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ABSTRACT

The Human Systems Engineering (HSE) Model was created to facilitate collaboration among education, business, and industry. It emphasized the role of leaders who converge with others to accomplish their goals while paying attention to the key elements that create successful partnerships. The partnership of XXsys Technologies, Inc., University of California San Diego (UCSD), California Department of Transportation (CALTRANS), and National Institute for Standards and Technology (NIST) began as a collaboration aimed at applying advanced composites for the seismic retrofitting of bridge columns. The chairman of XXsys realized the need to collaborate with leaders from various agencies to validate and commercialize XXsys's carbon jacketing technology. Along with this multidimensional collaboration came individual goals for participating members as well as the common goal. XXsys was motivated to take the risk to achieve a great reward. Doing good for others and pushing the frontier of knowledge motivated the company beyond the money to be made. UCSD conducted the research needed. The keys to success of the collaboration were the chemistry of the people and the support each partner had for others; definition of individual goals; and a broad vision. A CALTRANS representative felt collaboration yielded better quality but took longer to get things done. The NIST representative believed successful collaboration required good chemistry and a "win-win" attitude. (YLB)

# Human Systems Engineering: A Learning Model Designed to Converge Education, Business, and Industry



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The practice of converging education, business, and industry is commonplace among leaders who wish to move forward in a competing world that has little sympathy for limited resources, time, and capital. There is a need for a model designed to facilitate collaboration. The Human Systems Engineering Model© was created for this purpose. This model emphasizes the role of leaders who converge with others to accomplish their goals while paying attention to the key elements that create successful partnerships.

More traditional models such as Strategic Alliance refer to joint ventures that primarily focus on vertical and horizontal partnerships that represent different businesses working together for a variety of reasons including, political, economic, or technical. Additionally, there exists a clear focus on outcomes, cost reduction, and minimizing risk (Wright 1996). What is lacking, is found in Human Systems Engineering©.

Human Systems Engineering© (HSE) supports the notion that the purpose of collaboration is more than simply bringing participants together for a common goal with the intention of offsetting weaknesses with strengths, and minimizing risk. HSE celebrates the dynamic relationship between people who choose collaboration to accomplish their goal, invite risk, and work to promote transformational change. Burns (1978:3) suggests that the role of the leader who chooses transformational change as an outcome of the collaborative process is nothing if not linked to the collective purpose; that the effectiveness of leaders must be judged not by their press clippings but by actual social change measured by intent and by the satisfaction of human needs and expectations.

The primary components identified as crucial for successful convergence resulted from interviews conducted with four primary players. What the converging principals learned, was disclosed from interviews with representatives from education, business, and government who came together in a collaboration for a specific mission. They included leaders from the following organizations: (1) XXsys Technologies, Inc., (XXsys), (2) the University of California San Diego (UCSD), (3) the California Department of Transportation (CALTRANS), and (4) the National Institute for Standards and Technology (NIST).

The following table was created to identify the critical attributes of the Human Systems Engineering Model©. For clarification purposes, these variables are contrasted to the ones associated with Strategic Alliance.

| Strategic Alliance | Human Systems Engineering© |
|---|---|
| Leader focuses on common goal | Leader focuses on individual goals |
| Welcomes Minimum risk | Welcomes Maximum risk |
| Focus on outcomes | Focus on process |
| Emphasize transactional change | Emphasize transformational change |
| Focus on getting the job done | Focus on people who do the job |
| Balances strengths and weaknesses | Relies on strength of all participants |

The partnership between the aforementioned principals began as a collaboration aimed at applying advanced composites for the seismic retrofitting of bridge columns. The risks were high, and the final outcome of the project is still unknown. Yet, all of the primary representatives interviewed were certain of their opinion on what it would take for this partnership to be successful. Many of the players had previous experience with numerous partnerships and remained firm in their perspectives.

