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Stephen Prince

True Lies

Perceptual Realism, Digital Images, and Film Theory



Digital compositing in *Forrest Gump*

Digital imaging technologies are rapidly transforming nearly all phases of contemporary film production. Film-makers today storyboard, shoot, and edit their films in conjunction with the computer manipulation of images. For the general public, the most visible application of these technologies lies in the new wave of computer-generated and -enhanced special effects that are producing images—the watery creature in *The Abyss* (1989) or the shimmering, shape-shifting *Terminator 2* (1991)—unlike any seen previously.

The rapid nature of these changes is creating problems for film theory. Because the digital manipulation of images is so novel and the creative possibilities it offers are so unprecedented, its effects on cinematic representation and the viewer's response are poorly

understood. Film theory has not yet come to terms with these issues. What are the implications of computer-generated imagery for representation in cinema, particularly for concepts of photographically based realism? How might theory adapt to an era of digital imaging?

Initial applications of special-effects digital imaging in feature films began more than a decade ago in productions like *Tron* (1982), *Star Trek II: The Wrath of Khan* (1982), and *The Last Starfighter* (1984). The higher-profile successes of *Terminator 2*, *Jurassic Park* (1993), and *Forrest Gump* (1994), however, dramatically demonstrated the creative and remunerative possibilities of computer-generated imagery (CGI).

Currently, two broad categories of digital imaging exist. Digital-image processing covers applications

like removing unwanted elements from the frame—hiding the wires supporting the stunt performers in *Cliffhanger* (1994), or erasing the Harrier jet from shots in *True Lies* (1994) where it accidentally appears. CGI proper refers to building models and animating them in the computer. Don Shay, editor of *Cinefex*, a journal that tracks and discusses special-effects work in cinema, emphasizes these distinctions between the categories.¹

As a consequence of digital imaging, *Forrest Gump* viewers saw photographic images of actor Gary Sinise, playing Gump's amputee friend and fellow Vietnam veteran, being lifted by a nurse from a hospital bed and carried, legless, through three-dimensional space. The film viewer is startled to realize that the representation does not depend on such old-fashioned methods as tucking or tying the actor's limbs behind his body and concealing this with a loose-fitting costume. Instead, Sinise's legs had been digitally erased from the shot by computer.

Elsewhere in the same film, viewers saw photographic images of President Kennedy speaking to actor Tom Hanks, with dialogue scripted by the film's writers. In the most widely publicized applications of CGI, viewers of Steven Spielberg's *Jurassic Park* watched photographic images of moving, breathing, and chomping dinosaurs, images which have no basis in any photographable reality but which nevertheless seemed realistic. In what follows, I will be assuming that viewers routinely make assessments about the perceived realism of a film's images or characters, even when these are obviously fictionalized or otherwise impossible. Spielberg's dinosaurs made such a huge impact on viewers in part because they seemed far more life-like than the miniature models and stop-motion animation of previous generations of film.

The obvious paradox here—creating credible photographic images of things which cannot be photographed—and the computer-imaging capabilities which lie behind it challenge some of the traditional assumptions about realism and the cinema which are embodied in film theory. This essay first explores the challenge posed by CGI to photographically based notions of cinematic realism. Next, it examines some of the problems and challenges of creating computer imagery in motion pictures by drawing on interviews with computer-imaging artists. Finally, it develops an alternate model, based on perceptual and social correspondences, of how the cinema communicates and is intelligible to viewers. This model may produce a better integration of the tensions between realism and

formalism in film theory. As we will see, theory has construed realism solely as a matter of reference rather than as a matter of perception as well. It has neglected what I will term in this essay "perceptual realism." This neglect has prevented theory from understanding some of the fundamental ways in which cinema works and is judged credible by viewers.

Assumptions about realism in the cinema are frequently tied to concepts of indexicality prevailing between the photographic image and its referent. These, in turn, constitute part of the bifurcation between realism and formalism in film theory. In order to understand how theories about the nature of cinematic images may change in the era of digital-imaging practices, this bifurcation and these notions of an indexically based film realism need to be examined.

This approach to film realism—and it is, perhaps, the most basic theoretical understanding of film realism—is rooted in the view that photographic images, unlike paintings or line drawings, are indexical signs: they are causally or existentially connected to their referents. Charles S. Peirce, who devised the triadic model of indexical, iconic, and symbolic signs, noted that "Photographs, especially instantaneous photographs, are very instructive, because we know that in certain respects they are exactly like the objects they represent . . . they . . . correspond point by point to nature. In that respect then, they belong to the second class of signs, those by physical connection."²

In his analysis of photography, Roland Barthes noted that photographs, unlike every other type of image, can never be divorced from their referents. Photograph and referent "are glued together."³ For Barthes, photographs are causally connected to their referents. The former testifies to the presence of the latter. "I call 'photographic referent' not the *optionally* real thing to which an image or sign refers but the *necessarily* real thing which has been placed before the lens without which there would be no photograph."⁴ For Barthes, "Every photograph is a certificate of presence."⁵

