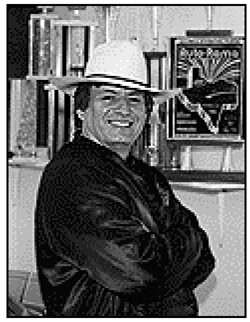
Richard Alfred Tapia



It is often said that hard times in life will either make you or break you. Richard Tapia is a prime example of a person who has taken his hard times in stride, and made the best out of them. Despite being teased as a child, having to overcome his wife's illness of multiple sclerosis, and the death of his oldest child who was only 22, Tapia has gone on to be a very successful Hispanic man in the world of mathematics (Featured)(Personal).

When Tapia's parents were young teenagers, they had separately immigrated from Mexico. His father came from Nayarit in Central Mexico, and his mother came from Chihuahua, where women are known for their beauty and strength in character. Tapia's parents had come to the US in search of educational opportunities for themselves and hopefully for future generations (SACNAS)(Richard).

Richard Tapia was born in Los Angeles, California on March 25, 1939. He has a twin brother, two younger sisters, and a younger brother. His parents, especially his mother, taught him and his siblings many important things in life – good work habits, to believe in themselves, take pride in who you are, respect others, and sensitivity to others needs. Once his mother had a goal set, there was nothing anyone could do that was going to prevent her from achieving this goal. Tapia learned from his mother that you can do anything you want to do, but you have to stay determined and not give up (SACNAS).

Tapia had some hard times when he was a boy in school. His classmates would tease and insult him because of his Mexican heritage. Many of his friends either dropped out of school or got involved with drugs. The counselors at his school often had low expectations for the students, so Tapia was not given advice on how to obtain the best education possible. Despite all of this, Tapia was always a good student. From the first grade on, him and his twin brother have always been good at math. Their teachers considered both of them to be math stars (SACNAS)(Featured).

When they were in junior high school, Tapia and his twin brother discovered that they were mechanically inclined. They had discovered this talent one day when the family car would not start. Tapia and his brother took the engine apart and proceeded to fix it. They started working for free in different local auto body shops and garages. They wanted to learn as much as they possibly could about cars. When they were fifteen, they built a 1932 Ford street roadster and would race it at the local drag strips. Tapia and his brother spent all their spare time on cars. They soon held many local records for racing. In 1968, Tapia and his brother set a world record for elapsed time for fuel dragsters. Because of his newfound talent, his grades in high school were not all A's, but they were still good. He believed that if being valedictorian meant taking away time from racing cars then it was not worth it (SACNAS).

Tapia had good enough grades in high school to attend a four-year university, but due to the lack of advice from his guidance counselor, he attended Harbor Junior College in Wilmington, California. His professors at Harbor noticed his mathematical talents, and encouraged him to apply to UCLA, where he later earned his degree in mathematics and met his future wife. After earning his degree, Tapia designed ships at Todd Shipyards for a year before going to graduate school. The first years he was in graduate school, he had to support himself, so he did not have a lot of money. There was a time when he did not even have a phone. Despite his money and living situation, Tapia claims that "this was a wonderful point (SACNAS)" in his life. After a while, he started to receive financial support from the department of mathematics and the Office of Naval Research, because he was doing so well (SACNAS)(Lecture).

Tapia's original plans were to work in industry after he completed his doctorate. These plans changed however, when his professors in graduate school told him that he would make a good researcher and teacher. He then decided to pursue a university career. After completing his postdoctoral fellowship in applied math at the University of Wisconsin, he was hired at Rice University in Houston, Texas. He chose this particular university because of its reputation for having excellent mathematics programs. Tapia decided that he wanted to go to Houston because of its excellent racial diversity. While at Rice University, he was told by some that he would never make tenure. Eventually his hard work, publishing papers, and completing research projects paid off and he was granted tenure (SACNAS)(Featured).

