LOUISIANA OFFICE

3501 HOLIDAY DRIVE, SUITE #314
NEW ORLEANS, LA 70114
CELL (24 HOURS): (504) 367-4072
FAX: (504) 367-3790

Email: oceanoilpazos@bellsouth.net
www.siterrific.com/pazos

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566 VILLA GRANDE AVE. S.
ST. PETERSBURG, FL 33707
PH: (727) 347-2556
FAX: (727) 343-9717
CELL (24 HRS): (727) 698-2556
Email: hectorpazos75597@aol.com

COLLISION OF A BOAT WITH A CHANNEL MARKER – DETERMINATION OF WHO WAS THE DRIVER THRU ANALYSIS OF THE INJURIES

By: Hector V. Pazos, P.E., Naval Architect, Marine Engineer and
Registered Mechanical Engineer
(www.siterrific.com/pazos)

The boat accident described below, resulting in the death of two occupants, presented the challenge of determining who of the four occupants of the boat was the driver at the time of the accident, and what was the seating position of each occupant.

To arrive to the basis for the final opinions, the author of this article developed an analysis combining basic engineering principles with detailed analysis of the injuries sustained by the occupants and anatomy of the human body, with emphasis in anatomy of the hand of the driver. Additionally, the cause of the accident was investigated.

Background of the Accident

In the early morning hours (approximately 2:20 a.m.) of July 10, 1988, an 18' speedboat collided with channel marker no. 11 located in New Pass Channel in Sarasota Bay in Florida, resulting in two deaths.

According to various witnesses, the boat was traveling at an estimated speed of 20 to 30 MPH.

The occupants of the boat at the time of the accident were a woman 29 years old, height: 66" = 5' – 6"; weight: 120-125 lbs; a 22 year old man, height: 74" = 6' – 2"; weight 180 – 190 lbs; a 21 year old man, height: 73.5" = 6' – 1 ½"; weight: 158 lbs; and a 20 year old man, weight: 145 lbs.

All occupants received serious injuries and as a result of their injuries, two of the occupants died, one woman and one man.

Boat Description

The boat was a 1981 Rally Sport of fiberglass construction, powered by a 200 HP Evinrude outboard engine. It has independent-adjustable bucket seats for the driver and forward passenger and a bench seat across the transom for the two astern passengers.

The forward areas of the deck and bottom are primarily built with two fiberglass woven roving mats, having a layer of chopped fiberglass (chopped strand mat (CSM) between the gelcoat and the two woven rowing mats. There are no internal stringers, frames or longitudinal stiffeners. It appears that the only reinforcements were provided by a wooden core in the keel area and an extra chopped strand mat thickness in the areas of each spray rail.

The boat had a gasoline tank, located at centerline, just forward of the cockpit (measuring 33" in length, 16" in width and a depth varying between 8" to 12"), which is secured by a small bracket connecting the tank to the underside of the deck, and also restrained by the filling line.

The following is a weight estimate of the boat including passengers, fuel and miscellaneous equipment:

Hull, Batteries, Tank, Etc.	750 lbs.
Motor	350 lbs.
4 people 125 + 185 + 165 + 165	470 lbs.
Gasoline ½ full	66 lbs.
Misc. equipment	100 lbs.
Total Weight	1,736 lbs.

Area Transited

The boat with 4 occupants left a restaurant-bar in Sarasota and was heading west toward the New Pass, where it collided with channel marker no. 11.

Channel marker no. 11 is a 12" unpainted wide flange (12" wide x 12" deep I-beam) steel beam, with an elevation of about 12' above he waterline and two signs (with the number 11 painted on each sign), secured to the flanges of the I-beam. Marker no. 11 was not illuminated. The marker and the signs form a slight angle (approximately 10 degrees) with respect to the orientation of the channel, resulting in the marker being less visible when a boat is moving in the channel in a westerly heading.