Because cinema is a photographic medium, theorists of cinema developed concepts of realism in connection with the indexical status of the photographic sign. Most famously, André Bazin based his realist aesthetic on what he regarded as the "objective" nature of photography, which bears the mechanical trace of its referents. In a well-known passage, he wrote, "The photographic image is the object itself, the object freed from the conditions of time and space which

govern it. No matter how fuzzy, distorted, or discolored, no matter how lacking in documentary value the image may be, it shares, by virtue of the very process of its becoming, the being of the model of which it is the reproduction; it *is* the model.”⁶

Other important theorists of film realism emphasized the essential attribute cinema shares with photography of being a recording medium. Siegfried Kracauer noted that his theory of cinema, which he subtitled “the redemption of physical reality,” “rests upon the assumption that film is essentially an extension of photography and therefore shares with that

began as a wireframe model in the computer, no profilmic referent existed to ground the indexicality of its image. Nevertheless, digital imaging can anchor pictured objects, like this watery creature, in apparent photographic reality by employing realistic lighting (shadows, highlights, reflections) and surface texture detail (the creature’s rippling responses to the touch of one of the film’s live actors). At the same time, digital imaging can bend, twist, stretch, and contort physical objects in cartoonlike ways that mock indexicalized referentiality. In an Exxon ad, an automobile morphs into a tiger, and in a spot for Listerine, the CGI bottle



Jurassic Park:
not the real T. Rex

medium a marked affinity for the visible world around us. Films come into their own when they record and reveal physical reality.”⁷ Like Bazin, Stanley Cavell emphasized that cinema is the screening or projection of reality because of the way that photography, whether still or in motion, mechanically (that is, automatically) reproduces the world before the lens.⁸

For reasons that are alternately obvious and subtle, digital imaging in its dual modes of image processing and CGI challenges indexically based notions of photographic realism. As Bill Nichols has noted, a digitally designed or created image can be subject to infinite manipulation.⁹ Its reality is a function of complex algorithms stored in computer memory rather than a necessary mechanical resemblance to a referent. In cases like the slithery underwater creature in James Cameron’s *The Abyss*, which

of mouthwash jiggles, expands, and contracts in an excited display of enthusiasm for its new formula.¹⁰

In these obvious ways, digital imaging operates according to a different ontology than do indexical photographs. But in less obvious ways, as well, digital imaging can depart from photographically coded realism. Objects can be co-present in computer space but not in the physical 3D space which photography records. When computer-animated objects move around in a simulated space, they can intersect one another. This is one reason why computer animators start with wireframe models which they can rotate and see through in order to determine whether the model is intersecting other points in the simulated space. Computer-simulated environments, therefore, have to be programmed to deal with the issues of collision detection and collision response.¹¹

The animators who created the herd of gallimimus that chases actor Sam Neill and two children in *Jurassic Park* were careful to animate the twenty-four gallis so they would look like they might collide and were reacting to that possibility.¹² First, they had to ensure that no gallis actually did pass into and through one another, and then they had to simulate the collision responses in the creatures' behaviors as if they were corporeal beings subject to Newtonian space.

As moving photographic images, Spielberg's dinosaurs are referentially fictional

In other subtle ways, digital imaging can fail to perform Kracauer's redemption of physical reality. Lights simulated in the computer don't need sources, and shadows can be painted in irrespective of the position of existing lights. Lighting, which in photography is responsible for creating the exposure and the resulting image, is, for computer images, strictly a matter of painting, of changing the brightness and coloration of individual pixels. As a result, lighting in computer imagery need not obey the rather fixed and rigid physical conditions which must prevail in order for photographs to be created.

One of the more spectacular digital images in *True Lies* is a long shot of a chateau nestled beside a lake and surrounded by the Swiss Alps. The image is a digital composite, blending a mansion from Newport, Rhode Island, water shot in Nevada, and a digital matte painting of the Alps.¹³ The compositing was done by Digital Domain, a state-of-the-art effects house created by the film's director, James Cameron. The shot is visually stunning—crisply resolved, richly saturated with color, and brightly illuminated across Alps, lake, and chateau.

Kevin Mack, a digital effects supervisor at Digital Domain who worked on *True Lies* as well as *Interview with the Vampire*, points out that the image is unnaturally luminant.¹⁴ Too much light is distributed across the shot. If a photographer exposed for the lights in the chateau, the Alps would film too dark, and, conversely, if one exposed for the Alps in, say, bright moonlight, the lights in the chateau would burn out. The chateau and the Alps could not be lit so they'd both expose as brightly as they do in the image. Mack

points out that the painted light effects in the shot are a digital manipulation so subtle that most viewers probably do not notice the trickery.

