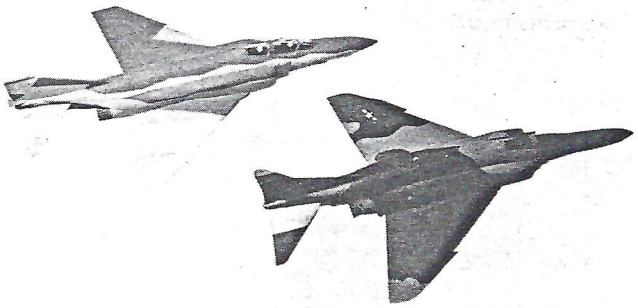
zontal stabilizer were painted in a light blue (Color Standard 65) not unlike the F-15's Air Superiority Blue.

(C) By the end of the Polish campaign many single- and twin-engined fighters were flying with field modifications to the dark paint scheme. Photographic evidence suggests fighter pilot concern for the dark silhouette presented by the dark standard paint on fuselage sides and vertical stabilizer. A light greenish-gray was oversprayed in patches, primarily in the side view. In some cases it appears that the lighter greenish-gray was used to increase contrast on the top of the wings as well.



(U) Lessons learned in the Polish campaign were incorporated in a new official camouflage scheme appearing on *Luftwaffe* fighters in the spring of 1940. The light blue (65), previously seen only directly from below, now covered the entire fuselage except for the upper decking and included the vertical tail surfaces. The darker splinter pattern was retained in the top view on wings, horizontal tail, and the very top parts of the fuselage.

(U) Aircraft with a primary ground attack or bomber mission remained in the overall dark color scheme generally throughout the war.

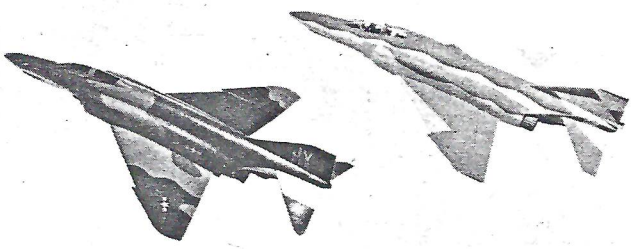


(C) Fighters with an air combat mission adhered to the air-to-air camouflage principles, yielding only to changes in detail and color with time and experience. Initial addition was application of soft spots of gray or grayish-green on sides and vertical tail to break recognizable silhouettes. Color in the side view gradually changed to a light gray (76) similar in value to the blue. The dark greens (70/71) of the upper surfaces gave way to grays (74/75) while in appearance the overall application to fuselage and vertical stabilizer became softer and softer. Wings remained in basic splinter patterns.

(U) Exceptions were widespread, especially on the Eastern and Mediterranean fronts. These were usually in the form of temporary finishes reflecting the need to hide aircraft from allied intruders while parked or working at low level. Aircraft based in North Africa did bow to the warmer color of that environment, changing to a sand color with locally applied spots of darker brown or green.

(C) Jet and rocket fighters adhered to air-to-air camouflage principles. Me 262 operational units appear to have used very light grays possibly reflecting higher operational altitudes. On many the upper decking was sprayed with darker paint. One does see photos of individual Me 262s with vertical tails darkened for surface concealment. The rocket powered Me 163 seems to have been delivered with the old 70/71 wing and fuselage, but with the vertical tail surfaces in light blue or gray. This is in line with its short flight duration and need for surface concealment.

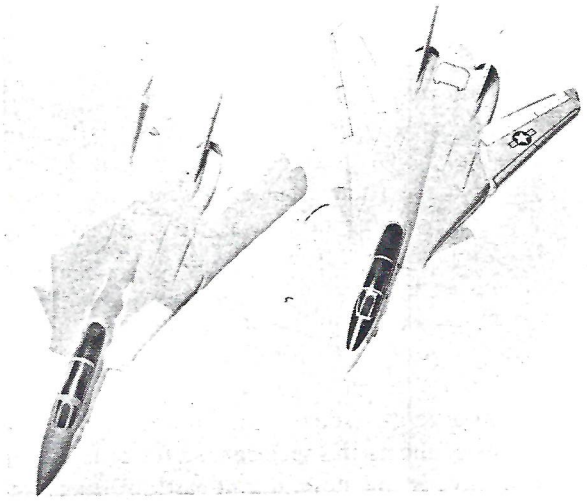
(U) German national insignia, which ironically was made more visible at the time of the change to specialized air-to-air camouflage in 1940, went through changes pro-



gressively reducing their visibility as the war progressed. The final form was a simple black or gray outline to a no-longer-existing cross, use of white being dispensed with completely.