It should be noted that channel marker no. 11 is very difficult to see by occupants in a boat approaching the bridge from the west due to the background illumination provided by lights on the bridge which may temporarily hinder a person's ability to see. In other words, the lights of the bridge and passing traffic have the effect of blinding the viewer and make almost impossible for the average person to distinguish the edges of the unpainted I-beam without a source of light. The sign itself may be slightly more visible, but because it is approximately 12 ft. above the water, it is not in the direct line of sight of a person driving a low profile boat. The direct line of sight of a person driving a low profile boat such as the boat under consideration will be about 3' above the water.

Boat Damages and Boat Response to the Collision

The boat contacted the marker on the port side, approximately 2" to 2.5" from centerline. After contact, the boat continued traveling generally forward for approximately 96 inches (8' – 0"), initially forming an angle of approximately 13 degrees between the centerline of the boat and the average line of the fractured deck gelcoat, and maintaining this angle for approximately 3' – 6".

Then the fracture continues approximately parallel to the centerline of the boat for the length of the main damage. The width of the fracture is approximately 18" for the first 36" to 48", then, the width increases to 24" for the remaining length of the damage.

The pattern of the fracture can be explained as follows:

Immediately after initial contact, as the fiberglass was being deformed, the gelcoat and the layer of chopped fiberglass cracked and the strands composing the fiberglass woven roving mats were being broken in shear and tensions, leaving overlapping mat sections remaining and attached to the rest of the boat, on the port and starboard side of the fracture.

The overlapping mat sections on the bottom of the boat wrapped the port side of the gasoline tank protecting it from damage and creating an "inclined plane" that was in contact with the channel marker for most of the fraction of a second of duration of the fracture's formation.

The creation of this slippery obstruction, together with the influence of the "v" shape of the boat and the "water-drop" shape of the 3 spray rails, resulted in the bow of the boat being forced to adopt, for a fraction of a second, a side motion or displacement to the starboard, simultaneously with the forward advance of the boat, which creates the impression to the unaware observer that the boat was making a turn to the right or starboard. The collision resulted in an initial horizontal angle of damage to the deck with respect to the boat's centerline of approximately 13 degrees to port.

Within a fraction of a second after the initial contact, the vector of the momentum located at the center of mass, as well as the resistant force developed by the breaking of the fiberglass, resulted in an offsetting reaction of the thrust of the propeller, creating a moment our couple to port, forcing the boat to rotate counterclockwise around the channel marker, once enough structural resistance was developed from the fiberglass and plywood floor.

Description of the Injuries Sustained by the Occupants

Two occupants of the boat received fatal or near fatal injuries.

Hair and brain material was found on the channel marker approximately 8 feet below the top of the beam, that is, about 4 feet above the waterline.

The characteristics of the injuries received by the occupants are summarized as follows:

The woman (66" – 120 to 125 pounds) that died (occupant #1), besides being injured, died of asphyxia due to drowning. She had the right side of her face and scalp scraped toward the backside of her head. Her scalp has a 7" angle laceration and her face had a 4" laceration opening into the face. The chin and right side of the throat had multiple abrasions. She also had an abrasion-contusion injury on her right shoulder and her right clavicle was fractured. She had a 2" zone of abrasion on her right breast and a 4" angle laceration with abrasion on her upper right arm. She had a contusion-abrasion varying from 1.5" to 3" on her right hand. The right leg had various injuries. The most distinct was a 4" longitudinal laceration on the lower part of the right leg. Other injuries of lesser degree were also found on her left leg.

Minute fragments of white and blue paint as well as larger irregular fragments of fiberglass material were identified on the body surface and within the margins of lacerations involving the right side of the face, right arm and right leg. Fragments of fiberglass material were adherent to her black dress which is torn in the central upper chest region in the posterior (back).

