THE COMPUTER MORPHOLOGY AND GEOMORPHOLOGY OF THE NATURAL OPENING AND ARTIFICIAL CLOSING OF LITTLE PIKE'S INLET AT WESTHAMPTON BEACH, LONG ISLAND (DECEMBER, 1992-SEPTEMBER, 1993).

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I. Computer Morphing Technique

Multimedia technology utilizing still aerial photography, video photography and digital imaging now allows for the visualization of time-lapse still photographs in a new and innovative manner. Using this technology one can now recreate, through computer morphing, natural geological events to analyze and document their geomorphic changes and rates of change.

Using a Commodore/Amiga computer equipped with Video Toaster 4000 and Morphplus software, and a 10-month sequence of aerial photos (supplied by Aerographics Corp. Bohemia, N.Y. under contract with the N.Y. State Conservation Department) a time lapse morphology of the breach at Westhampton Beach, Long Island was produced as a computer morph. This sequence of nearly equally-spaced monthly intervals covered the period from December 1992 through September 1993 (i.e. a time that included two of the "storms of the century"). The interval began with the opening of Little Pike's Inlet at Westhampton Beach, and ended with the artificial closure of the inlet by the U.S. Army Corps of Engineers.

The morphing was created to explore the possibilities of using the computer morph technique as a tool to gain further insight into the process, and the rates of change associated with the geomorphic evolution of the inlet and its related features. Using the same aerial photos and sequential drawings made from these photos, prior documentation of the geomorphic changes in the bayside, oceanside, and associated features related to the inlet were already presented (Wolff, 1993, 1994). The accuracy of the morphing technique is dependent on the number of actual photos of the event, the time span between the photos, and the calibrated scale of the photos used.

In order to produce this morph effect, video images of the aerial photos need to be loaded into a morph program. MorphPlus was the arbitrary program of choice. MorphPlus is an integrated set of powerful menu-driven image processing tools which facilitate the creation of high quality imagery that runs on the Amiga computer platform. (MorphPlus is a licensed software program and is produced by ASDG Corporation of Madison, Wisconsin).

Once the monthly photo images have been scanned with a video camera and loaded into MorphPlus as RGB images, the morphing process can begin. Source and destination images must be defined, as well as an output image sequence filename for each individual morph event (see Figure 1).

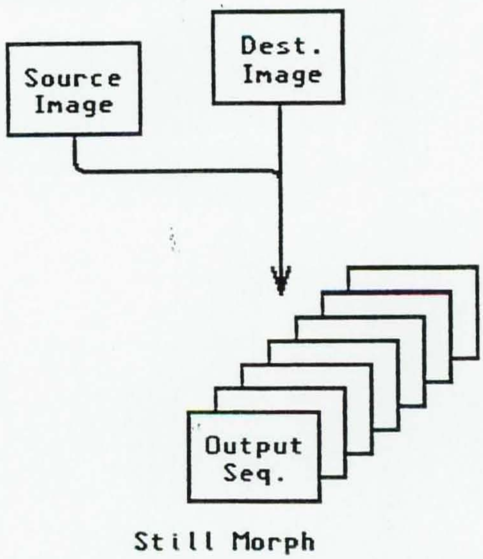

Figure 1. MorphPlus processing of the source and destination images.

The software processes the source and destination files and sets up a morph user interface which lets you work on both images at the same time. MorphPlus uses an "onion skin" visual user interface where the source image can be mixed with the destination image, making the images seem transparent. A slider bar is used to adjust the transparency levels (see Figure 2).

Figure 2. Components of the VUI Screen.

In order to have an accurate and successful morph, a relationship or correspondence between points of the source and destination images must be defined, this is accomplished through the use of vectors (see Figure 3).