(U) Historical analysis of the fundamental concepts laid down by the Germans in World War II led me to develop my thesis for a modern deceptive aircraft paint system.

(C) As mentioned earlier, I have been doing paintings of aircraft in flight for a good many years. I have painted machines of allies and enemy engaged in most of the major conflicts in which aviation has played a part. I do not intend here, however, to compare colors or camouflage patterns of the combatants. That mass of detail is more



appropriate for the artist, the model builder, or those engaged in restoration for museums. In disguising an aircraft for a particular environment, the basic concept is of greater importance than color or pattern.

(C) In contrast to the purposes of camouflage, the artist strives to define his aircraft as clearly as possible. He chooses an overall silhouette which identifies the aircraft at a glance. He carefully shows its form, its bank angle attitude, and direction of flight as well as its position relative to the sun, earth, and other aircraft. (Do those visual clues sound familiar?) Portraying the aircraft itself involves careful analysis of the effect of sun or other light source and of reflected light and shadow as they play over the form of the machine. Obviously the paint scheme of the aircraft is defined in the process.

(C) The sky is an arena of enormous depth. Capturing that depth in paintings has driven home to me the fact that the greater distances involved in the air degrade detail far more than is apparent on the ground. As things grow smaller in size with distance, they also grow progressively lighter in value, less distinct, and more gray in color. This is the background against which one sees the air-to-air paint scheme.

(C) It has become apparent that the more effective the air-to-air paint scheme of an aircraft, the more difficult it is for me to clearly define in a painting. The camouflage principles which are most likely to delay visual acquisition and identification are the same as those which will empede portrayal of your aircraft by this artist.

(U) Conversely, if I am able to portray a camouflaged aircraft with ease in a painting, I believe that the basic concept of its paint scheme is suspect.

(U) Surprising as it may seem, the majority of *Topgun* and USAF 64th FWS aircraft appear to me to be fairly easy to portray under most lighting conditions.

(C) Let's see if we agree on the purposes for camouflage on aircraft with an air superiority mission. Since no paint scheme is going to render our aircraft invisible (for long, if at all), what can we reasonably expect it to do for us? I suggest that it do the following:

--Delay visual acquisition by opponents.
--Once acquired, make continued visual contact difficult.
--Disguise aircraft type and identity.
--Impair estimation of range and airspeed.
--Disguise attitude, bank angle, and actual direction of flight.
--Delay recognition of your actions by disruption of visual clues.

(C) The purpose, then, is to prompt indecision and to induce mistakes on the part of an opponent. Concealment becomes secondary. Suppose he can't tell whether you are upright or inverted? You are really ahead of the game if he can't tell that you are an airplane!

aircraft. It is a straight line ending with a short vertical or swept line implying a vertical stabilizer. The second directional line identifies the symbol as an aircraft while also indicating its direction of light and telling us that it is flying upright.

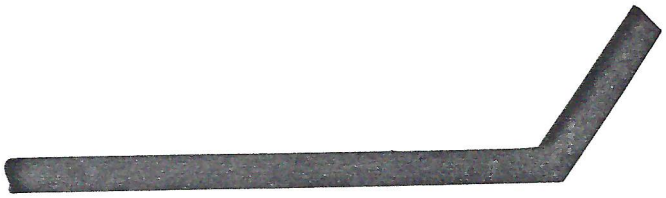


Figure 1.

(C) Removal of the symbolic vertical stabilizer, as in Figure 2, leaves a line with no clues to identity, direction, or attitude.

Figure 2.

(C) Another simple symbol that will indicate an aircraft is the arrow-like combination of lines shown in Figure 3.