Under the leadership of Chairman and Chief Executive Officer, Gloria Ma, Ph.D., XXsys, a California based corporation, was engaged in developing and commercializing advanced materials and composite technologies originally developed for the defense and aerospace industries. Founded in 1985, it specialized in the research and development of sensor and non-destructive testing (NDT). Due to the drastic cuts in federal defense spending for sensor/NDT technology, Ma pursued the availability of United States government grant funds accessible to companies who would prove promising in their efforts to find alternative uses for composite materials. Ma was instrumental in acquiring a $2.7 million dollar grant from NIST for the purpose of accelerating the commercialization of the composite technology for bridge column retrofitting. In order to successfully meet the objectives of the company, she formed a partnership with other agencies who would help her achieve her goal.

Ma marshaled resources and obtained support from the Federal Highway Administration (FHWA), the Advanced Research Projects Agency (ARPA), the National Institute for Standards and Technology, and the California Trade and Commerce Agency in order to validate and commercialize XXsys's carbon jacketing technology. It was obvious that in order for Ma to advance her mission, she needed to collaborate with leaders from various agencies. Along with this multi-dimentional collaboration, came individual goals for participating members as well as the common goal identified by the participating members. During an interview with Ma, she stated, "We knew we could replace steel in the retrofitting process if we could automate the process and lower the cost. Whether or not we could adapt the technology, presented the challenge." When asked about her incentive to collaborate, Ma replied, "No one will pay more for doing the same thing than they themselves can afford to do. The calculated risk in using the University of California San Diego's paper studies proved to be a good one." Furthermore, when asked to comment on how she negotiated with other agencies and coordinated the project, she commented, "I spent a lot of time talking to people at

CALTRANS. They were in need of field assurances for what we were promising in the area of seismic retrofitting with composite materials. I knew the material we were using would comply, but whether or not we could compete, became our greatest concern." As to what gave her the courage to continue with her mission, Ma replied, "I wanted to do something that no one else had done. We wanted to take the risk and we knew the reward would be great. Besides, I have competent people."

When asked about how she felt the collaboration had affected the people participating in the program and what she had learned thus far, Ma commented, "It brings people together. They need to understand one another. The trust between them must be established and there needs to exist a mutual dependency so that things can get done." She added that one of the most difficult challenges was to bring engineers from different backgrounds together. She commented that they have their own interest and way of doing things that sometimes made it difficult when it came to agreeing on how to get things done. Ma added that doing good for others and pushing the frontier of knowledge forward, motivated her beyond the money to be made. Ma stressed that in the future, there needed to be a greater understanding between cultures. "In addition", she remarked, "it is important to solicit support from individuals in the local communities who could assist in moving the collaborations forward." This comment by Ma, demonstrated the dynamics of collaborations in terms of how they extend beyond original players into numerous directions. Along with additional participants, there are added individual goals that remain the focal point of making collaborations work. In regard to future aspirations, Ma stated in an interview with Owens (1996), "The market is huge. It's not even limited to the seismic retrofit market, and besides California, it includes the entire West Coast and the Pacific Rim" (p.35).

The role of the University of California San Diego, was to conduct the research needed to validate the strength of composite materials and other composite performance characteristics used in retrofitting. What UCSD had, and what XXsys needed, was the composite material and the validation testing done at the Powell Structural Resource Lab. This was required to use the Robo-Wrapper™, a machine designed by XXsys to mechanically retrofit structures. Robert Asaro, Ph.D., Professor of Engineering, who was instrumental in his contribution to the partnership, commented that UCSD had a very positive working relationship with XXSys. He referred to the underlying science, lab testing, and evaluation of material systems as crucial to the success of the collaboration. He stated, "In the old world view of technology transfer, you could not forecast how long it would take to commercially apply technology. It would take forever and a day, and by the time commercial application arrived, the technology would either be inefficient or it would break down along the way." In reference to individual goals and cooperation between partners, Asaro added, "The key to success of collaboration is the chemistry of the people and the support that each entity has for other partners. It is important that each entity involved in the collaboration makes its goal known to the others. The individual goals need to be defined so that each party can reach its goal and support other partners in reaching theirs." He added, "The goals of all the other entities are your goals too. The initial goals go far beyond what is expected as each participant becomes supportive and takes pride is the success of each partner's progress."