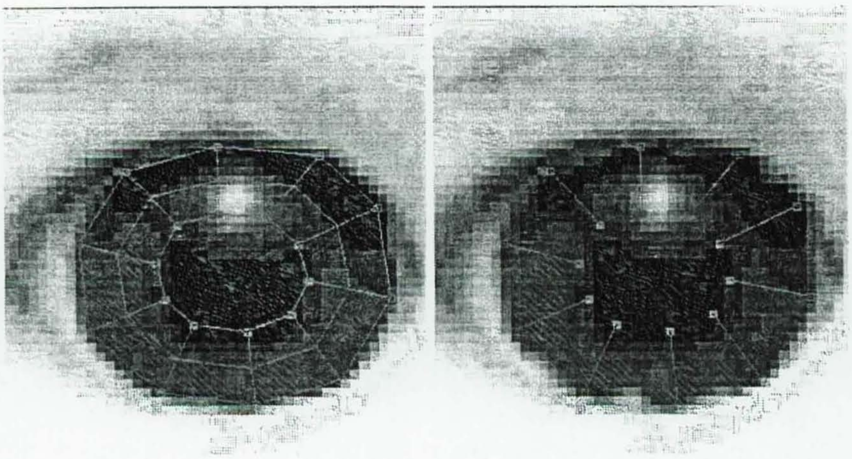

Figure 3. Vectors used from the source to the destination image.

Once all the vectors are placed at the designated reference points selected to maximize the changes between images, the images are ready to be prepared. At this critical point, the program creates the individual frames that will become the transitions between the source and destination images. The number of frames are defined during the set up portion of the program (30 frames/sec is standard video speed). Rendering time (the time it takes the program to produce these frames) varies, depending on the number of frames requested, number of vectors and complexity of the morph being produced. To animate the morph once it's complete, the output sequence file (comprising the 30 frames rendered in MorphPlus) must be loaded into the "Video Toaster" modeler program. The "Video Toaster" is a multidimensional video computer using the Commodore/Amiga platform. This system provides an array of video production features. It can perform real-time video effects, broadcast-quality titling modeling and 3D graphics. The Video Toaster is a product of the New Tek Corp., Topeka, Kansas.

The modeler module of the Video Toaster takes the individual frames of the output sequence file from MorphPlus and forms an animation file, this process enables the Video Toaster to sequence the individual images at the prescribed rate (in this case 30 frames/sec) to produce the animation. To show the multiple months of animation a utility program is used to combine all the output animation files. This can be done because each frame produced is sequentially numbered, allowing an indefinite number of frames to be combined for the animation. It is fortuitous that, in shooting the image at 30 frames/sec, this was equal to about one days change between images (30 days/month) used to model the inlet features.

This method of visualization is one of many now available. The Department of Conservation does not endorse the use of specific hardware and software in the merging of the raw data, but the computer hardware, software, and the scientists conceptual knowledge of the processes, all integrate into a new tool that could be utilized in the visualization of natural phenomena--in this case, the opening and closing of Little Pike's Inlet at Westhampton Beach.

The graphics used at prior presentations of the geomorphic changes at Little Pike's Inlet relied on the interpretation of features observed on the aerial photos or on overlays made of the aerial photos (Figure 4). The purpose of the original presentaions was to counteract the very negative publicity given to the opening of the new inlets along Westhampton Beach by the homeowners, coastal engineers and by the news media (Wolff, 1989, 1994).