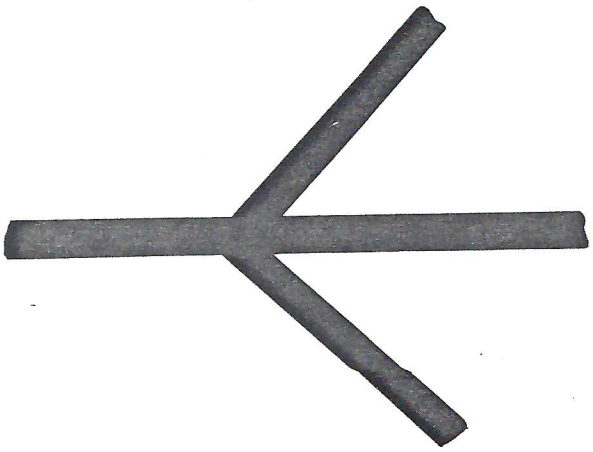


Figure 3.

(C) Deletion of half of one of the wing lines changes the attitude of the symbolic aircraft completely as in Figure 4.

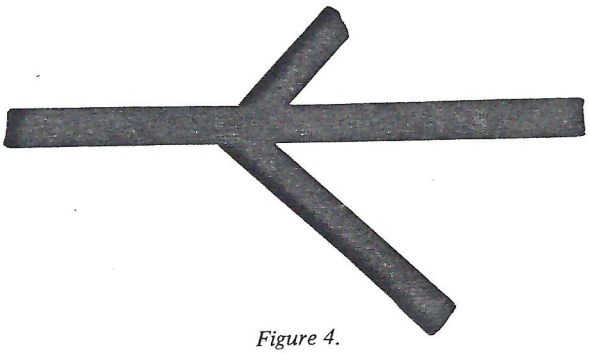


Figure 4.

(C) This implies to me that the eye sorts out even the most complicated airframe and reads it as aircraft, even by type, apparent flight path, and attitude, all by these simplest of visual clues.

(C) Theoretically an aircraft at a distance appears as a silhouette, darker or lighter than its background, depending upon atmospheric conditions. I believe that average conditions for air combat patrol altitudes will give you the darker silhouette against a light and grayed background, the aircraft being picked out on its upper edge by the sun's highlight. If he turns into you, he probably will betray a light silhouette as the sunlight plays over his upper surfaces. The sunlit upper surface may have called your attention to him in the first place. His vertical stabilizer identified him as an aircraft. Its character possibly even told you his type. As he rolls toward you, the relative positions of both wingtips, nose, and tail tell you instantly what he is up too. Your opponent is presented with similar clues in spotting and dealing with you.

(C) I propose a paint scheme to counter those clues and compound his problems of acquisition, identification, and reaction. It is tailored specifically to air combat altitudes, visual ranges, light, and atmospheric conditions.

(C) You will note that in answering those requirements, we find the line of demarcation between specified paints or colors generally paralleling the longitudinal axis of our aircraft rather than lying across it as is usually the case with the classic camouflage.

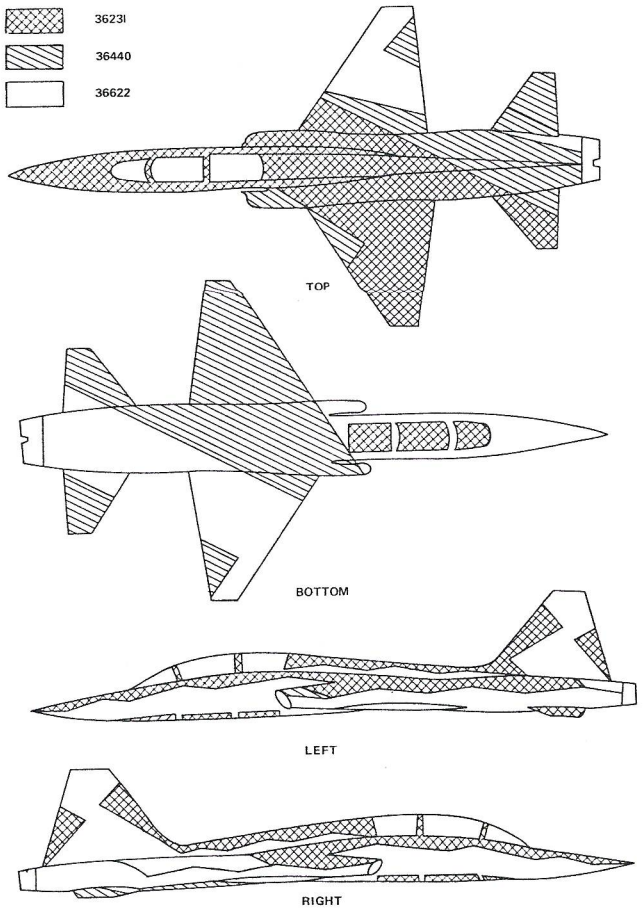


Figure 5.