The man (74" – 180 to 190 pounds) that died (occupant #2) sustained a blunt impact on his face and neck primarily on the right side. The configuration of his head was altered due to a crushing injury to the right side of his head. The right side of his head and face had multiple skull fractures. The right side of his head near the hairline (scalp) had a 4/5" laceration with the fractured bone ends – brain tissue exposed. On the right side of the nose and between the eyebrows there was a 2" laceration with nasal cavity region opened to the exterior. The mandible (jaw) on the right side had multiple fractures. There was a small laceration (0.8") over his left eye and a 3" laceration on his scalp on the right side of his head. His right shoulder had a 6" x 1" longitudinally oriented abrasion and a fracture on his right clavicle. He had a fracture to his thoracic spine at the T-5-T-6 level (middle back). His right hand had a 3" zone of abrasions of skin surface within which there are 2 small lacerations on the inside of his hand. He had a small abrasion-contusion of the anterior right thigh.

There was also a small laceration of the spleen. On his left forearm there were two small parallel abrasions or scratches. There were 2 small abrasions in the region of the left breast. His left shoulder had a large zone of abrasion. There was a contusion of soft tissues in and around the larynx.

Male occupant #3 (145 pounds), sustained an open fracture of the right tibia with gross displacement, an open fracture dislocation of the left fourth metacarpophalangeal joint with complete destruction of the ulnar 2/3 of the articular surface of the proximal phalange and volar 1/3 of the articular surface of the distal end of the fourth metacarpal bone and full thickness lacerations over the right anterior chest area (Preoperative Diagnosis). The preoperative diagnosis included in the surgeon's operative notes from Memorial Hospital regarding Occupant #3 contains the following diagnosis of the injuries to his left hand.

> "Open defect over the dorsal ulnar aspect of the 4th metacarpophalangeal joint showed that there was complete destruction of the ulnar ½ of the extensor mechanism, 2/3 of the articular surface of the proximal phalanx, and volar 1/3 of the articular surface of the distal end of the 4th metacarpal bone".

Also, the surgeon's operative notes from Memorial Hospital regarding occupant #3 contain the following description of the surgery performed on his left hand.

> "Examination of the open defect over the dorsal (1) ulnar aspect of the 4th metacarpophalangeal joint showed that there was complete destruction of the entire ulnar ½ of the extensor mechanism and joint capsule and there was complete disruption of the lateral 2/3 of the articular surface of the proximal aspect of the proximal phalanx and the volar 1/3 articular surface of the metacarpal head".

<u>Glossary</u>

Dorsal = back of hand

Ulnar = of or rear the inner and larger bone (ulnar) of the forearm

Aspect = position in regard to viewing

Volar = pertaining to the palm of the hand

Tibia = shin bone

Phalange = finger bone

Proximal = next or nearest the point of attachment.

Articular = referring to a joint

Palmar = corresponding to the palm of the hand

Metacarpus = the part of the hand between wrist and fingers

Carpus = pertaining to the wrist

Anterior = front

Distal =- towards the end of a structure, opposite of proximal

Fibula = outer bone of human leg below the knee

The fourth metacarpal, has a ball like articulate surface on the outer end. This ball engages a socket like end of the fourth phalange. The ball and socket combination forms the metocarphhalangeal joint of the fourth finger.

Occupant #3 also had “multiple abrasions and flap type wounds of the anterior chest”, Operative Report, Memorial hospital – Sarasota, FL.

His chest injuries were further described in the medical records as follows: “ … multiple full thickness lacerations over the right anterior chest”.

Occupant #4 (73.5” – 158 pounds) had an open fracture to the tibia and fibula of his left leg, a small laceration on the right inner thigh and a small abrasion to the center of his forehead with no laceration. The open fracture of the left leg consisted of two open lesions over the left tibia, one at the site of the fracture, and one just below that. Furthermore, the tibia fracture was described as a transverse fracture.

Occupant #4 also had a “small laceration over the right inner thigh” and a “small bump on forehead, but does appear to be more than just a small contusion. There is no laceration” (Notes from physical examination).

It is important to note the lack of frontal injuries, injuries that would be expected had someone contacted the steering wheel.

Conflicting Notes From Interview of Occupant #3 by the Homicide Investigator

Occupant #3 initially indicated that he was sitting in the astern seat and the girl was sitting in the front.

Occupant #3 initially indicated that he was on the port side, rear seat and he indicated that occupant #2 was on the right or starboard side of the rear seat.