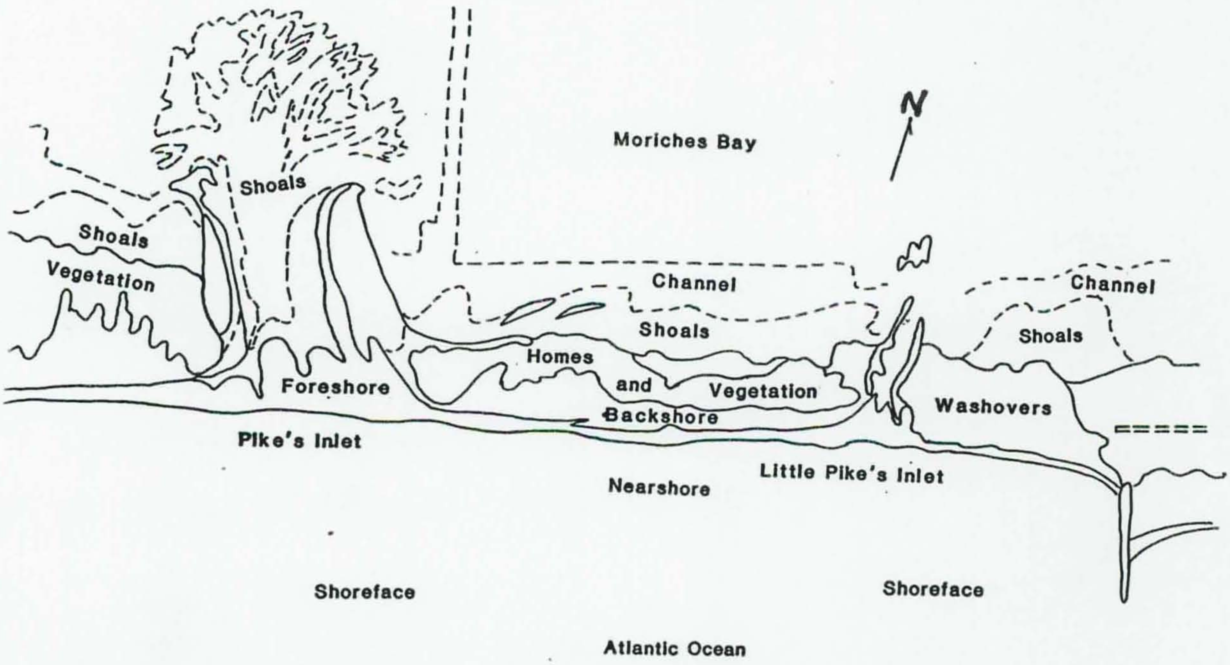

Figure 4. Depositional features associated with the opening of two new inlets at Westhampton Beach, L.I. after the December, 1992 "Nor'easter".

This is understandable, since any sand migration (usually referred to as "erosion") conveys an image of destruction, even though the impact on the natural features was the opposite--the deposition of sand through the inlet would lead to the construction of a bayside shoal that, after further overwash, would lead to the further preservation of Westhampton Beach. The concept of destruction is further emphasized by the loss of beach, dunes, houses, pavement, through the process of flooding (i.e. what makes all this "gloom and doom" a media event). Little attention was paid to the numerous depositional features used to demonstrate the natural landward sand migration produced by such storms. It is these episodic "spikes" that actually help to preserve the barrier island-inlet environments during this long period (20,000 years) of sea level rise. (Wolff, 1993, 1994)

Besides the use of overlays of aerial photos, to illustrate changes, a direct offshoot is the development of superimposed sequential overlays--either in sets of 2-3-4-5 or even 6 (Figure 5). These are meant to convey a more dramatic graphic of before and after geomorphic changes, as well as changes in some of the more detailed features of sub-environments.

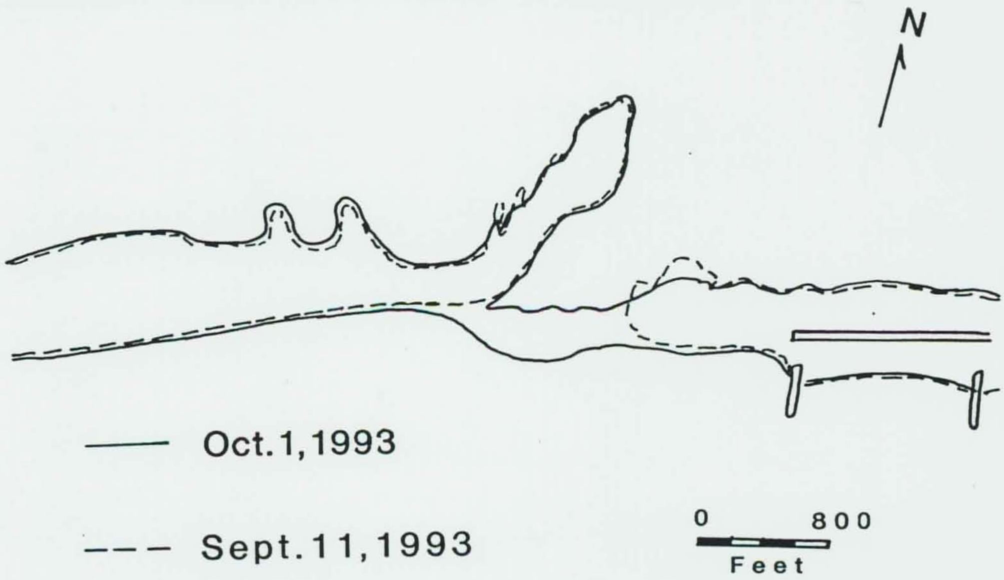

Figure 5. Sequential overlays of the closing of Little Pike's Inlet at Westhampton Beach detailed features of sub-environments.