(C) This characteristics will identify this as an air-to-air camouflage concept unrelated to those designed to hide aircraft while parked.

Side View

(C) To reduce the contrast of the side view silhouette against the lighter backgrounds of air combat altitutde, the side view should be basically a light, flat, neutral gray (36622). This would include the vertical stabilizer and would continue around and under the fuselage. The upper portion of the fuselage, receiving light from above, would be painted a medium gray (36231). Viewed from the side or slightly below, this would in effect be counter shading, a system used to bring a bright highlight closer to the value of the unlit surface below it. The purpose is to inhibit perception of form and to make an object appear flat and nondescript.

(U) We have to concede that under some conditions even a white aircraft will appear as a dark silhouette against a bright background.

(C) The line of demarcation between lighter and darker grays should not be straight but an almost angular scallop of varying dimensions. The edges need not be soft. Indeed, a hard edge to this scallop will add to the difficulty in perceiving form. Under different conditions of light, either of two extremes may exist. We may present a light silhouette against a dark background or have a situation where our dark painted areas are silhouetted by themselves against a light or netural background. We may present a light silhouette against a dark background or have a situation where our dark painted areas are silhouetted by themselves against a light or neutral background. Seen by themselves against contrasting backgrounds, neither the light-painted portion nor the dark-painted upper part of the fuselage look like an aircraft without the visual support of the other part. The vertical stabilizer shape will give us away, however, so we break leading and trailing edges with rectangular and triangular bites of our darker gray.

(C) Our side view is now painted for the pirmary purpose of blending with the lighter backgrounds of altitude while killing the highlight. It will also give us unrecognizable shapes should either light or dark portions of our paint scheme predominate.

Top View

(C) Our primary purpose in the top view is to reduce the sun's effect over the entire upper surface of the aircraft. We have taken care of the fuselage for that purpose. We now do the same for wings and horizontal tail surfaces while introducing a third gray (36440), a shade midway between our light and darker grays.