Starting from the beginning of his career as a teacher, Tapia knew he wanted to reach out to minority groups, especially Hispanics. He wanted to show minority students that if they really wish to do something with their lives, it is possible. Tapia believed that he could improve the participation of minorities in mathematics and science if he could serve as a role model. His first goal at becoming someone that young people could look up to was to become an excellent scientist. This goal was accomplished in 1992 when he was elected to the prestigious National Academy of Engineering. Tapia became the first native-born Hispanic to ever receive this recognition. In 1996, he was appointed by President Clinton to serve on the National Science Board. Tapia is currently the only Hispanic on that board. While on the board, Tapia has the power to influence the future of science and education in this country. One of Tapia's main concerns is why Hispanics are so poorly represented in most leadership positions and at the national level (SACNAS).

Tapia also serves as the Associate Director of Minority Affairs for the Office of Graduates at Rice University. Since Tapia has been at the university, the number of minority graduate students has increased from 5% to 15%. Thanks to Tapia, Rice University leads the nation in the number of minority Ph.D. students in applied mathematics (Lecture).

Tapia attributes his sensitive, caring personality, and his success in part to his culture. He feels strongly about paving the way for young people to follow after him. The message that Tapia would like to send out to all minority students is "that they must not close their eyes to the possibility of a career in science or mathematics. If we do, we will never take our rightful place-to control our destiny and to lead America (SACNAS)."

Despite being teased him school, Tapia had been taught by his mother to be proud of his heritage. Tapia was never able to truly feel this pride in his ethnic background, until he went to Mexico. Even then, he struggled to figure out where he fit in. When in Mexico, people called him a "gringo," implying that he was not really Mexican. When in the US, he was teased for being Mexican. He still ponders this issue today (Featured).

Today, Tapia still has a love for cars, which is shared by his family of three children and his wife. One of their cars recently won every show that it was entered. He is still at Rice University as Noah Harding Professor of Computational and Applied Mathematics. His job description includes teaching mathematics and science to college students, writing books, doing research, and working with the community. He travels around the country to lecture students, professors, and professional organizations. His lectures mostly consist of the importance of recruiting, training, and encouraging young minority students to pursue advanced work in mathematics and science (SACNAS)(Featured)(Personal).

Since this time, Tapia has received an abundance of awards and honors. He has been named one of the twenty most prominent leaders in math education by a minority, Educator of the year by the Hispanic Engineer Magazine, and was awarded the "George R. Brown Award for Superior Teaching." Besides this, he has been featured in numerous magazine articles including the Houston Chronicle, Hispanic Engineer, and SACNAS. Richard Tapia's determination and unending devotion to mathematics has left a tremendous impact not only to the world of mathematics, but also to those around him. While professor at Rice University in Houston, Texas, he received first place in student teacher evaluations. He also received the "Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring", as well as being appointed to the National Science Board by President Clinton (Honors). Tapia continues to devote his time and effort to his work and will continue to be a role model for those around him.

One of Richard Tapia's papers which we are going to focus on, is entitled "The Weak Newton Method and Boundary Value Problems." The purpose of this paper is to apply the Kantorovich theorem to "a class of two point boundary value problems containing the Euler-Langrange equation for simple variational problems and most second order ordinary differential equations. Then with this, we can find the roots of the Euler-Lagrange equation (Numerical)."

In Tapia's paper, the Weak Newton method is used to find numerical solutions. This method involves finding the Hessian matrix (or second derivative matrix) for an initial x, multiplying it by f , and subtracting it from our old x. In this method the matrix A is found only once. In regular Newton's method, A is calculated multiple times. The idea behind this method is that we can find the roots of systems of equations by estimating the x-intercept of the tangent line. First you begin by choosing an initial point in the complex plane, and then iterate until you get better and better guesses. If we start close to the root, then Newton will converge quadratically (Hirst).

