08 Assessing disruption: Measured Mile or System Dynamics?

Construction Dynamics Solutions LLC – On Disruption and Delay

The second edition of the Society of Construction Law's "Delay and Disruption Protocol" (2017) continues to hold the 'Measured Mile' ('MM') as the most widely accepted method for assessing disruption on construction and engineering projects[1] – but, for the first time, the Protocol now also introduces a newer method: 'System Dynamics' ('SD'.) So: How do these methods really compare, and which one should you use?

Note that, as has been generally the case in this series of articles, we will be focusing on the assessment of disruption on large, severely disrupted projects.

Proving disruption

Before we start debating about how best to assess disruption, it would probably be useful to quickly review what are the pre-requisites that an assessment method needs to fulfil in order to be valid and robust, and why assessing disruption is so complicated.

As we discussed at length in our previous article in this series, in order to be successful a disruption assessment method must fulfil a series of requirements:[2]

a) It should be able to prove the case (establish causation, take liability into account, and quantify the damage actually suffered);

b) It should deliver a valid ("scientific") assessment (admissible as evidence in legal settings or arbitral proceedings); and

c) Its results should be credible (understandable, robust.)

Obviously, fulfilling these requirements is an extremely tall order: Disruption is generally not well understood, the consequences of disruptive events ripple through projects well after the causing events are over, they tend to expand into all areas of the project… and consequences of different events tend to interact and compound each other[3].

Based on all this, it may look like assessing disruption is an impossible task… but thankfully disruption cases have to be proven only "on the balance of probabilities" – in other words, the case for disruption only needs to be more credible – albeit sometimes only slightly so – than the case against it. Expressing this in terms more relevant to our purposes in this article: We don't need to find the <u>perfect</u> assessment method… we just need to find the <u>better</u> one: the one more likely to succeed, the one more likely to prove damages defensibly on our particular project.

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[1] The term "disruption" accounts for project overruns caused by losses in efficiency. If you are not familiar with disruption, please refer to our earlier article in this series, "03 Disruption: Such a Tricky, Elusive Animal". All our articles can be found on our website, at www.constructiondynamics.global/publications.

[2] For more detailed information the acceptance criteria for disruption assessment methods, please refer to our article "07 So You Are Still Concerned About Using System Dynamics? Don't Be!".

[3] Again – see footnote #1!

The Measured Mile method

So far in this series we have discussed the nature of disruption, the difficulties in assessing it, and how System Dynamics can help us to do so – but we have not yet introduced the most widely accepted method to assess disruption in construction and engineering projects: the Measured Mile.

In the words of the Society of Construction Law:[4]

> *"[T]the preference remains for the measured mile analysis, where the requisite records are available and it is properly carried out."*

The Measured Mile assesses disruption by analysing the project's as-built productivity data. Actually, most projects produce no productivity data *per se*, so productivity is calculated by comparing the data for cumulative direct man-hours spent to the data for cumulative construction progress achieved: When plotted against each other, the slope of the resulting curve indicates the productivity achieved at each point in time (or, depending on which variable is plotted against the x-axis, the inverse of productivity – as is the case in Figure 1 below.)

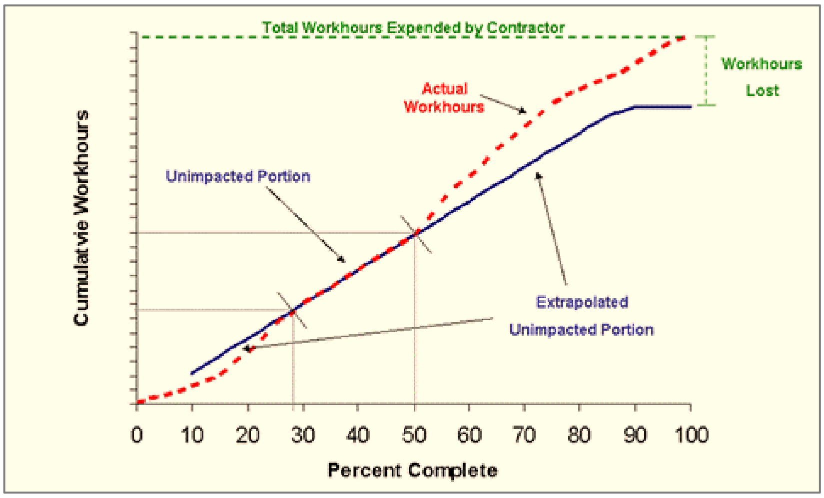

Figure 1: A graphical illustration of the Measured Mile.