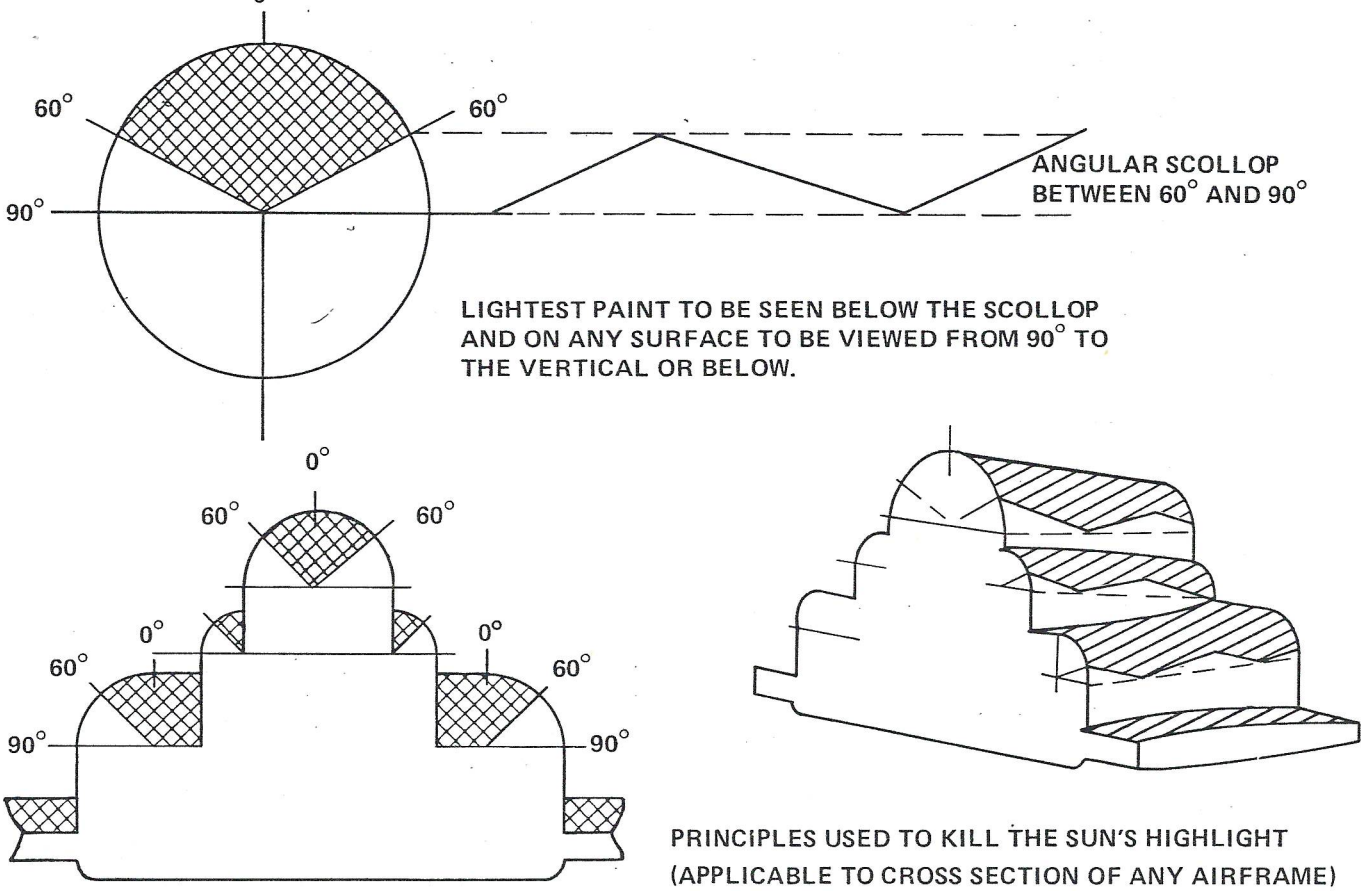


Figure 6.

(C) To delay recognition of our actions, our bank angle and attitude, we add a carefully planned deceptive pattern to the top view. We employ a basic two-thirds dark to one-third light ratio in our design using a hard-edged pattern running diagonally across wings, fuselage, and horizontal stabilizers in the top view. Most of the left wing and horizontal stabilizer appear in the darkest of our grays (36231). An angular bite taken out of the inboard leading edge continues onto the upper surface of the left intake. Notice that the line formed parallels the line of demarcation or our darkest gray as it crosses the fuselage diagonally from the right wing leading edge to a point on the trailing edge of the left horizontal stabilizer. The position and angle of the line of demarcation was chosen to allow the darker gray a path up the vertical stabilizer leading edge, again killing that highlight and giving us the triangular bite which, joined by a trailing edge triangle, impairs recognition of the shape of that surface. The medium gray (36440), which covers the left intake as well as the aft fuselage beyond the established angle, avoids the continuous dark shape of the fuselage in the top view. That on the intake avoids delineating both intakes, which together are valuable visual clues. The medium gray on the rear fueslage is carefully calculated to avoid giving us all of the area ruled shape as a recognition aid.

(C) The medium gray (36440) also may be seen just outboard of the darker gray on inner quarter of the right wing. The outer three-quarters of the right wing would be painted in our lightest gray (36622). The purpose here would be to concede the darker silhouette of left wing, horizontal stabilizer, and fuselage while attempting to visually lose the right outer wing panel. As with the vertical stabilizer, we disrupt the light silhouette of the outer panel with our triangular bite of medium gray (36440).

(C) The principle is: never have both wingtips painted in the same color, shape, or shade. This betrays the position of both wingtips automatically defining bank angle. We would concede the sun's effect on the light outer panel for the sake of maximum contrast with the opposite wingtip.

(C) The horizontal stabilizers adhere to the same principle. In fact, we could say: never give them two of anything in the same color, shape or shade.

