# What K-12 Education Can Learn from Research Parks

David D. Thornburg, PhD
Executive Director, Thornburg Center for Space Exploration
dthornburg@aol.com
www.tcse-k12.org


My professional career started in 1971 when, on receiving my PhD, I joined the (then) new Xerox Palo Alto Research Center – a research facility belonging to the Xerox corporation where scientists and engineers could explore scientific phenomena and invent the future. In our case, the inventions of the 1970's were staggering: The Ethernet, laser printers, graphical user interfaces, portable computers, touch sensitive graphics tablets and other innovations are just the tip of the innovation iceberg that emerged from that one facility in less than a decade. Other corporate research labs (such as the famed Bell Laboratories in Murray Hill, NJ) produced amazing results as well – the transistor, for example – which suggests that there was something in the structure and operation of these facilities that provides the stimulus for amazing work. Yes, of course, the people who do the work are essential, but lacking the right climate, these people might not do their best work and, as a result, their inventions and discoveries may never come to light.

In the intervening years, closed corporate research labs have given way (in general) to research parks where multiple educational institutions and corporate sponsors establish a variety of labs that cover everything form basic research to the birth of new companies. These facilities are scattered all over the world, and they are magnets to talent, and producers of tremendous developments that shape the tools most of us use every day.

Aerial view of Porto Digital, Recife, Brazil

With our current focus on STEM skills, perhaps there is something to be learned from the structure of research parks and centers that can have a positive impact on K-12 education. While these research parks are home to highly educated workers, and typically have strong connections to major universities, this does not mean that there aren't elements of their structures that can't be used in the K-12 environment to foster and develop interest and skills in the STEM areas, as well as in other academic subjects. The key question is how to craft an educational setting that encourages engagement and high-quality work – at any level. Below, I list a few of the attributes of these labs, and and then show how we might connect these to K-12 education.

**Characteristics of a research center...**

- Highly interdisciplinary
- Strong connection between science and the arts
- Work is driven by individual inquiry
- Failure is seen as a learning experience
- Resources are readily available
- Work is incorporated with play
- Time is the variable, learning is the constant

***Highly interdisciplinary***

A visit to a research center is likely to involve seeing people from multiple disciplines working as a team on the same problem. Interdisciplinary teams are beneficial because they insure that any challenge is looked on with fresh eyes. The expertise of the “specialist” can often block solution to a big challenge because we assume the specialist has the correct insights. While specialized knowledge has its place, it can sometimes inhibit creative solutions to a problem, especially if the specialist gets "stuck."

The benefit of having an interdisciplinary team is two-fold. First, people from different disciplines bring their insights to the challenge and, second, they can express questions that are considered "obvious" to others without criticism. Sometimes, these "obvious" questions hold the key to novel solutions.

When I was at Xerox PARC, we had, in addition to engineers and scientists from many disciplines, anthropologists, sculptors, a medical doctor, and others whose backgrounds didn't "fit" the mold of a research group focused on information technologies at first glance.

***Strong connection between science and the arts***

I have fond memories of interacting with various artists who had appointments at PARC. Some of them worked on fairly obvious challenges (e.g., design of graphical user interfaces, making the "mouse" easy to hold and operate) but beyond that they looked at the domain of creative expression in general. Their own artwork was influenced by the lab's work, and their insights shaped many projects. When FM music synthesis was developed (producing very accurate replicas of acoustic instruments), a composer created a piano piece that was impossible for a single pianist to play, but which sounded spectacular when played by the computer. (Note: this was done many years before MIDI was invented.)

The artists also taught us that nothing requires more computing power than arts-based software. The ability to draw and render images on a computer in real time was (in the 1970's) at the limits of our capabilities. This led to the design of more efficient computing architectures, and the creation of separate graphics processing chips – all of which is commonplace today.

The point is, if we had only focused on "business" applications, we would never have pushed the limits of our computers, and new technologies would have been left undiscovered at the time.

***Work is driven by individual inquiry***

Research positions at PARC were filled with self-starting people who had strong interests in fields that were likely to be of long-term interest to the corporate sponsor. These scientists and engineers were then set free to work on projects of their own design. Key to this process was the formulation of a research question. What task was sufficiently compelling to occupy a year or more of the researchers time? Rather than work on projects dictated from above, the management of PARC realized that the researchers were the best qualified people to identify what questions were compelling, and likely to bear productive fruit in the long term. Sometimes the questions were very broad (What does an optimal programming language look like?) and sometimes they were more specific (How do we represent typefaces so they can be displayed on a variety of devices and resolutions?)

We soon realized that the quality of the question was as important as the answer.

***Failure is seen as a learning experience***

While successful completion of projects can be important, so can carefully documented failures. A failure to detect a predicted phenomenon can reveal flaws in the underlying model of how a phenomenon operates. This can often be at least as valuable to know since it provides the basis to rethink a theory, and to direct research in another direction. While failure is a powerful learning tool in science, it can be useful in engineering as well. When one solution to a problem does not yield the desired results, this can open the door to more creative solutions to the problem, of which one may be perfect! At PARC we were not expected to always succeed, only to make progress in our understanding of the underlying phenomenon or process being studied. This was part of the underlying culture of the organization, a culture shared by many other excellent laboratories throughout the world. To those who have not directly experienced living in a climate like this, the thought that "failure" was considered a normal part of the learning process might seem strange indeed. In fact, without it, we would not have had the courage to seek the answers to complex questions, and likely would not have created a fraction of the breakthroughs for which our lab became deservedly famous.