The idea that informs the MM method, then, is to find an "unimpacted" period (during which productivity would have been highest – i.e., when the curve in Figure 1 is flattest), and compare it to the productivity achieved when the project was "impacted" by disruptive events (when the curve in Figure 1 is steeper.)

The MM method is ideally applied:

- To cover a part of the project impacted only by claimable events, and not by events for which the claimant himself would be responsible.
- To assess work comprising activities of a similar nature.
- Using an "unimpacted" period that is long enough (and during which productivity is steady enough) to provide a representative baseline.

[4] Society of Construction Law, "Delay and Disruption Protocol" (2nd Edition), February 2017, p. 3.

When these conditions are met, the MM method can be used to calculate the difference between the hours that were actually be spent, and those that would have been spent if productivity had always been as high as in the "unimpacted" period – this calculation then provides the basis to determine the damages to be claimed.

How do both methods compare?

To evaluate the advantages and limitations of both methods, and to make sure that we look at the whole picture and from every significant angle, we will examine how the Measured Mile and System Dynamics perform on the following eight dimensions:

1. Does the method use actual project productivity data?
2. Is the method's analytical framework simple to understand and implement?
3. Does it prove causation?
4. Can it separately evaluate / track the disruption caused by each event?
5. Does it use all relevant project data?
6. Is there generally sufficient data to apply the method to the whole project?
7. How confident are you in the results? Are the results testable?
8. Is the method generally accepted?

1. Does the method use actual project productivity data?

Both methods use actual productivity data, an advantage acknowledged by both the SCL[5] and the AACEI[6].

The only difference between both methods here is that the Measured Mile is normally applied at a more detailed level, while System Dynamics is generally applied at the project level (and may at most distinguish major phases of the works.)

2. Is the method's analytical framework simple?

This is probably the dimension in which the differences between the Measured Mile and System Dynamics are most evident: The biggest advantage of the MM is the simplicity of its analytical framework, where disruption damages are inferred directly from the project's as-built performance data.

System Dynamics, on the other hand, was created with the objective of acknowledging the complexity inherent to projects – and thus the method incorporates this complexity into its analytical framework. At first blush, this may seem ludicrous (after all, why would anyone want to address such complexity, if a simpler alternative would already do the trick?), but as we shall see shortly, simpler is not necessarily always better. Here, H. L. Menchen's well-known maxim comes to mind:

"[T]here is always a well-known solution to every human problem—neat, plausible, and wrong.."[7]

[5] Society of Construction Law (2017), "Delay and Disruption Protocol", 2nd Edition.

[6] American Association of Cost Engineers (2004), "RP25R-3 Estimating lost labor productivity in construction claims".

[7] Mencken, H. L. (1921), "Prejudices: Second Series", Jonathan Cape, p. 158.

Can you find a representative "unimpacted" period?

The description of the Measured Mile we use corresponds to the "original" version of the method, as proposed by Zink in 1986[8], because it best showcases the simplicity and the logic that make the method so attractive. Since then, several variants have been presented (mainly by Thomas in 1999[9], by Gulezian and Samelian in 2003[10], by Ibbs and Liu in 2005[11], and by Zhao and Dungan in 2013[12]) – and all these variants have focussed on the same issue: They all propose statistical approaches to ensure that the "baseline", "reference" or "clean" mile is more representative, and to improve the robustness and accuracy of the analysis. This proliferation of variants clearly shows that finding a representative baseline is not as straightforward a matter as our earlier description of the method may have led us to believe.