Like lighting, the rendering of motion can be accomplished by computer painting. President Kennedy speaking to Tom Hanks in *Forrest Gump* resulted from two-dimensional painting, made to look like 3D, according to Pat Byrne, Technical Director at Post Effects, a Chicago effects house that specializes in digital imaging.¹⁵ The archival footage of Kennedy, once digitized, was repainted with the proper phonetic mouth movements to match the scripted dialogue and with highlights on his face to simulate the corresponding jaw and muscle changes. Morphs were used to smooth out the different painted configurations of mouth and face.¹⁶

When animating motion via computer, special adjustments must be made precisely because of the differences between photographically captured reality and the synthetic realities engineered with CGI. Credible computer animation requires the addition of motion blur to simulate the look of a photographic image. The ping-pong ball swatted around by Forrest Gump and his Chinese opponents was animated on the computer from a digitally scanned photographic model of a ping-pong ball and was subsequently composited into the live-action footage of the game (the game itself was shot without any ball). The CGI ball seemed credible because, among other reasons, the animators were careful to add motion blur, which a real, rapidly moving object passing in front of a camera will possess (as seen by the camera which freezes the action as a series of still frames), but which a key-framed computer animated object does not.

In these ways, both macro and micro, digital imaging possesses a flexibility that frees it from the indexicality of photography's relationship with its referent.¹⁷ Does this mean, then, that digital-imaging capabilities ought not be grouped under the rubric of a realist film theory? If not, what are the alternatives? What kind of realism, if any, do these images possess?

In traditional film theory, only one alternative is available: the perspective formulated in opposition to the positions staked out by realists like Kracauer, Bazin, and Cavell. This position, which might be termed the formalist outlook, stresses cinema's capacity for reorganizing, and even countering and falsifying, physical reality. Early exponents of such a position include Rudolf Arnheim, Dziga Vertov, and Sergei Eisenstein. In his discussion of classical film theory, Noël Carroll has pointed out this bifurcation

between the camps of realism and formalism and linked it to an essentializing tendency within theory, a predilection of theorists to focus on either the cinema's capability to photographically copy physical reality or to stylistically transcend that reality.¹⁸

This tension in classical theory between stressing the ways film either records or reorganizes profilmic reality continues in contemporary theory, with the classical formalist emphasis upon the artificiality of cinema structure being absorbed into theories of the apparatus, of psychoanalysis, or of ideology as applied to the cinema. In these cases, cinematic realism is seen as an *effect* produced by the apparatus or by spectators positioned within the Lacanian Imaginary. Cinematic realism is viewed as a discourse *coded* for transparency such that the indexicality of photographic realism is replaced by a view of the "reality-effect" produced by codes and discourse. Jean-Louis Baudry suggests that "Between 'objective reality' and the camera, site of inscription, and between the inscription and the projection are situated certain operations, a *work* which has as its result a finished product."¹⁹ Writing about the principles of realism, Colin McCabe stresses that film is "constituted by a set of discourses which . . . produce a certain reality."²⁰

Summarizing these views, Dudley Andrew explains, "The discovery that resemblance is coded and therefore learned was a tremendous and hard-won victory for semiotics over those upholding a notion of naive perception in cinema."²¹ Where classical film theory was organized by a dichotomy between realism and formalism, contemporary theory has preserved the dichotomy even while recasting one set of its terms. Today, indexically based notions of cinema realism exist in tension with a semiotic view of the cinema as discourse and of realism as one discourse among others.

In some of the ways just discussed, digital imaging is inconsistent with indexically based notions of film realism. Given the tensions in contemporary film theory, should we then conclude that digital-imaging technologies are necessarily illusionistic, that they construct a reality-effect which is merely discursive? They do, in fact, permit film artists to create synthetic realities that can look just like photographic realities. As Pat Byrne noted, "The line between real and not-real will become more and more blurred."²² How should we understand digital imaging in theory? How should we build theory around it? When faced with digitized images, will we need to discard entirely notions of realism in the cinema?

The tensions within film theory can be surmounted by avoiding an essentializing conception of the cinema stressing unique, fundamental properties²³ and by employing, in place of indexically based notions of film realism, a correspondence-based model of cinematic representation. Such a model will enable us to talk and think about both photographic images and computer-generated images and about the ways that cinema can create images that seem alternately real and unreal. To develop this approach, it will be necessary to indicate, first, what is meant by a correspondence-based model and, then, how digital imaging fits within it.

