**25 years of Concurrent Design in Team-X**

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1. **Introduction**

Team-X was born from a need to perform rapid, space mission design for PI-led competed proposals in the mid-1990s. Throughout the last 25 years Team-X has expanded its application of the collaborative, concurrent study approach into every facet necessary to win competed proposals.

1. **Cost**

Early on in the development of Team-X, it was recognized that engineering design, while necessary to establish the technical feasibility of a competed proposal concept, was not sufficient to establish whether or not a competed proposal concept was economically viable, and thus likely to prevail in a competition amongst competing proposals. Team-X has long utilized validated, subsystem level, institutional cost models developed and backed by the doing organizations responsible for their respective areas of subject matter expertise. However, even cost estimation capabilities, while necessary, are also still not sufficient to guide design choices in a collaborative and concurrent design setting. In the last few years, Team-X has begun utilizing statistical techniques with data drawn from actual space missions, and its vast array of space mission studies, now numbering in the thousands, to predict cost outcomes before design work is complete, and sometimes, even before it starts.

1. **Review**

With the capability to rapidly, concurrently, and collaboratively scrutinize a space mission and or instrument design and cost, it was only natural to use this capability to review the dozens of proposals submitted each year. As the database of reviewed proposals, and proposal outcomes, has grown, numerically predictive capabilities that can be used to prioritize feedback have emerged.

1. **Writing**

The advantages of concurrent, collaborative, work is not restricted to the numerical aspects of a space mission design alone, and Team-X has been increasingly assisting proposal and advocate teams (e.g., decadal survey inputs) in compiling the narrative necessary for these campaigns.

1. **Science**

The subject matter driven, collaborative, concurrent study approach has also found success in the concept development of not only the engineering of space missions, but also in the concept development of the science motivating the space missions in the first place. Writing a successful proposal requires transformative science that is achievable. Team-X collaborative, concurrent studies help develop these winning concepts.

1. **Implementation**

The current decade has ushered in an era of NewSpace, of which one of the major characteristics is the fundamental shift from an industry which was heavily dependent on government agencies (and taxpayers’ money) to a more agile and an independent private sector that relies on innovation, and working with much smaller budgets than the early space industry, and with shift from a ‘cost-plus’ to ‘fixed-price’ contracts. While these new capabilities were naturally incorporated into the component databases underlying the Team-Xc CubeSat and SmallSat mission study capability, they have also become a part of the databases of potential partners used in architecture studies in which Team-X helps teams find the most cost effective, yet realistic, implementation for their concepts.

1. **Remote Concurrent Engineering**

As Team-X entered its 25th year, it had consistently been conducting about one mission study per week on average. Often booked as much as 6 weeks in advance, Team-X already had a full schedule when the COVID-19 pandemic forced Team-X to become a virtual team within two weeks of its next study. The people, processes, and tools involved in a Team-X mission study have remained largely unchanged in the transition from co-located to distributed/virtual work-from-home operating mode. Several procedures and technologies, however, have been central in the ability of Team-X to maintain its previous pace of studies.