Furthermore, it should be noted that finding an "unimpacted" mile is often quite a difficult task, especially in large complex projects: Disruption tends to spread to all areas of the project, so once it starts it will be ever more difficult to find an area not affected by it. Since most complex projects are disrupted from the very start (in the design / engineering phase[13]), this difficulty is normally project-wide.

3. Does the method prove causation?

The Measured Mile "proves" causation by *reductio ad minimum* (pardon our Latin) – that is, by looking at areas and/or periods of the project that are small enough to reflect only the impact of one causal event (or related group of events.) The implied assumption is that, in these circumstances, causation is self-evident.

One obvious limitation of this approach is that it breaks down when projects are so heavily disrupted that the impacts of different events all overlap and compound each other – as is the case in many large construction and engineering projects.

But there is another circumstance that can complicate establishing causation in this way even further: In large projects, many disruptive events occur in the design and engineering phases, in the form of inadequate requirements, design changes, delays to the drawing approval process, etc. It is our professional experience that the full disruptive consequences of these types of events, especially the cumulative impact of a large number of them, can take a long time to manifest themselves. And in this case, how can you prove that design changes happening early in the project's history were the cause for disruption (loss of productivity and rework) happening months (or perhaps even years) later, based solely on manpower histograms and construction S-Curves?

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8 Zink, D. A. (1986), "The Measured Mile: Proving construction inefficiency costs", Cost Engineering, 28(4).

9 Thomas, H. R., and Sanvido, V. E. (2000), "Quantification of losses caused by labor inefficiencies: Where is the elusive measured mile?", Journal of Construction, Engineering and management, 1(3).

10 Gulezian, R., and Samelian, F. (2003), "Baseline determination in construction labor productivity-loss claims", Journal of Engineering Management, 19:4(160).

11 Ibbs, W., and Liu, M. (2005), "Improved measured mile analysis technique", Journal of Construction and Engineering Management, 131:12(1249).

12 Zhao, T. and Dungan, J. M. (2013), "Avoiding the pitfalls in implementing the measured imle method", CDR.1246.1-13, AACE International Transactions, Morgantown WV.

13 A project without a "clean" mile is best exemplified by the agonised plea of the project manager who has to execute the works based on deficient contract documents issued for construction.

System Dynamics overcomes both of these limitations: SD simulation models are based upon a causal framework, and this allows SD assessments to include a detailed causal narrative of how the disruptive events led to the overruns being claimed, all based on project data and on the output of the simulation model.

As described in earlier articles in this series[14], the causal framework used by SD has been validated via its use on hundreds of projects over the last four decades – and by the repeated ability of the simulation models that are based on it to accurately re-create their projects' actual performance.

4. Can the method assess disruption by event?

Barring data availability issues that will be discussed later, System Dynamics is implemented in a way that allows it to separately assess the disruption of each event (or group of events) that impacted a project. This, by extension, implies that the method definitively separates the impact of client-responsible events from the overruns for which the contractor is responsible.

The Measured Mile, on the other hand, relies on being able to isolate areas and periods of the project that only felt the impact of one single disruptive event… but as we just saw, this is actually very rare on large, complex projects, and as a result MM claims are often unable to isolate the damage caused by different disruptive events.

5. Is there generally sufficient data to apply the method to the whole project?

As stated earlier, the Measured Mile needs to be applied at a detailed level so as to be able to address causation properly. Unfortunately, project data usually does not provide this much detail – the required manpower and S-Curve charts usually apply to all of construction; sometimes the data may show breakdowns for smaller parts of the works, but these will not often coincide with areas impacted by a single disruptive event (or group of related events), so it is normally difficult to use the MM to cover the for the totality of the works.

Of course, there is the alternative: To apply the Measured Mile at the aggregate level, so that each "mile" will cover large parts of the works. However, when applied like this the method still loses most of its ability to establish causation, and thus the resulting assessments are much less reliable.

System Dynamics is actually applied at the aggregate level, distinguishing only major project work phases, so its assessments always cover the whole project. Also, SD is more flexible in the data that it needs: The method only requires the same data that would be needed by an aggregate-level MM assessment (construction direct manpower histograms and S-Curves.)