An extensive body of evidence indicates the many ways in which film spectatorship builds on correspondences between selected features of the cinematic display and a viewer's real-world visual and social experience.²⁴ These include iconic and non-iconic visual and social cues which are structured into cinematic images in ways that facilitate comprehension and invite interpretation and evaluation by viewers based on the salience of represented cues or patterned deviations from them. At a visual level, these cues include the ways that photographic images and edited sequences are isomorphic with their corresponding real-world displays (e.g., through replication of edge and contour information and of monocular distance codes; in the case of moving pictures, replication of motion parallax; and in the case of continuity editing, the creation of a screen geography with coherent coordinates through the projective geometry of successive camera positions). Under such conditions, empirical evidence indicates that naive viewers readily recognize experientially familiar pictured objects and can comprehend filmed sequences, and that continuity editing enhances such comprehension.²⁵

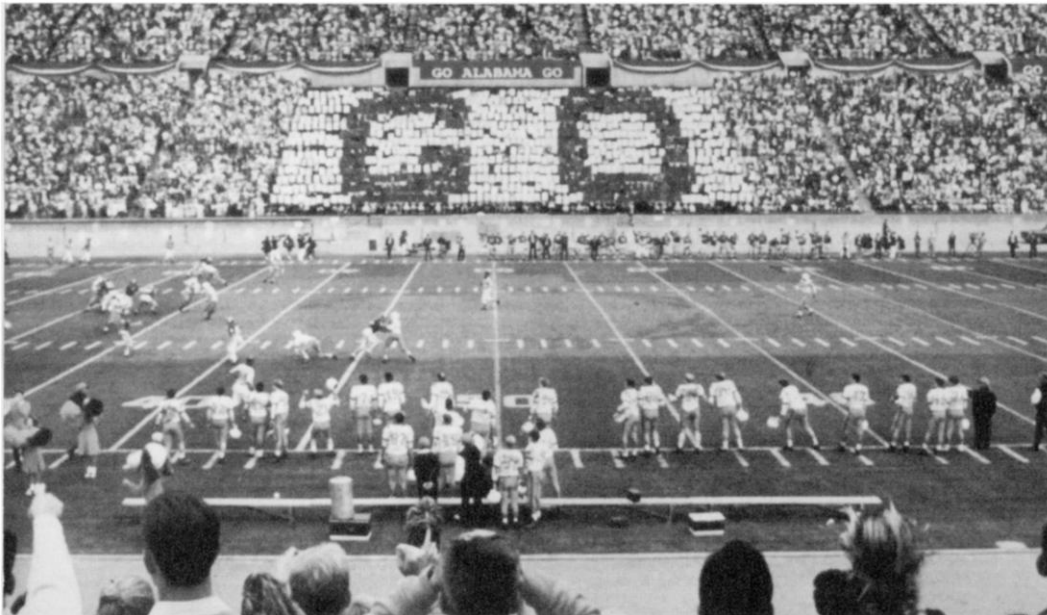
At the level of social experience, the evidence indicates that viewers draw from a common stock of moral constructs and interpersonal cues and percepts when evaluating both people in real life and represented characters in the media. Socially derived assumptions about motive, intent, and proper role-based behavior are employed when responding to real and media-based personalities and behavior.²⁶ As communication scholars Elizabeth Perse and Rebecca Rubin have pointed out, "'people' constitutes a construct domain that may be sufficiently permeable to include both interpersonal and [media] contexts."²⁷

Recognizing that cinematic representation oper-

ates significantly, though not exclusively, in terms of structured correspondences between the audiovisual display and a viewer's extra-filmic visual and social experience enables us to ask about the range of cues or correspondences within the image or film, how they are structured, and the ways a given film patterns its represented fictionalized reality around these cues. What kind of transformations does a given film carry out upon the correspondences it employs with viewers' visual and social experience? Attributions of realism, or the lack thereof, by viewers will inhere in the ways these correspondences are structured into and/or transformed by the image and film. Instead of asking

refer to creatures that once existed, but as *moving photographic images* they are referentially fictional. No dinosaurs now live which could be filmed doing things the fictionalized creatures do in *Jurassic Park*. By contrast, referentially realistic images bear indexical and iconic homologies with their referents. They resemble the referent, which, in turn, stands in a causal, existential relationship to the image.²⁸

A perceptually realistic image is one which structurally corresponds to the viewer's audiovisual experience of three-dimensional space. Perceptually realistic images correspond to this experience because film-makers build them to do so. Such images display



Forrest Gump:
computer-generated crowd

whether a film is realistic or formalistic, we can ask about the kinds of linkages that connect the represented fictionalized reality of a given film to the visual and social coordinates of our own three-dimensional world, and this can be done for both "realist" and "fantasy" films alike. Such a focus need not reinstate indexicality as the ground of realism, since it can emphasize falsified correspondences and transformation of cues. Nor need such a focus turn everything about the cinema back into discourse, into an arbitrarily coded reorganization of experience. As we will see, even unreal images can be perceptually realistic. Unreal images are those which are referentially fictional. The Terminator is a represented fictional character that lacks reference to any category of being existing outside the fiction. Spielberg's dinosaurs obviously

a nested hierarchy of cues which organize the display of light, color, texture, movement, and sound in ways that correspond with the viewer's own understanding of these phenomena in daily life. Perceptual realism, therefore, designates a relationship between the image or film and the spectator, and it can encompass both unreal images and those which are referentially realistic. Because of this, unreal images may be referentially fictional but perceptually realistic.