***Projects are shared in open meetings***

Every week there were several seminars put on by each research lab in which people shared their current work with their peers. These sessions (which became quite vocal on occasion) were places where input could be provided by anyone present. This was of tremendous value to the researchers since it gave them an opportunity to share all aspects of their work – including those aspects that were causing problems. It was not uncommon at these meetings for people with diverse research interests to attend, and they sometimes made significant contributions because of their ability to see the challenge with fresh eyes.

***Resources are readily available***

When I was there, Xerox PARC not only had an amazing library, it had great librarians, people who would help you do the background paper searches germane to the problems we were exploring. We considered these librarians essential members of our team. We also had funding for equipment, travel, conferences, etc. The "mother ship" understood that we needed resources to do our work. Because our work was hard to associate with a "profit center," we were funded as a pure research endeavor with the hope that, in five to ten years, some of our breakthroughs would have a positive financial impact. (Needless to say, royalties on the laser printer alone made the lab a good investment!)

Many of us attended professional conferences where we shared many aspects of our work with the larger community. While some of our work was proprietary, much of it was done with public awareness, making us seem more like a University lab than a corporate research center. By sharing our work with others, we built close connections to other research groups and even established some strong collaborations that were of great benefit to everyone involved.

***Work is incorporated with play***

PARC (and labs like it) are more than just exciting places to work – they are great places to hang out. The chef who ran our cafeteria was hired away from a local restaurant so we would have great lunches without having to leave the campus! Sometimes, if someone was looking for me, they were directed to the "particle physics lab" which was the room where the pool table was located. We had table tennis, an informal bicycle club, soccer matches, etc. Furthermore, these activities sometimes took place during "work time." Since many of us were at the facility at all hours of the day, we were trusted to balance play with work, with the understanding that, through play, our minds might get refreshed and we could look at a problem with a new perspective.

Even the architecture of our building supported casual interaction. Hallway corners might have a comfortable couch where chance encounters could turn into productive conversations. I was even convinced that offices were designed to be hard to find just to facilitate this kind of chance encounter. Rather than spend our days inside our individual caves (our offices), we were encouraged to visit the "watering holes" in the hallways to converse with our colleagues. The general rule was that an open office door was an invitation to come in and chat. It is impossible to document the tremendous number of powerful ideas that emerged from the informality of our building space.

***Time is the variable, learning is the constant***

While we each had performance reviews at least once per year, it was expected that our work would proceed largely at its own pace. As long as we showed some progress toward a goal, we were generally encouraged to proceed. Sometimes, of course, a project would hit a complete stall, and it would be time to put that project on hold and start a new one.

The lab's goals were expressed in terms of long enough time horizons to allow this approach to work – five to ten years, for example. Without the pressure of a ticking clock, the quality of the work was much higher than it would have been if there was constant pressure to produce results. Sometimes shortcuts are disastrous.

**Looking at School**

How do these attributes align with what is possible in the K-12 setting? Amazingly, many of them are well within the reach of our schools. All it takes is some creative thinking and a commitment to change. Ask yourself the following questions:

- Does your school setting encourage faculty with a wide range of interests to have students explore these in the context of a single subject (connecting, for example, music and mathematics)?
- Does the arts teacher work with students in other subjects? Do students explore the esthetic aspects of their work (page layout, graphic design, etc.)?
- Are students encouraged to ask (and find answers to) their own questions related to the curriculum? Are these questions reflective of deep thought about a topic, or are they simply surface questions?
- Do students have the chance to fail at a task and see that as a chance for more learning, rather than as a personal failure?
- Are school resources available outside of "school time?" For example, a school library could become a "coffee shop" where students work on assignments after school in a warm and inviting setting. Online school resources can be made available 24 hours per day. Do students have the chance to exhibit at science fairs, give presentations at conferences, etc.?
- Are students enjoying themselves in class? Is there a sense of appropriate "play" in the course of the day?
- Are students measured by ultimate mastery, or by learning within a certain time frame? Does your school acknowledge that different students learn different subjects at different rates?

Our educational system is tasked with preparing all of our youth for a dynamic and unknowable future. In this way, schools have similar goals to major research labs and research parks. It may be that some of the attributes that have made these research facilities so successful can be applied to the world of K-12 education as well – with positive results.

**About the author**

David is the Founder and Director of Global Operations for the Thornburg Center. He is an award-winning futurist, author and consultant whose clients range across the public and private sector throughout the planet. His razor-sharp focus on the fast-paced world of modern computing and communication media, project-based learning, 21$^{st}$ century skills, and open source software has placed him in constant demand as a keynote speaker and workshop leader for schools, foundations, and governments.

As a child of the October Sky, David was strongly influenced by the early work in space exploration, and was the beneficiary of changes in the US educational system that promoted and developed interest in STEM (science, technology, engineering, and math) skills. He now is engaged in helping a new generation of students and their teachers infuse these skills through the mechanism of inquiry-driven project-based learning. (For details, visit www.tcse-k12.org.)

His educational philosophy is based on the idea that students learn best when they are constructors of their own knowledge. He also believes that students who are taught in ways that honor their learning styles and dominant intelligences retain the native engagement with learning with which they entered school. A central theme of his work is that we must prepare students for their future, not for our past.

David splits his time between the United States and Brazil. His work in Brazil also is focused on education, and he is currently part of a team redesigning curricular practice for some schools in and near Recife, his home city.