6. Does the method use all relevant project data?

As just stated, the Measured Mile is based on two key pieces of information about the project: how much effort was spent, and how much progress this effort accomplished. This is enough to infer the productivity actually achieved on the project… but leaving out the vast majority of project information (and especially ignoring all data relative to the disruptive events) is often perceived as weakness.

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[14] Please refer to our earlier article "Applying System Dynamics to assess disruption and delay: The 'D3A' approach" for more detailed information on how System Dynamics addresses causation.

System Dynamics assessments can be based solely on the same minimum amount of data… but this "stripped down" application of SD would not yield very reliable results. Thankfully, the method is set up to make good use of all the remaining pieces of information about the project: Its scope, its key milestones, phases (design / procurement / construction / commissioning, etc.), submittal logs, RFI logs, QA/QC logs, average hire and discharge times… and of course, data on the disruptive events themselves (timing and magnitude of changes, duration of inspection or approval delays, etc.) Thus, the disruptive events are intrinsically woven into the analysis, as are all other key aspects of the project – and the more data is available, the more reliable the assessments become.

7. How confident are you in the results? Are the results testable?

Expert evidence is supposed to be based on scientific methods, and one consequence of this is that the results of any assessment method are supposed to be testable[15] – i.e., we should be able to verify their reliability.

The results produced by a properly executed Measured Mile analysis are automatically verified by the data used: If each measured mile applies to works of a similar nature and affected by events that are the responsibility of one party, then it can be readily assumed that the overruns assessed will be solely the responsibility of that party. But, as we explained earlier, on complex projects the consequences of disruptive events tend to ripple and expand through the whole project, so that often their impacts are felt simultaneously… and then they interact with and compound each other… which means that in practice, MM results can often not be fully validated.

On the other hand, System Dynamics analyses are based on a fully validated causal framework, and their reliability is further validated by their ability to faithfully reproduce the as-built performance of the projects underlying the claims.

So, because of the assessment process followed, SD analyses deliver highly reliable results. This notwithstanding, because of the complexity of the simulation models involved, questions are still often raised about this reliability – as in: "Exactly how certain can we be that these results of yours are correct?" Thankfully, SD can also precisely answer this type of question: By running a Monte Carlo test on its results, SD can determine the confidence ranges surrounding its claim estimates.

8. Is the method generally accepted?

There are two main reasons why the Measured Mile is the most widely accepted disruption assessment method in the construction and engineering industries today:

- It uses a simple and elegant analytical framework;
- It is based on project data, and this data is generally available (in the form of manpower histograms and construction progress charts, or 'S-Curves'.)

As stated, these two reasons have historically made the Measured Mile the disruption assessment method of choice…. which, of course, by itself is already another advantage. Since the MM method is the most widely used and most recommended one, nobody questions its suitability to assessing any particular project – it is

[15] See footnote #2.

always implicitly assumed that it is the right method to be used (as long as there is sufficient data to apply it properly.)

And yet… the method's track record is actually nowhere near flawless: An informal survey of industry experts confirms that recovery rates in disruption claims that used the Measured Mile have historically been low, and courts and tribunals have rejected assessments based on the method in an alarmingly high number of instances.[16]

System Dynamics, on the other hand, is still fighting the up-hill battle of convincing the industry of its reliability, as many consultants, lawyers, engineers, contractors, arbitrators and judges are not yet familiar with the method – and even fewer have had any actual experience with it. However, the small-but-positive track record that has been accumulating over the past four decades appears to finally be bearing fruit, and significant inroads have been made over the past decade – the most significant of which was the inclusion of System Dynamics in the list of recognised disruption methods in the Society of Construction Law's "Delay and Disruption Protocol" (2nd Edition, 2017.)

Overall comparison

Figure 2 below summarizes the relative capability / performance of both the Measured Mile and System Dynamics along the eight dimensions previously described.

The clear conclusion that can be drawn from our analysis is that System Dynamics delivers more reliable results when applied to complex, heavily disrupted projects. So, then, why is the Measured Mile method still more widely accepted? The main reason appears to be the simplicity of its analytical framework, which makes MM results easier to understand and interpret by other experts, lawyers, judges and arbitrators. And, one should never forget that general acceptance is also a big advantage all by itself: In the construction and engineering industries (like anywhere else), people still prefer the "*devil they know to the one they don't"*.