> NOTE: As per various sections of this analysis, it is not possible for occupant #2 to have been on the right side of the aft seat at the time of collision. If occupant #2 had been in the starboard rear seat, he could not have hit the channel marker, hence, occupant #3’ recollection of the seating arrangement at the time of the accident was erroneous. Research studies have indicated that person’s involved in a traumatic accident have very unreliable

recollection of the facts, hence, occupant #3 statements were not only unsupported by the facts but cannot be taken into account on the basis of statistical research.

<u>Other Notes from Interview of Occupant #3</u>

Occupant #3 then made the statement, quote: "Yes, I was the driver of the boat and I want to get this over as soon as possible".

<u>Notes Regarding Bone Strength versus Muscle Effort</u>

The human body is designed with muscles, which are attached to bones, which can meet and stabilize at the joints, which are further held together by ligaments.

For instance, the bone and muscle action of the arm and hand can be described as follows:

> The BICEPS are connected to the RADIOUS bone in the lower arm.
> The TRICEPS are connected to the ULNA.
> The joint, for fulcrum is at the elbow.
> When the TRICEPS contracts, the arm is straightened.
> When the BICEPS contacts or shortens, the arm is flexed.

Almost all muscles are arranged in pairs, each is an antagonist to the other. One muscle works to move a bone, the other works to move it back. Depending on what the brain wants the arm to do, both muscles can work at the same time, for a rigid arm, or one can contract a little more than the other, or both can relax, causing the arm to hang there, limp at the side.

The strength of the human bone can be measured by its resistance to pull (tension) or pressure (compression) when external stress is applied, or shear (bending) if the force is applied across the grain of the bone.

The tensile strength of bone is more than 200 times greater than that of the muscle, yet a strong muscular contraction can sometimes break a bone. There are many cases on record of bones broken by muscular action.

Voluntary muscles, as previously discussed, are normally arranged in pairs. If the muscles require precise movement, as do those in the hand, there is one motor serve to only a few muscle fibers.

One end of the muscle is fastened to a bone by means of a strong cord of connective tissue called a tendon. The other end is also attached by a tendon to a bone.

Muscles accomplish work when the body machine moves bone levers for the purpose of lifting, grasping, etc.

The three components of a lever system are:

1. The fulcrum, the joint on which the lever turns;
2. The resistance, the weight to be moved;
3. The effort, the source of energy (muscles).

For instance, we can determine the amount of effort (force) that the biceps muscle must generate to overcome the resistance and lift a weight of 40 lbs.

Assume, for instance that, the distance from a 40-pound weight to the fulcrum is 16 inches, and the distance from the muscle's attachment to the fulcrum is 3 inches.

Hence, the effort = $\frac{40 \times 16}{3}$ = 214 pounds.

That is, the biceps must apply a 214-pound effort to lift 40 pounds.

The muscles in the legs working in the same manner, for instance, the muscles of the legs must apply 10 pounds of effort for every pound lifted, that is, for a man to lift 200 pounds on his back, a total force of 2,000 pounds is needed from muscles.

In summary: The muscles of the hand can effectively be the source of energy that can result in injuries to the bones and joints of the hands.

Analysis

Summary: The injuries to the occupants of the boat of reference, as described above, indicated that two people contacted the change marker, occupant #1 and occupant #2.

The position of the occupants in the boat, and the configuration of these people a fraction of a second before impact, is discussed below.

Occupant #1 and occupant #2 had their faces fairly close together and their bodies were in such a position that occupant #1's face was a few inches forward of occupant #2 and slightly lower and on the left side of occupant #2. In other words, occupant #2 was just a few inches aft of occupant #1.

Hence, occupant #1 was seated in the front left seat with occupant #2 in a semi-standing or crouching position behind her, that is, leaning forward with his face very close and behind occupant #1's right ear. The above-described configuration is the only one that could have resulted in the type of injuries received by occupant #1 and occupant #2.