The trouble with these is that, after more than two superimposed overlays, even the general outline of the principle features usually begins to appear confusing and difficult to separate. Further, even if discernable, it is not possible to visualize or determine the rates of change between separated superimposed sequences. By transferring these aerial photos to video, and loading into Morph Plus with the visual user interface, the process of morphing can begin. The major advantage is the reproduction of what appears to be a continuing video of daily geomorphic changes--from still monthly aerial photos that can represent a long period of time.

II. Pattern of Events as Viewed From the Computer Morphing

1. The vertical opening of Little Pike's Inlet (December, 1992-February, 1993).

The first set of images indicate the slow gradual opening of this inlet, about 200 meters west of the most western groin at Westhampton Beach. Though the opening was actually initiated in deep embayments adjacent to storm overwash lobes on the bayside (Wolff, 1994c) the video shows the vertical (north-south) opening as occurring from both the bay and the ocean. A long thin sand bar on the west side of the inlet gradually spreads out as a sand shoal in the bay. The sand eroded from the breach is spread as a flood tidal delta in the ocean. The beach on the east side of the inlet shows bayside widening (from wave overwash) and beach erosion; on the west side there is beach accretion and shoaling from the flood tidal currents at the new inlet.

2. The lateral widening of the inlet (February-March, 1993)

Now the vertical opening of the inlet is superceded by its lateral widening from the effects of the March 15 "Nor'easter" and by the onshore movement of sand from the shoreface.

3. Rapid inlet widening and bayside migration (March-April, 1993).

While the inlet becomes more shallow and widens, the plume of the flood tidal delta also continues to accrete sand and widen as fair-weather conditions return. The ebb tidal delta persists and grows as sand continues to be transferred from the shoreface onto shoals on both sides of the inlet. The curved spit on the west side also grows and widens.

4. Slow inlet widening and spit accretion (May-June, 1993).

As the flood tidal delta continues to disperse bayside sand and shoal there is lengthening and widening of the spit on the west side of the inlet by the longshore currents and wave overwash, with sand continuing to be supplied from the eroding beach and the ebb tidal delta. The beach on the eastern side also widens by beach erosion and shifts landward by bayside overwash accretion.

5. Continual shoaling and growth of western spit (June-July, 1993).

As the elbow of the western spit migrates landward, the deepest part of the inlet channel also shifts landward and towards the western spit. Some sand still continues to move in from the shoreface onto the ebb tidal delta into the inlet and on to the beaches on both sides of the inlet. The Coreolis effect on the inlet tidal currents may be the reason for more sand movement along the western spit, while overwash broadens its northern tip. The eastern beach remains stationary as the inlet continues to widen.

6. Artificial closure of inlet from eastern side (July-September, 1993).

Offshore dredging of sand by the U.S. Army Corps of Engineers begins in July with the buildup of a base "working platform" on the east side of the inlet. Through the use of pile-driven steel sheeting, sand dredging and bulldozers, the eastern spit begins to widen and move westward in a series of constructional pulses. Near the final closure the western end widens from the longshore transfer of some dredged sand across the narrow inlet, and then it closes. Continued dredging adds more sand to the eroded western beaches, straightens the shoreline, and the closure is completed.

The morphing of the monthly aerial photos demonstrates not only the dominant coastal processes regarding onshore, offshore, or longshore sand movement, but also synthesizes the rates of these processes. The purpose of this study was to note that, even with the presence of the groin field east of this area, sand would still accumulate on the west side of a new inlet. Here it would form a series of beach ridges and an elongate spit, while in the throat of the inlet it would appear as a flood tidal delta. Instead of the usual longshore sand source (blocked by the 15 groins) the source of sand supplying the coast would now be the ebb tidal delta - but the source for the sand would have to come from the shoreface, and this was demonstrated by the use of the aerial photos (Wolff, 1994) and now more clearly by the computer morphing technique.

Computer morphing works best with aerial photos if there are widespread or continual changes in the geomorphology of the landforms--as was the case for the Little Pike's Inlet. It does not have the resolution to demonstrate only beach or dune erosion (light-colored features), and works better when having contrasts with the darker ocean or bayside features. It has been a valuable tool in integrating the changes between monthly aerial photos that can illustrate the processes and features associated with the opening and closing of inlets.

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