INITIAL COMMENTS ON THE NSF PROPOSAL REVIEWS

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Overall I agree with the reviewers, and do not care to complain about the outcome.

The main problem seems to be cultural (in hindsight, it could have been avoided, oh well). The "syntactic" approach to algebra is based on *what actually happens in 90% of high school classrooms*. The reviewers, however, based their responses on idealism, on what *should happen in classrooms* if math education was what it ought to be, according to academic research and philosophy.

This may be due to the fact that great math teachers tend to become academics, and good math teachers tend to leave high schools due to burn-out.

I have a personal story on this. My son Ian is in a 5th year math teaching credential program at San Jose State. He is doing his student teaching at Palo Alto High, one of the best ten high schools in California (and his alma mater). Ian grew up with two teachers and IMHO he is a superb math teacher. He is being threatened with failure by his Paly supervisors *because he is making his classrooms enjoyable*. The supervising teachers want him to be harsher, to alienate his students in order to conform to their program. This despite the fact that his students are performing better on standardized tests that all other math teachers at Paly.

The hidden agenda is, of course *don't make us look bad by improving classroom teaching*. Our reviewers would love Ian's style.

Another obvious factor is that the reviewers form an old boys (persons?) network. This is the way NSF works, and cannot be contested. We failed to include them or their ideas in our proposal.

I'm really happy to abandon Spatial Algebra, its agenda is quite esoteric, too Pure Math, and it did manage to completely misplace the focus of the proposal on the wrong aspect.

What I want to use as motivator is:

"VR will be a Nintendo toy in Christmas 1993, with distribution in the millions. Do educators want to replicate the video game experience and be caught by surprise, or does NSF want to understand the teaching implications of the phenomena before it is mass marketed?"

So, course of action, either:

1. Rewrite for math using idealism and the semantic approach. Resubmit to the same reviewers. I'm confident this would win, would be exemplary, and would not anchor to classroom practice. Does your department have a math educator?

2. Resubmit using Physics. This is the easy way out, application would be obvious, VR would be glitzier. Risk is that a new batch of reviewers would be called in.

Some specific comments on the reviews (I assume they are in the same order in your packet):

I: Solution: use physics, not math as a clearer application. I don't want to get into disadvantaged work.

II: Academic self-righteousness is tolerable when it is correct. I bet this reviewer has never taught high school math. Solution: use cognitive modeling as rationale. I like the idea of abandoning cognitive science as a foundation. I did address the technical point of idempotency in space, but it is subtle and difficult. My thesis research suggests that only the top end math students and their highly qualified teachers fall into the mistake of *imposing a metric on space*. Yes space does change meaning depending on the *domain theory* of the objects. I corrected the possible misinterpretation in later versions of the Spatial Algebra paper, but the bottom line is that space is polymorphic until a domain theory is imposed, and the domain theory is *contextual*. Context dependency is just too hard for traditional mathematicians to understand. I will still support that it is the natural way naive students approach representation. The reviewer's traditionalism also shows in the insistence that addition is binary. I really didn't want to fight the math foundations battle here, and it is our error to have phrased the proposal so broadly.

III: We should have reviewed NSF funded representation theory.

IV: Yep, solution: use a less ambitious domain; don't mix objectives of VR and abstract representation.

V: Spatial metric error again. Who would say that the denominator is "lower" than the numerator of a fraction? Yep, wrong application.

VI: We failed to emphasize the experiential aspect of Spatial Algebra. Solution: use a more obvious domain. It is a shame that we fully agree with the idealism of math ed techniques, but failed to promote them. I tried too hard to be realistic about classrooms. This reviewer is clear about what should be. There is a fundamental truth that VR is future and should be based

in future ideal curriculum. Our error. And yes, we did not engage recent math ed research, and should have expected to offend the reviewers. Humans are deeply territorial animals, concept is territory. Again, the math aspects of spatiality are too novel to be understood. It's a shame we failed to convey our knowledge of Theorist, and recent work by Clement, Kaput, etc. I know them all, my fault for not being more active on the math ed theory side. Why not use a 2d screen? We must emphasize that the question is empirical, and stress natural interaction as a necessary learning model. This again suggests a more obvious domain.

VII: Yes, we should have pressed the representation further and I should not have made it up on the fly. Our deep failure was to let the innovative application idea dominate the more central research question: *Is VR good for any educational applications?* The idea of testing Spatial Algebra with physical blocks is good only at the surface, it indicates that the spatial idea was *not* communicated. Again, the algebra got in the way of the proposal.

Overall, we have learned a tremendous amount about what will win. I let our team down by not being more conscientious about math ed and by letting our interests in spatial representation dominate the more important issues of finding an obvious application. Solutions:

Get obvious.
Get a domain expert involved.
Get me more dedicated to the particular application.