# Advanced Vibration Prediction: Protecting Your Bottom Line

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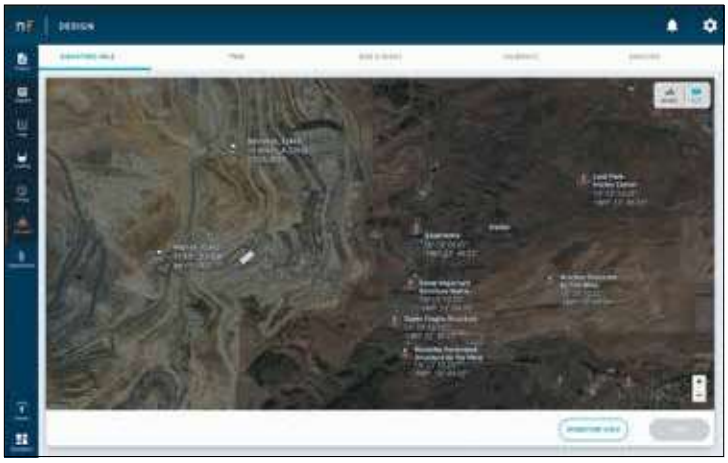
**AS MINERS, WE HAVE** a responsibility to the community around us to conduct our business safely. Ground and air vibrations play a huge role in safety, and more specifically, community relations. Safety and community relations can determine the success or failure of mining operations across the U.S. We especially see issues in blasting vibration in regions where quarries are nestled into residential neighborhoods or in specific geologic conditions that can make vibration waves travel further. It has been a constant battle over the years to predict vibration readings and mitigate these vibration concerns. Despite the importance of controlling ground vibrations, the mining industry commonly uses empirical methodologies based on concepts related to the nuclear tests era (specifically, charge weight scaling relationships).

Over the past decade, attempts have been made to popularize more elaborate methodologies. Many algorithms and software programs were built to solve this ever-present issue. These programs tend to have steep learning curves and often require the user to have a deep understanding of the basic principles of sound vibration and acoustics. These methods range from basic waveform superposition to analytical and numerical methods. Such methodologies are difficult to utilize daily because of their complexity, occasional low accuracy (despite their sophistication), requirements for difficult-to-obtain parameters and the time needed to reach solutions using complex algorithms.

Dyno Nobel's Advanced Vibration Prediction tool is an industry-leading vibration modeling tool that allows users to predict future blasting outcomes accurately and confidently through stochastic modeling. The largest challenge with the traditional signature hole method is the lack of variability that comes with standard wave convolution. The assumption that every blast hole will generate an identical wave is incorrect and can lead to sub-optimal designs and outcomes. There are several factors that account for variability in a blast, including confinement, charge weight, bearing to structure, geological discrepancies and destructive and constructive interference. Using traditional signature hole methods does not account for these varying factors, making most commercially available vibration tools less than accurate. Relying on standard k-factor type analysis does not account for relativistic geological factors, assuming all geology falls within a standard empirical model. While empirical models have proven the least accurate of vibration control methodologies, traditional signature hole convolution also leaves room for a consistent and accurate methodology. Taking a relativistic stochastic approach accounts for intrinsic variability in blasting while maintaining the signature hole analysis focal



*Dyno Nobel's Advanced Vibration Prediction Tool's Map View*


*Sample of Calibration Output in Advanced Vibration Prediction Tool*



point of vibration prediction at the heart of the methodology.

While complex at the core of the methodology, Dyno Nobel's Nobel Fire suite of tools has the user at the center of our vision. We are taking our most sophisticated and advanced tools and making them accessible to users in an easy-to-use, advanced open platform. This allows users to easily integrate with their existing digital ecosystem to perform advanced blasting design and analysis functions while continuing to use the current digital tools they know and trust. The Advanced Vibration Prediction tool is the perfect example of this dedication to working with customers' existing digital ecosystems.

The use cases for an accurate vibration prediction tool are vast. The most common use case is obviously compliance. While operating a quarry, we must be good stewards in our communities to have a long-lasting positive rapport with our communities. One of the many problems that arise when mitigating vibration is that often, a timing for a blast that is good for vibration does not equate to a timing consistent with adequate, let alone good, fragmentation. Due to the resonant frequency of the geology in the quarry, we often find ourselves making significant production sacrifices for the sake of compliance. Sometimes this cannot be avoided, but most often through more thorough analysis, we can maintain a focus on compliance while simultaneously maintaining targeted fragmentation for optimization of production. This means that we can maintain or improve our production while staying in compliance, ensuring we remain good stewards in our communities.

The next use case for vibration control is being good neighbors. The perception around ground vibrations as it pertains to homeowners is an area in which Dyno Nobel has a lot of experience. We often find that most homeowners think any vibration perceived in their homes is damaging their home. Science disagrees, but the

perception remains. Having a community outreach with a knowledgeable subject matter expert often alleviates some concern; however, there are steps that can be taken to reduce the perceived vibration at residential structures. Frequency control is the lever that has the most prolific effect on vibration perception. Accurately and confidently manipulating the frequency of a blast has the most effect on perceived vibration from a homeowner's viewpoint, addressing their concerns and helping to maintain and/or improve the relationship between a quarry operator and their community.

Another use case for vibration control directly affects a quarry's bottom line. We have seen many instances of residential neighborhoods organically encroaching on quarries, often leading to premature lifecycle ends of quarries. Using traditional vibration control methods has proven an ineffective tool for extending the life of a quarry when rapidly encroached, leading to significant cost increases of operation and even the end of operation in some cases. Decreasing charge weight is one traditional lever used, which leads to more boreholes, which means more cost, often making the cost too prohibitive to continue production. Repeatedly, using our advanced tools, we have been able to help customers delay drastic drill and blast changes that would adversely affect their bottom line through more accurate vibration modeling. Not only can we delay those mitigating operational measures, but often extend the mining operation's progression to get more yield than projected due to the accuracy and effectiveness of the Advanced Vibration Modeling tool. This allows customers to mine cost-effectively longer and extend the overall yield in many cases, extending the life and profitability of the mine.

Dyno Nobel's Advanced Vibration Prediction tool will help you stay in compliance, be a good neighbor and reduce your overall blasting costs when vibration is of concern at your quarry operation. ■

*Advanced Vibration Prediction's Analysis Functionality*