We should now return to, and connect this discussion back to, the issue of digital imaging. When lighting a scene becomes a matter of painting pixels, and capturing movement is a function of employing the correct algorithms for mass, inertia, torque, and speed (with the appropriate motion blur added as part of the mix), indexical referencing is no longer required for

the appearance of photographic realism in the digital image. Instead, Gump's ping-pong ball and Spielberg's dinosaurs look like convincing photographic realities because of the complex sets of perceptual correspondences that have been built into these images. These correspondences, which anchor the computer-generated image in apparent three-dimensional space, routinely include such variables as surface texture, color, light, shadow, reflectance, motion speed and direction.

Embedding or compositing computer imagery into live action, as occurs when Tom Hanks as Gump "hits" the CG ping-pong ball or when Sam Neill is "chased" by the CG gallimimus herd, requires matching both environments. The physical properties and coordinates of the computer-generated scene components must be made to correspond with those of the live-action scene. Doing this requires precise and time-consuming creation and manipulation of multiple 3D perceptual cues. Kevin Mack, at Digital Domain, and Chris Voellmann, a digital modeller and animator at Century III Universal Studios, point out that light, texture, and movement are among the most important cues to be manipulated in order to create a synthetic reality that looks as real as possible.²⁹

To simulate light properties that match both environments, a digital animator may employ scan-line algorithms that calculate pixel coloration one scan line at a time, ray tracing methods that calculate the passage of light rays through a modelled environment, or radiosity formulations that can account for diffuse, indirect illumination by analyzing the energy transfer between surfaces.³⁰ Such techniques enable a successful rendering³¹ of perceptual information that can work to match live-action and computer environments and lend credence and a sense of reality to the composited image such that its computerized components *seem* to fulfill the indexical conditions of photographic realism. When the velociraptors hunt the children inside the park's kitchen in the climax of *Jurassic Park*, the film's viewer sees their movements reflected on the gleaming metal surfaces of tables and cookware. These reflections anchor the creatures inside Cartesian space and perceptual reality and provide a bridge between live-action and computer-generated environments. In the opening sequence of *Forrest Gump*, as a CG feather drifts and tumbles through space, its physical reality is enhanced by the addition of a digitally painted reflection on an automobile windshield.

To complete this anchoring process, the provision of information about surface texture and movement is

extremely important and quite difficult, because the information provided must seem credible. Currently, many of the algorithms needed for convincing movement either do not exist or are prohibitively expensive to run on today's computers. The animators and renderers at Industrial Light and Magic used innovative software to texture-map³² skin and wrinkles onto their dinosaurs and calibrated variations in skin jostling and wrinkling with particular movements of the creatures. However, while bone and joint rotation are successfully visualized, complex information about the movement of muscles and tendons below the skin surface is lacking.

Kevin Mack describes this limit in present rendering abilities as the "human hurdle"³³—that is, the present inability of computers to fully capture the complexities of movement by living organisms. Hair, for example, is extremely difficult to render because of the complexities of mathematically simulating properties of mass and inertia for finely detailed strands.³⁴ Chris Voellmann points out that today's software can create flexors and rotators but cannot yet control veins or muscles.

Multiple levels of information capture must be successfully executed to convincingly animate and render living movement because the viewer's eye is adept at perceiving inaccurate information.³⁵ These levels include locomotor mechanics—the specification of forces, torques, and joint rotations. In addition, "gait-specific rules"³⁶ must be specified. The *Jurassic Park* animators, for example, derived gait-specific rules for their dinosaurs by studying the movements of elephants, rhinos, komodo dragons, and ostriches and then making some intelligent extrapolations. Beyond these two levels of information control is the most difficult one—capturing the expressive properties of movement. Human and animal movement cannot look mechanical and be convincing; it must be expressive of mood and affect.

As the foregoing discussion indicates, available software and the speed and economics of present computational abilities are placing limits on the complexities of digitally rendered 3D cues used to integrate synthetic and live-action objects and environments. But the more important point is that present abilities to digitally simulate perceptual cues about surface texture, reflectance, coloration, motion, and distance provide an extremely powerful means of "gluing" together synthetic and live-action environments and of furnishing the viewer with an internally unified and coherent set of cues that establish correspondences with the properties of physical space and living sys-

tems in daily life. These correspondences in turn establish some of the most important criteria by which viewers can judge the apparent realism or credibility possessed by the digital image.

Digital imaging exposes the enduring dichotomy in film theory as a false boundary

Obvious paradoxes arise from these judgements. No one has seen a living dinosaur. Even paleontologists can only hazard guesses about how such creatures might have moved and how swiftly. Yet the dinosaurs created at ILM have a palpable reality about them, and this is due to the extremely detailed texture-mapping, motion animation, and integration with live action carried out via digital imaging. Indexicality cannot furnish us with the basis for understanding this apparent photographic realism, but a correspondence-based approach can. Because the computer-generated images have been rendered with such attention to 3D spatial information, they acquire a very powerful perceptual realism, despite the obvious ontological problems in calling them “realistic.” These are falsified correspondences, yet because the perceptual information they contain is valid, the dinosaurs acquire a remarkable degree of photographic realism.