Most of the witnesses to the post-accident events clearly indicated that occupant #3 was on top of the boat (aboard the boat) within a few seconds after the accident, while occupant #4 was still swimming or still in the water when these witnesses reached or spotted the accident site for the first time, that is, occupant #3 was probably the only person that did not loose complete contact with the boat.

It is clear that immediately after collision, the boat continued to move approximately forward for a fraction of a second until enough structural strength (primarily the wooden floor of the cockpit) was accumulated to resist the forward momentum, and at this point the boat continued turning around the marker counterclockwise until the ignition was turned off.

The structural strength of the boat increases toward midship, and the increase is greater approximately in the forward area of the cockpit because the wooden cockpit floor folded or piled-up at this location.

A fraction of a second before collision, the boat was in an almost straight course. To support the conclusion that the coat was not in a turn at the time of contact with the channel marker, it should be mentioned that the configuration of the fractures on the deck and bottom, indicate that at the time of contact with the channel marker (and during the fraction of a second that took to stop the forward motion of the boat), the boat was almost level (no list) to port or starboard. Should the boat have been in the process of making a turn, a differential distance from centerline of the boat to the line of the fractured areas on the deck and the bottom hull should have been noticeable.

An angle of list is developed in a ski boat because the boat will "bank" when making a turn, otherwise it would continue the "pre-turning-slide" due to the lack of a skeg or fin to offer lateral resistance. No indications of differential fracture or "after-slide" turning were noted in the boat.

Furthermore, the characteristics of the damages to the aluminum rail located at the joint between the deck and the side, indicates a direct forward contact rather than a tangential contact, which should have resulted if the boat was making a turn. No "tangential contact" was observed in the aluminum rail.

It was observed during the trial of a sister boat (sister to the boat involved in the collision with the channel marker), that as the boat turned, the boat heeled in the direction of the turn. That is, when the boat turned to starboard, it also heeled to starboard.

The horizontal surfaces fixed in the boat, such as the rear passenger seat and the forward passenger seats, will incline or form an angle with the horizontal when the boat is heeling during a turn. Hence, an occupant sitting in any of the passenger seats will slide to the starboard side (in a starboard turn) due to the effect of gravity on the person's body. In other words, the passenger seats become inclined, thus a person tends to slide towards the lower end of the inclined seat.

Within a fraction of a second after collision, the forward momentum of the mass of the boat and its occupants was suddenly decreased as much as 50% when the 4 occupants partially released their contact with the boat. All the occupants except occupant #3 were propelled away from their original positions in the boat. Occupant #3 probably retained contact with the steering wheel and with the throttle for a fraction of a second longer, a conclusion that appears to be supported by occupant #3's fracture and dislocation of the left hand – (4th metacarpal phalangeal joint) and by his position on the deck of the boat as sighted by the witnesses shortly after the accident.

The relation of the described injuries of occupant #3 when the hand is in position to grasp a round object, such as a steering wheel are obvious.

The steering wheel is "fixed" and will not move significantly when a force is applied to it, while the throttle lever is designed to move, thus it is not capable of supporting or resisting horizontal movement. That is, when a force, such as a gripping force from hand muscles simultaneous with a horizontal force due to a person's forward movement, is applied to the throttle lever, the lever will move forward. Hence. Occupant #3 did not break his right hand probably because the throttle lever did not offer as much support to resist occupant #3's forward motion, as did the steering wheel.

In other words, since occupant #3 was probably holding the wheel with the left hand and holding the throttle with the right hand, the actions of holding onto these two items offered resistance to being projected from the boat. Therefore, his body was not thrown far out of the cockpit, and consequently, he never fell in the water, or he was able to climb back to the boat within a few seconds of impact.

The fact that his left hand was broken, apparently without indication of external impact, support the conclusion that he held onto the wheel with extraordinary muscular effort which resulted in the 4th metacarpal phalange in his left hand breaking.

Seating Position and Motions of Occupant #3

The analysis developed in this investigation allows the conclusion that occupant #3 was driving the boat at the time the boat contacted the channel marker.