Asaro identified what he thought were the most important elements of success for converging participants. He remarked, "People who have a vision need to understand what the others want and need. The vision cannot be narrow. For example, the fundamental research that provides the underpinnings to support collaboration, from the university, was a university mandate." Asaro continued, "University professors are required to expand the frontier of knowledge. If a company has capital but cannot share this same commitment to expand the frontier of knowledge, then the collaboration is going nowhere. In other words, although the university goal is to expand the frontier of knowledge and the company goal is to make a profit, both parties, according to Asaro, need to maintain their own goal and support the goal of the other as well. "It is essential," he added, "for the university community to understand that companies need to make money."

An additional member of this collaboration was the California Department of Transportation (CALTRANS) who opened up the door to the use of composites for the purpose of increasing performance and competition so that the costs for retrofitting would be minimized. As a consequence, their membership in this collaboration seemed obvious as the partnership between UCSD and XXsys was attempting to do just that. Jim Roberts, the Chief of Structures at CALTANS, in an interview with Steve Loud, Editor of *Composites News*, stated, "We are finally getting what we want from vendors such as XXsys Technologies and Hexcel Fyfe in the area of quality assurance. We must replicate in the field installations what we have seen in the labs and in the demonstrations" (Loud, 1995:3). In a later interview with Clark, Roberts remarked, "I have been instrumental in organizations and supportive of industry's advising committees and partnership teams that introduce different technical concepts. The use of composite materials in aerospace technology is focused on use, due to the cold war. All the technology developed and tested really challenges civil engineers who are used to working with concrete and metal. Concrete engineers do not understand composite engineers. They must confront the use of advanced composite materials that are stronger and weigh less, and in some cases are non- corrosive." Roberts added, "Regarding collaborative models versus independent models, our business is highways. If we do not reach out to manufacturers, then we only get input from the design side." When asked his opinion about the disadvantages versus the advantages of collaboration, Roberts said, "You get better quality from collaboration. Partnerships help to hammer out solutions. The disadvantage is that it takes longer for things to get done due to the number of parties offering their input. Plus, people like to sit and watch. We do the work from the ground up, and then others want to come along."

The federal government's role in this case study occurred by way of a grant awarded to XXsys Technologies from the National Institute of Standards and Technology (NIST). Limited by non-disclosure guidelines, Carol Schutte, Ph.D., Program Manager, commented exclusively on the subject of collaboration and not on any specifics regarding the participants cited in this case study. When asked to comment on what she believed made collaboration successful, Schutte remarked, "It is wonderful when it is done for the right reasons. People need to get along well, and there needs to be good chemistry between team members." "From my experience," she added, "teams who come to us who have worked together in the past, seem to work together better. It is important for each participant to understand their goal. When asked to reflect one year later on the experience, team members should be able to tell me why they were successful, how they

determined the success, as well as how it was measured." Schutte commented that in order for successful collaboration to exist there needs to be a "win-win" attitude by all the players. "It is essential," she said, "that collaboration does not become just another fad, but that it is done for the right reasons. Our job is to facilitate in the collaborative process."

Schutte's comments reinforced the idea that collaboration is much more than representatives, from various organizations simply getting together to conduct "a mutual business deal." Schutte suggested that in order for partnerships to be successful, the leaders need to learn how well they can work together than on how "their" piece of the puzzle fits another piece of the puzzle. To further this point, Robert Bloks Berg-Fireovid, a business analyst from NIST stated during his interview, "If the principles have the strength to overcome the challenges of people working together from various organizations, then collaboration can be successful."

In conclusion, interviews with the principal players unveiled their opinions about what it took for a successful partnership to occur and what they had learned that was critical to successful collaboration. In each case, the interviewees offered their unique point of view and individually articulated the attributes they felt were most important. From this interview process, the Human Systems Engineering Model© was created to help identify the successful components of converging principals. Although it is still in its formative stage, the Human Systems Engineering Model© offers a paradigm shift away from the traditional past into an exciting future of collaborative ventures that focus on learning and transformational change.

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