Bottom View

(C) The basic color in the bottom view would be the light gray (36622) seen in the side view. A diagonal pattern of the medium gray (36440) would be laid across the underside of the right wing and central fuselage. A triangu-

lar bit would be taken out of the trailing edge of the lower left wing, its pattern continuing onto the lower left stabilizer to disrupt silhouette.

(C) Our final thing will be worth a try. Paint a duplicate of the canopy shape in the darker gray (36231) on the bottom of the fuselage directly below the cockpit. This may on occasion be mistaken for the cockpit with resulting confusion as to our intentions. It sounds silly but it might work, Have you ever noticed the large eye designs on some butterfly wings?

(C) The foregoing description of the paint system has applied to T-38 aircraft. It is equally effective on most other aircraft. Each type has its own peculiar characteristics requiring careful consideration when applying each of the principles which make up the system. In summary those principles, in order, are:

- Provide a basic light silhouette in the side view.
- Kill the highlight with a darker gray on the upper surfaces, while using opposing triangles on the vertical stabilizer(s) to minimize its (their) shape as a recognition feature. The scallop on the fuselage minimizes its shape as a recognition feature.
- When you roll toward your opponent, you give him a basic one-third light to two-thirds dark silhouette to disrupt his visual clues by never giving him two of anything in the same *shape, color,* or *shade* for comparison.
- When you roll away from him, show him a top view painted on the bottom of your aircraft—still adhering to the one-third light to two-thirds dark (though on the bottom this is the medium gray).

It all adds up to deception while still achieving initial concealment.

Color and Specific Paints

(C) My choice of Federal Standard Colors 36622, 36440, and 36231 is an "eyeball" suggestion seeming to offer an effective combination for operations in most climates. In direct sunlight, 36231 reduces in value approximately to that of 36622 in shadow. Warmer brownish-grays might be substituted in shades of similar value to 36440 and 36231 for the upper portion of aircraft operating exclusively in dry desert country.

(C) I have tried to make the point that because of the great distances involved at air combat altitudes, color and detail forming the background for the patrolling fighter will be reduced in value and considerably grayed. Color of camouflage paints then becomes less imporant than their value in the gray scale. Ground attack aircraft should be painted using the same principles if our concern is to defeat the surface eyeball gunner. He uses the same visual clues, and sees the attacker against cloud and sky just as does the airborn opponent.

(C) Official camouflage studies may have addressed themselves to specular (reflectivity) analysis of paints and spectral analysis of the effects of various colors on the eye. The results of these may offer scientific assistance in our choice of paint.

(C) Adoption of paint designed to reduce IR signature as well as visual evidence of the sun's reflected light would be worthwhile.

Markings

(C) To avoid compromising the effectiveness of the paint scheme, all required aircraft insignia, markings, lettering, and numbers should be subdued. I recommend that each be painted in a gray slightly darker than the surface to which it is being applied. On our lightest gray (36622) one would use gray number 36559. On 36440 use 36373, and on our darkest gray (36231) use 36173. That includes our national star and bar which should appear in reduced size as seen on USAF camouflaged aircraft. Gray should replace both insignia blue and insignia red, and the surface color should show through the star and bar replacing white. Ejection seat triangle could be in thin dull red (32356) outline, the supporting lettering in the grays as specified above. Turbine stripes also could be in this red (32356) outline. Yellow emergency entrance markings could be grayed to a value (33617) similar to the surface to which they are applied; their accompanying black instruction panel could be in medium gray (36440), with its lettering in light gray (36622).

Classic Camouflage

(U) I mentioned earlier that most camouflage schemes do not pose a particularly difficult problem to this artist as he attempts to portray them clearly and accurately in a painting. A look at the reason for this might be useful.

(C) Any aircraft that is of a single color, whether white, black natural aluminum, gray, or Air Superiority Blue, offers the artisit a fairly straight-forward task. The task is to define the form, starting with light source, graduating through reflected light to cast shadow, unhindered by contrasting areas of paint lying parallel to the axis of the form. Since all extremities are of the one color, they are fairly easily defined. The light colored ones against a light background obviously are more subtle but are betrayed by direct light. Your eye reads the actual aircraft in the same manner air-to-air.