In a similar way, President Kennedy speaking in *Forrest Gump* is a falsified correspondence which is nevertheless built from internally valid perceptual information. Computer modelling of synthetic visual speech and facial animation relies on existing micro-analyses of human facial expression and phonetic mouth articulations. The digital-effects artist used these facial cues to animate Kennedy’s image and sync his mouth movements with the scripted dialogue. At the perceptual level of phonemic articulation and facial register, the correspondences established are true and enable the viewer to accept the photographic and dramatic reality of the scene. But these correspondences also establish a falsified relationship with the historical and archival filmic records of reality. The resulting image is perceptually realistic but referen-

tially unreal, a paradox that present film theory has a hard time accounting for.

The profound impact of digital imaging, in this respect, lies in the unprecedented ways that it permits film-makers to extend principles of perceptual realism to unreal images. The creative manipulation of photographic images is, of course, as old as the medium of photography. For example, flashing film prior to development or dodging and burning portions of the image during printing will produce lighting effects that did not exist in the scene that was photographed. The tension between perceptual realism and referential artifice clearly predates digital imaging. It has informed all fantasy and special-effects work where film-makers strive to create unreal images that nevertheless seem credible. What is new and revolutionary about digital imaging is that it increases to an extraordinary degree a film-maker’s control over the informational cues that establish perceptual realism. Unreal images have never before seemed so real.

Digital imaging alters our sense of the necessary relationship involving *both* the camera and the profilmic event. The presence of either is no longer an absolute requirement for generating photographic images that correspond to spatio-temporally valid properties of the physical world. If neither a camera nor an existent referent is necessary for the digital rendition of photographic reality, the application of internally valid perceptual correspondences with the 3D world *is* necessary for establishing the credibility of the synthetic reality. These correspondences establish bridges between what can be seen and photographed and that which can be “photographed” but not seen.

Because these correspondences between synthetic environments and real environments employ multiple cues, the induced realism of the final CG image can be extraordinarily convincing. The digital-effects artists interviewed for this essay resisted the idea that any one cue was more important than others and instead emphasized that their task was to build as much 3D information as possible into the CG image, given budgetary constraints, present computational limitations, and the stylistic demands of a given film. With respect to the latter, Kevin Mack pointed out that style coexists with the capability for making the CG images look as real as possible. The Swiss chateau composite in *True Lies* discussed earlier exemplifies this tension.

The apparent realism of digitally processed or created images, then, is a function of the way that multiple levels of perceptual correspondence are built into the image. These establish reference points with the

viewer's own experientially based understanding of light, space, motion, and the behavior of objects in a three-dimensional world. The resulting images may not contain photographable events, but neither do they represent purely illusory constructions. The reliability or nonreliability of the perceptual information they contain furnishes the viewer with an important framework for evaluating the logic of the screen worlds these images help establish.

The emphasis in contemporary film theory has undeniably shifted away from naive notions of

either indexically records the world or stylistically transfigures it. Cinema does both. Similarly, digital-imaging practices suggest that contemporary film theory's insistence upon the constructedness and artifice of cinema's discursive properties may be less productive than is commonly thought. The problem here is the implication of discursive equivalence, the idea that all cinematic representations are, in the end, equally artificial, since all are the constructions of form or ideology. But, as this essay has suggested, some of these representations, while being referentially unreal, are perceptually realistic. Viewers use and rely upon these perceptual correspondences when



Computer imaging
in *The Mask*

indexical realism in favor of an attention to the constructedness of cinematic discourse. Yet indexicality remains an important point of origin even for perspectives that reincorporate it as a variant of illusionism, of the cinema's ability to produce a reality-effect. Bill Nichols notes that "Something of reality itself seems to pass through the lens and remain embedded in the photographic emulsion," while also recognizing that "Digital sampling techniques destroy this claim."³⁷ He concludes that the implications of this "are only beginning to be grasped,"³⁸ and therefore limits his recent study of the filmic representation of reality to non-digitized images.

Digital imaging exposes the enduring dichotomy in film theory as a false boundary. It is not as if cinema

responding to, and evaluating, screen experience.

These areas of correspondence coexist in any given film with narrative, formal, and generic conventions, as well as intertextual determinants of meaning. Christopher Williams has recently observed that viewers make strong demands for reference from motion pictures, but in ways that simultaneously accommodate style and creativity: "We need films to be about life in one way or another, but we allow them latitude in how they meet this need."⁴⁰ Thus, Williams maintains that any given film will feature "the active interplay between the elements which can be defined as realist, and the others which function simultaneously and have either a nonrealist character (primarily formal, linguistic or conventional) or one

which can be called anti-realist because the character of its formal, linguistic or conventional procedures specifically or explicitly tries to counteract the cognitive dimensions we have linked with realism.”⁴¹ Building 3D cues inside computer-generated images enables viewers to correlate those images with their own spatio-temporal experience, even when the digitally processed image fails in other ways to obey that experience (as when the Terminator morphs out of a tiled floor to seize his victim). Satisfying the viewer’s demand for reference permits, in turn, patterned or stylish deviations from reference.