To solve a nonlinear system of equations using Newton's method, we use the formula

$$\mathbf{x^{(k+1)} = x^{(k)} - [f'(x^{(k)})]^{-1} f(x^{(k)})}$$

where $f'(x^{(k)})$ is the Jacobian matrix or $\begin{vmatrix} \partial f_1/\partial x & \partial f_1/\partial y \\ \partial f_2/\partial x & \partial f_2/\partial y \end{vmatrix}$. We can also see that this is the tangent line approximation. In Newton's method, the x-intercept of the tangent line is the root estimate, in our case (x_k,y_k). The slope of the tangent line through these points is $f'(x)$. Now, using the equation of a line we get $y-y_k = f'(x_k)(x-x_k)$. Next, we want to solve for x, which changes the equation to $x = x^k+(y-y^k/f'(x^k))$. Because we want to find the roots of the equation which occur when the tangent line crosses the x-axis, then y must be zero. Plugging in zero for y, $f(x^k)$ for y_k, and then bringing $f'(x^k)$ up to the numerator gives us the above formula for Newton's method (Analysis). Now, to demonstrate Newton's method we will look at the following system of equations with the starting point (-0.5,.25).

$$3x^2+4y^2-1$$
$$y^3-8x^3-1$$

The Jacobian matrix for this system turns out to be $\begin{vmatrix} 6x & 8y \\ -24x^2 & 3y^2 \end{vmatrix}$. From this we can calculate the wron by plugging in our initial points for x and y, and then taking the determinant of the Jacobian matrix. For instance, the determinant of the matrix $\begin{vmatrix} a & b \\ c & d \end{vmatrix}$ is ad-bc. Hence, the wron should become 11.4375. From here we calculate our new x and y by the following two formulas.

$$x^{(n+1)} = x^{old} - ((\partial f_2/\partial y_1)* \text{ eq1} - (\partial f_1/\partial y_1)*\text{eq2})/\text{wron}$$
$$y^{(n+1)} = x^{old} - ((\partial f_1/\partial x_1)*\text{eq2}-(\partial f_2/\partial y_1)*\text{eq1})/\text{wron}$$

After plugging in our x and y values, we should get (-.497,.254) as our new points(Hirst).

Because Newton's method involves linearization and solving repeatedly to find a solution to a nonlinear equation, we would continue calculating x and y until we are sufficiently close to the root (Hirst).

Richard A. Tapia's determination and desire has proved to be an impeccable characteristic, which has helped him to surpass many racial obstacles and unfortunate circumstances to become one of the greatest Hispanic mathematicians. His many awards and honors only further prove that he is truly a prime example of what a great mathematician should be.

References

Featured Scientists: Richard Tapia, PH.D.
http://www.breakthrough.org/series/scientist/bios/Tapia/tapia.htm (Featured)
Was used for some information about his childhood.

SACNAS Biography: Richard A. Tapia, Mathematician.
http://www.sacnas.org/bio/tapiahig.htm (SACNAS)
This was probably the most useful resource. It contained the most information about Tapia, and he wrote it.

Richard Alfred Tapia
http://www.maa.org/summa/archive/tapia.htm (Richard)
This one did not contain a lot of useful information, but we were able to find a little about his parents.

1999 J Ernest Wilkins Lecture
http://www.math.buffalo.edu/mad/NAM/jernest-wilkins-lecture/wilkins-lecture1999.html (Lecture)
Was used to talk about his career.

Personal Data
http://www.caam.rice.edu/~rat/cv/personal_data.htm (Personal)
Did not contain a lot of information, but did tell us some important dates.

A Brief Biography for Richard A. Tapia
http://www.caan.rice.edu/~rat/biography.htm
This resource was not used in the paper. I t did contain a lot of good information, but it was repeated facts that we had already obtained from the above resources.

Richard A. Tapia-CV-Honors & Awards
http://www.caam.rice.edu/~rat/cv/honors_awards.html (Honors)
This resource was very useful in obtaining information about the awards and honors received.

The Weak Newton Method and Boundary Value Problems
http://www.jstor.org/cgi-bin/jstor/viewitem/00361429/di976155/ (Numerical)
This information was useful in knowing exactly what type of math he worked on.

Holly Hirst Numerical Method Notes
http://www.mathsci.appstate.edu/~hph/4310 (Hirst)
This information was very useful in understanding Newton's method and how it works.

Ward/David, Cheney and Kincaid. Numerical Mathematics and Computing. Brooks/Cole Publishing Company, 1999.
This book was also very useful in understanding the Newton method.