(U) The most common camouflage is the classic one. A person asked to define the word "camouflage" often describes a paint scheme which you visualize as an object painted in a pattern of alternating bands of specific colors.

(C) I think of aircraft carrying the more common camouflage scheme as being painted in plug type camouflage. These offer little additional hindrance to the artist who can analytically define the aircraft painted in a single color. The reason for this is that the plugs are defined in form exactly as in the single color scheme. One simply

changes color from one plug to the next.

(U) The fact that the plugs lie generally across the longitudinal axis of the aircraft, much like the fuselage stations or frames, actually assists the artist in explaining the form.

(C) Another common practice is painting the vertical stabilizer in a horizontal pattern of serveral colors. This usually leaves the angle and location of both leading and trailing edges clearly betrayed in each of the colors used. This practice again assists the artist in portraying the type clearly.

(C) The eye, then, will continue to read aircraft which are painted in plug type camouflage. Those in darker, more contrasting colors will be at an even greater disadvantage at altitude.

(U) Figure 7 shows diagramatically the effect of seeing the lighter and darker plugs separately against a contrasting background. This could be called the sausage effect. If you cut a sausage into eight or ten segments and remove every other piece without disturbing the remaining segments, you still have a sausage. Ends, top, and bottom lines, of the silhouetted segments remain. They are visually continued by the eye despite the gaps. The overall shape is still defined.

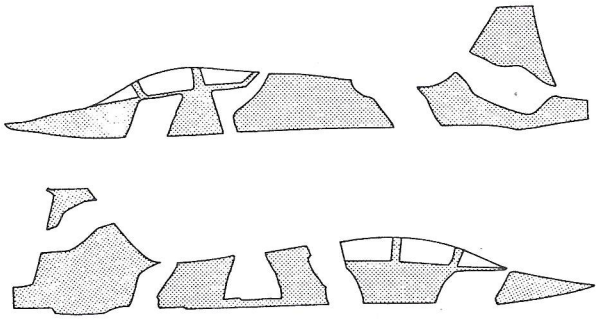


Figure 7. "Plug" type camouflage, or the "Sausage" effect

(U) A sausage divided longitudinally in irregular scalloped fashion would be much harder to recognize as a sausage.

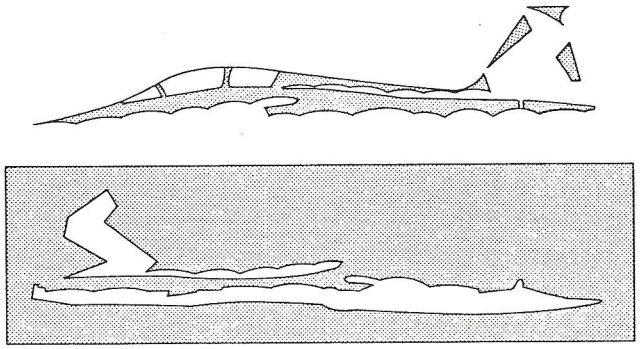


Figure 8. "Longitudinal" camouflage (the "Sausage" cut lengthwise)

(U) It appears that we are once again revisiting ground trod by others before us. The Germans were known for their methodical operational test and evaluation of weapons and aircraft. Do you suppose that they performed similar tests on the subject of fighter camouflage? If so, have the records of those tests survived?

(U) My efforts to portray World War II *Luftwaffe* fighters in paintings called my attention to their unique paint scheme. To show realistically the form of the aircraft, I would have to minimize the design of its camouflage. It eventually occurred to me that this is the common denominator of the effective air-to-air camouflage scheme.

(U) No other country appears to have developed a system of camouflage specialized exclusively for air combat at altitutde. The RAF changed specific colors of their primarily surface oriented patterns as altitudes increased. They did allow an overall blue shceme for Photo-Reconnaissance Units operating at altitude. The RAF also used a medium gray scheme on very high altitude interceptors used to counter the threat of pressurized German bombers. These fighters carried Photo-Reconnaissance Unit blue on their undersurfaces.

(U) Camouflage is an intriguing subject which, viewed historically, offers endless detail. I have attempted to look beyond the detail to single out a concept offering advantages in the air-to-air environment.

(U) It's food for thought . . . maybe even another "nickle on the grass."