Stressing correspondence-based transformational abilities enables us to maintain a link, a relationship, between the materials that are to be digitally transformed (elements of the 3D world) and their changed state, as well as providing a means for preserving a basis for concepts of realism in a digitized cinema. Before we can subject digitally animated and processed images, like the velociraptors stalking the children through the kitchens of *Jurassic Park*, to extended meta-critiques of their discursive or ideological inflections (and these critiques are necessary), we first need to develop a precise understanding of how these images work in securing for the viewer a perceptually valid experience which may even invoke, as a kind of memory trace, now historically superseded assumptions about indexical referencing as the basis of the credibility that photographic images seem to possess.

In the correspondence-based approach to cinematic representation developed here, perceptual realism, the accurate replication of valid 3D cues, becomes not only the glue cementing digitally created and live-action environments, but also the foundation upon which the uniquely transformational functions of cinema exist. Perceptual realism furnishes the basis on which digital imaging may be carried out by effects artists and understood, evaluated, and interpreted by viewers. The digital replication of perceptual correspondence for the film viewer is an enormously complex undertaking and its ramifications clearly extend well beyond film theory and aesthetics to encompass ethical, legal, and social issues. Film theory will need to catch up to this rapidly evolving new category of imaging capabilities and grasp it in all of its complexity. To date, theory has tended to minimize the importance of perceptual correspondences, but the advent of digital imaging demonstrates how important they are and have been all along. Film theory needs now to pay closer attention to what viewers see on the screen, how they see it, and the relation of these processes to the

larger issue of how viewers see. Doing this may mean that film theory itself will change, and this essay has suggested some ways in which that might occur. Digital imaging represents not only the new domain of cinema experiences, but a new threshold for theory as well.

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Notes

1. Telephone interview with the author, October 19, 1994.
2. Quoted in Peter Wollen, *Signs and Meanings in the Cinema* (Bloomington, IN: Indiana University Press, 1976), pp. 123–24.
3. Roland Barthes, *Camera Lucida: Reflections on Photography*, trans. Richard Howard (New York: Hill and Wang, 1981), p. 5.
4. *Ibid.*, p. 76.
5. *Ibid.*, p. 87.
6. André Bazin, *What Is Cinema?* vol. 1, ed. and trans. Hugh Gray (Berkeley, CA: University of California Press, 1967), p. 14.
7. Siegfried Kracauer, *Theory of Film: The Redemption of Physical Reality* (New York: Oxford University Press, 1960), p. ix.
8. Stanley Cavell, *The World Viewed* (Cambridge, MA: Harvard University Press, 1979), pp. 16–23.
9. Bill Nichols, *Representing Reality: Issues and Concepts in Documentary* (Bloomington, IN: Indiana University Press, 1991), note 2, p. 268.
10. The design and creation of these ads are profiled in detail in Christopher W. Baker, *How Did They Do It? Computer Illusion in Film and TV* (Indianapolis, IN: Alpha Books, 1994).
11. See Ming C. Lin and Dinesh Manocha, “Interference Detection Between Curved Objects for Computer Animation,” in *Models and Techniques in Computer Animation*, ed. Nadia Magnenat Thalmann and Daniel Thalmann (New York: Springer-Verlag, 1993), pp. 43–57.
12. Ron Magid, “ILM’s Digital Dinosaurs Tear Up Effects Jungle,” *American Cinematographer*, vol. 74, no. 12 (December 1993), p. 56.
13. Stephen Pizello, “True Lies Tests Cinema’s Limits,” *American Cinematographer*, vol. 75, no. 9 (September 1994), p. 44.
14. Telephone interview with the author, October 25, 1994.
15. Telephone interview with the author, October 25, 1994.
16. Ron Magid, “ILM Breaks New Digital Ground for *Gump*,” *American Cinematographer*, vol. 75, no. 10 (Oc-