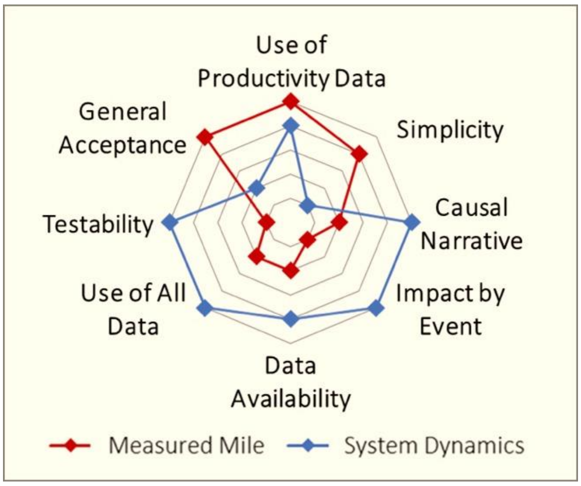

Figure 2: How do the Measured Mile and the System Dynamics methods fulfil key reliability criteria?

[16] Dale, W. S., and D'Onofrio, M. (2016), "Construction Schedule Delays", Thomson Reuters. In a sample of 138 U.S. court and board cases from 1951 to 2015, 30 of them used the Measured Mile to analyse disruption – the analyses were not accepted in 16 of these 30 cases.

However, as more and more people in the industry realise that there is an alternative to the Measured Mile (especially when dealing with complex and heavily disrupted projects), we expect that over time it will become clearer and clearer that the "simplicity" achieved by the Measured Mile comes at the cost of foregoing better causation, making more extensive use of project data, assessing disruption by event, covering the whole project and producing testable results. As expressed by Goodchild (White & Case):[17]

> *"There is a 'synergy' between the problems commonly acknowledged in proving the scale of disruption impacts, and the solutions offered by SD modelling".*

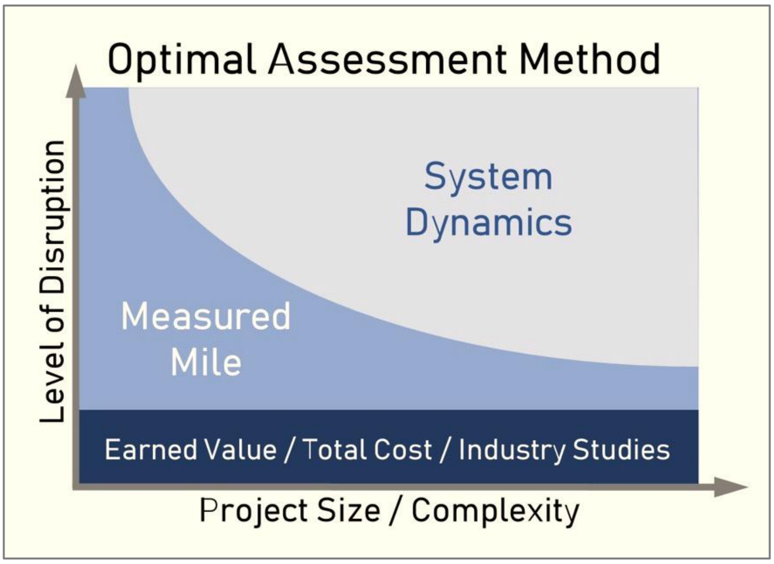

Figure 3: Optimal application ranges for different disruption assessment methods.

In conclusion, both the Measured Mile and System Dynamics are clearly useful in assessing disruption on construction and engineering projects – but their different strengths and weaknesses make them suitable to different kinds of projects. The larger and more complex a project, and the higher the level of disruption encountered on it, the more the chances of success of the claim improve with the use of System Dynamics.

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[17] Goodchild, R. (2018), "Proven by Computer? System Dynamics and Disruption Claims", Society of Construction Law, p. 16. This paper is based on the author's joint second prize winning entry in the SCL 2017 Hudson essay competition.