As previously described, prior to impact, occupant #3's right hand was probably holding the throttle while his left hand was holding the steering wheel, and his body was configured in the typical position that people driving light, fast power boats normally adopt, that is, he was leaning slightly forward.

Occupant #3's forward momentum, immediately after impact, was opposed by the frictional force (gravity weight x coefficient of friction) between the top of the seat and his pants; the frictional force (pressure of shoes on floor x coefficient of friction) between the floor of the boat and the bottom of his shoes' soles; by the restraining force developed in his left arm with his hand on the steering wheel.

Upon impact, occupant #3 slid forward, with little or no upper torso rotation, until his right leg contacted the dashboard. The forward movement of his upper torso was resisted at the shoulder/arm connections, which were above the center of mass of his body, and the restraining force developed in his arms was much large than the frictional force developed between his pants and the seat and his shoes' soles and the floor of the boat.

Probably occupant #3's left leg was extended (or in a prone position), or at an angle, that is, not parallel to centerline, and his right leg was bent at the knee in such a way that the part of his leg below the knee was almost vertical with his right foot resting on the sloping floor, which is approximately 3" above the level or flat portion of the floor.

Hence, when occupant #3 slid forward, the first part of his body to contact the dashboard was his right leg at a point located below the knee, and impacted the dashboard with enough force to fracture his leg.

The contact between occupant #3's knee and the dashboard will partially resist his forward rotation. Nevertheless, the upper torso will continue to move forward, overcoming the resistance of occupant #3's left and right arm, and rotate forward about his leg/hip joint.

Due to the forward translation and rotation of occupant #3's upper torso, both the left and right side of his chest contacted the wheel of the boat causing the injuries to his chest, as noted in the medical report.

For the reasons previously described in the following pages, the following can be concluded: Occupant #3 was in the right front seat driving the boat. He broke his left hand while holding the steering wheel, and his right leg when his body was suddenly propelled out of the cockpit. The breaking of his right leg occurred when his leg hit the coaming of the cockpit because his right leg was positioned in the narrow space between the wheel and the control box of the throttle.

Seating Position and Motions of Occupant #1

Occupant #1 was sitting in the forward port seat. Occupant #1 forward velocity immediately after impact will initially be opposed by the frictional resistance between the top surface of the seat and her dress and the frictional resistance between the floor of the boat and her feet.

This frictional resistance will offer very little restraint against the forward motion of her body although a slight forward rotation of the upper torso will occur because the location of the frictional forces is lower than the center mass of the body.

Some of occupant #1's kinetic energy (1/2 M V2) is lost because of the work done (F x d) to overcome the dynamic friction force as her body mass "slides" forward rectilinearly.

Occupant #1 will continue moving forward in a motion which is a superposition between rectilinear motion and rotation, until the part of her leg at her knees (occupant #1's legs were probably shorter than occupant #3's legs) contact the "dashboard", an event that will increase the rotation of her upper torso due to the couple created between the newly created resisting force (knees on "dashboard") and the forward movement of the center of mass. The contact of her knee and dashboard did not result in broken bones because.

1. Her seat was probably in the aftermost position.
2. Her legs are relatively short an the contact was close to the knee, that is, close to the reaction point, rather than approximately in the middle of the bone.
3. She was not holding onto anything hence she was propelled upward by the reaction of her feet on the floor.

The rotation of her upper torso superimposed with her body's forward translation will cause her buttocks to come out of the seat as the rotation of the upper torso and translation of her body continues.

Upon impact with the channel marker, as the boat continued advancing generally forward for a fraction of a second and while the boat was yielding to the channel marker, occupant #1 was propelled forward a few inches above the deck, eventually (2' to 3' from her previous sitting position) contacting the channel marker tangentially with the right side of her face, also hitting the marker with her right shoulder and right breast and continuing her trajectory towards the water.

The right shoulder impact resulted in the body increasing downward motion (dropping off the port side of the boat) due to her loss of forward momentum and the effect of gravity forces, while scraping her right leg against the broken fiberglass and the distorted aluminum railing, before continuing towards the water.