- tober 1994), p. 52.
17. I do not wish to imply that photography was ever a mere mechanical recording of the visual world. During shooting, printing, and developing, photographers found ways of creating their own special effects. Despite this, theorists have insisted upon the medium's fundamental indexicality.
 18. Noël Carroll, *Philosophical Problems of Classical Film Theory* (Princeton, N.J.: Princeton University Press, 1988).
 19. Jean-Louis Baudry, "Ideological Effects of the Basic Cinematographic Apparatus," in *Narrative, Apparatus, Ideology*, ed. Philip Rosen (New York: Columbia University Press, 1986), p. 287.
 20. Colin McCabe, "Theory and Film: Principles of Realism and Pleasure," in *Narrative, Apparatus, Ideology*, p. 182.
 21. Dudley Andrew, *Concepts in Film Theory* (New York: Oxford University Press, 1984), p. 25.
 22. Telephone interview with the author, October 25, 1994.
 23. Noël Carroll has urged film theory in this direction by recommending smaller scale, piece-meal theorizing about selected aspects of cinema rather than cinema in toto and on a grand scale. See *Philosophical Problems of Classical Film Theory*, p. 255, and Carroll, *Mystifying Movies: Fads and Fallacies in Contemporary Film Theory* (New York: Columbia University Press, 1988), pp. 230–34.
 24. For a fuller discussion of this literature, see my essays "The Discourse of Pictures: Iconicity and Film Studies," *Film Quarterly*, vol. 47, no. 1 (Fall 1993), pp. 16–28 and "Psychoanalytic Film Theory and the Problem of the Missing Spectator," in *Post-Theory: Reconstructing Film Studies*, ed. David Bordwell and Noël Carroll (Madison, WI: University of Wisconsin Press, 1996).
 25. See Uta Frith and Jocelyn E. Robson, "Perceiving the Language of Films," *Perception*, vol. 4 (1975), pp. 97–103; Renee Hobbs, Richard Frost, Arthur Davis, and John Stauffer, "How First-Time Viewers Comprehend Editing Conventions," *Journal of Communication*, no. 38 (1988), pp. 50–60; Julian Hochberg and Virginia Brooks, "Picture Perception as an Unlearned Ability: A Study of One Child's Performance," *American Journal of Psychology*, vol. 74, no. 4 (December 1962), pp. 624–28; Robert N. Kraft, "Rules and Strategies of Visual Narratives," *Perceptual and Motor Skills* no. 64 (1987), pp. 3–14; Robert N. Kraft, Phillip Cantor, and Charles Gottdiener, "The Coherence of Visual Narratives," *Communication Research*, vol. 18, no. 5 (October 1991), pp. 601–16; Robin Smith, Daniel R. Anderson, and Catherine Fischer, "Young Children's Comprehension of Montage," *Child Development* no. 56 (1985), pp. 962–71.
 26. See Austin S. Babrow, Barbara J. O'Keefe, David L. Swanson, Renee A. Myers, and Mary A. Murphy, "Person Perception and Children's Impression of Television and Real Peers," *Communication Research*, vol. 15, no. 6 (December 1988), pp. 680–98; Thomas J. Berndt and Emily G. Berndt, "Children's Use of Motives and Intentionality in Person Perception and Moral Judgement," *Child Development* no. 46 (1975), pp. 904–12; Aimee Dorr, "How Children Make Sense of Television," in *Reader in Public Opinion and Mass Communication*, ed. Morris Janowitz and Paul M. Hirsch (New York: Free Press, 1981), pp. 363–85; Cynthia Hoffner and Joanne Cantor, "Developmental Differences in Response to a Television Character's Appearance and Behavior," *Developmental Psychology*, vol. 21, no. 6 (1985), pp. 1065–74; Paul Messaris and Larry Gross, "Interpretations of a Photographic Narrative by Viewers in Four Age Groups," *Studies in the Anthropology of Visual Communication* no. 4 (1977), pp. 99–111.
 27. Elizabeth M. Perse and Rebecca B. Rubin, "Attribution in Social and Parasocial Relationships," *Communication Research*, vol. 16, no. 1 (February 1989), pp. 59–77.
 28. I am indebted to Carl Plantinga for clarification of some of these distinctions.
 29. Telephone interviews with the author, October 25, 1994.
 30. Stuart Feldman, "Rendering Techniques for Computer-Aided Design," *SMPTE Journal*, vol. 103, no. 1 (January 1994), pp. 7–12.
 31. With respect to digital-imaging practices, rendering is distinct from the phases of model-building and animation and refers to the provision of texture, light, and color cues within a simulated environment.
 32. Texture-mapping is a process whereby a flat surface is detailed with texture, such as skin wrinkles, and can then be wrapped around a three-dimensional model visualized in computer space. Some surfaces texture-map more easily than others. Pat Byrne, at Post Effects, points out that spherical objects are problematic because the top and bottom tend to look pinched. Telephone interview with the author, October 25, 1994.
 33. Telephone interview with the author.
 34. Author's interview with Kevin Mack. See also Tsuneya Kurihara, Ken-ichi Anjyo, and Daniel Thalmann, "Hair Animation with Collision Detection," in *Models and Techniques in Computer Animation*, pp. 128–38.
 35. See Stephania Loizidou and Gordon J. Clapworthy, "Legged Locomotion Using HIDDs," in *Models and Techniques in Computer Animation*, pp. 257–69.
 36. *Ibid.*, p. 258.
 37. Nichols, *Representing Reality*, p. 5.
 38. *Ibid.*, p. 268.
 39. Christopher Williams, "After the Classic, the Classical and Ideology: the Differences of Realism," *Screen*, vol. 35, no. 3 (Autumn 1994), p. 282.
 40. *Ibid.*, p. 289.

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