Many of the lacerations on occupant #3' body are due to the distorted aluminum railing.

Seating Position and Motions of Occupant #2

Occupant #2 was positioned just aft of occupant #1 and slightly inboard of her.

Simultaneously with the movement of occupant #1, occupant #2 was being propelled forward a few inches behind and above occupant #1, impacting the channel marker bluntly. Both occupant #1 and occupant #2 had their right shoulder clavicle broken, which indicates that a fraction of a second before impact they had their torso turned slightly toward the port side of the boat with the right clavicle lined up in a orientation such that their clavicles were almost in the same plane as the right side of their faces.

Occupant #1's body being forward of occupant #2, acted as a protective "mat" for occupant #2, flattening the pieces of fiberglass that were flying out of the deck or that were being sheared or deformed ahead of the channel marker and protecting occupant #2 from lacerations that the aluminum rail would have caused had occupant #1's body not been very close to occupant #2.

Seating Position and Motions of Occupant #4

It can also be concluded that occupant #4 was on the starboard side of the rear seat. Occupant #4 was in a relaxed configuration with his left leg towards the two forward bucket seats.

For this reason, occupant #4's left leg broke when he was propelled out of the cockpit, hitting the back of the starboard bucket seat with his left leg. He was thrown farther away from the cockpit than occupant #3, that is into the water in a dynamic action (momentum and trajectory) like occupant #1 and occupant #2, because similar to that of occupant #1 and occupant #2, occupant #4 was not holding onto anything.

In the x-rays of occupant #4's left leg, it was observed that the fractures to occupant #4's tibia and fibula are not in line, hence, it appears that the fractures may have been caused by an angular low to the leg. In other words, it appears that the fractures to the bones in occupant #4's leg are not consistent with the expected injuries had occupant #4 contacted the dashboard or console with his left leg.

Also, occupant #4 sustained almost no other injuries because his muscles were in a relaxed condition at the time the boat impacted the channel marker, an because occupant #4 contacted occupant #3, resulting in two effects:

a. Occupant #3's body acted as a protection to occupant #4, hence occupant #4 did not his the deck or other parts of the boat.

b. Occupant #3's obstruction to the path or trajectory of occupant #3's body resulted in occupant #4 falling overboard.

Furthermore, if the muscles of a person are in a relaxed or limp state, a person falling or hitting something or splashing in a body of water is less prone to get injuries or broken bones because the muscles act as a cushion for the bones.

When any part of the body moves, besides feet, legs and back, a kinetic analysis of the movement, including factors such as gravity, friction, mass distribution, etc., could me made.

Conclusions and Opinions

1. The primary cause of the accident was the presence of an unlighted, unpainted steel channel marker, having a slight angle with the channel, located in such a way that the lights from a bridge make the channel marker very difficult, if not impossible, to see when traveling in a westerly direction. This combination results in a marker very difficult to be sighted on a dark nigh.
2. The severity of the accident was due to the type of marker, that is, a steel wide flange pile, rather than a round creosote covered timber pile. A creosote timber pile would have probably resulted in the boat being deviated or "bounced" without major fractures of the boat.
3. The seating arrangement of the 4 occupants of the boat at the time of the accident was:
   - Occupant #1, left front seat.
   - Occupant #2, partially on left rear seat.
   - Occupant #4, right rear seat.
   - Occupant #3, right front seat (was the driver at the time of the accident).

About the Author:

Hector V. Pazos is a Naval Architect, Marine Engineer and a Registered Mechanical Engineer and has been engaged in Accident Investigation/Reconstruction for more than 40 years. He has been retained as an Expert Witness in over 1,200 Maritime cases, related to both commercial vessels and pleasure crafts, for both defense and plaintiff.

He has offices in St. Petersburg, FL and New Orleans, LA. He can be reached by phone at (727) 347-2556 or (504) 367-4072 or by email at: **oceanoilpazos@bellsouth.net** or **hectorpazos75597@aol.com**.

For more information, please visit our website at: **www.siterrific.com/pazos.**