How technology is advancing capital planning

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Derek Blackmore *is President of AkitaBox. His passion for and understanding of buildings started early, with various jobs in the construction industry prior to and after college. Over the past decade, he has held various roles in high-growth technology companies. His focus has always been on building value with clients through best-in-class software solutions. Derek combines his love of buildings and his software experience to drive AkitaBox to deliver creative facilities management tools. He believes technology is most valuable when it addresses long-standing, industry-wide challenges, while enabling closer alignment to and pursuit of the overall mission of the organisation.*

Abstract

This paper examines the shortcomings of current capital planning methods, most notably the facilities condition assessment (FCA). The FCA as we know it today does not provide the data and other deliverables needed for effective capital planning; however, new technologies are changing that. This paper describes key ways technology is already and will continue to accentuate the FCA and capital planning processes.

Keywords: capital planning, facilities condition assessment, digital twin, capital planning platform, CMMS

INTRODUCTION

We have a problem: an ageing infrastructure. The average age of a commercial building in the US is 53.08 years.[1] The average building in the US was built in 1968 by the greatest generation. This generation came home from world-wide wars on a mission to build a better homeland. We see the results all around us. That is not the problem, however.

The problem is that what they built has capital improvement needs that often are not being captured or met. Furthermore, our existing process for assessing and addressing the gap between what is and what should be has room for improvement. In many cases this gap is wide, and there is much work to do.

Some organisations are taking extreme measures by planning to spend billions of dollars trying to address this problem.[2] It is not an easy problem to solve, but there is a unique opportunity available to us that can help us be more effective in closing this gap by doing better capital planning. Part of the inheritance of our forefathers is the responsibility to maintain what they left behind as well as what we have built ourselves.

This paper proposes an improvement in the methods we use to maintain what we have been given. In doing so, the paper will argue that new technology in our industry allows for better assessment of the current state of facilities. We will begin by describing the goal of this capital planning process and the most prevalent current practices used to accomplish it.

FACILITY CAPITAL PLANNING DEFINED

For the purposes of this paper, 'capital planning' is defined as an exercise organisations

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complete to determine the exact dollar amount needed for facilities improvements in order to accomplish the organisational mission. Typically there are three key elements to the process:

- Assess the current state of facility conditions;
- Create a spending plan for those facilities that improves the condition to a level that allows the organisation to accomplish its mission;
- Appropriate budget to the execution of the spending plan.

The mission of the organisation is a key element in this process that should be examined. Mission helps define success factors in capital planning. Every organisation's mission is unique to them. For example, a higher education organisation may focus more on the visible building elements of a capital plan as compared to a material manufacturer, since beautiful buildings are important to attracting students but do not necessarily support the goals of greater efficiency and uptime common for a manufacturer.

Each organisation must individually examine what they are trying to achieve and create a target for what is needed in their facilities to accomplish their mission. From there, the work of assessing and addressing the gap between what is and what should be can begin. Perhaps the most important part of the capital planning process is accurately assessing the existing facilities. It is this particular area that will be discussed here.[3]

EXISTING ASSESSMENT PROCESS (FCA)

Now that we have defined our purpose, we need to describe the common current process that organisations use today so that we can provide some critiques and propose a better path forward. Commonly, the most integral part of the capital planning process is a facilities condition assessment (FCA).

The FCA as we know it today was born in the 1980s. Pre-1980, organisations generally only assessed the physical condition of their facilities. The FCA combined the assessment of the physical condition with an assessment of a facility's ability to serve its intended purpose.[4] This approach brought much more valuable data to the capital planning process. Over time, the tools and processes used to complete an FCA have evolved, but the general process still looks much as illustrated in Figure 1.

Typically, an outside company is hired to complete the FCA cycle. The company begins by collecting data of various types. They may speak with individuals responsible for the maintenance of the facility to learn from their experiences. They collect data from the facility itself by examining some of the assets and assemblies that make up that facility. They then analyse what they have gathered and make determinations for condition, life cycle, cost and function of the elements they have collected. Finally, the FCA company coalesces all this data into a report. This report includes an assessment of the facility as well as a spending plan to address the gap between what is and what should be to meet the organisation's goals. Once this process is completed, it must be done again at a certain interval, usually every 3–7 years.

This process seems familiar to those who have been involved with it over the course of long careers. No process is perfect, however, and there are a few critiques. What follows will be a general discussion about some of the struggles that this existing process brings to our industry.

FCA CRITIQUES

The first, and perhaps most important, critique is that the current FCA process has limited long-term value. As explained above,

Figure 1 FCA cycle

the work of assessing a facility is currently principally done by outside consultants who deliver a report after completing their data collection. This report is frequently delivered as a document and only reflects the condition of the facility at a single point in time. It cannot reflect the ever-changing nature of facility conditions and, therefore, quickly loses its effectiveness as a tool. The report's inability to change with the live state of the facility can cause organisations to misappropriate funding to the most needed items and devalue the FCA process. Organisations are kept in a constant state of needing better information to drive better decisions.

Another struggle with the current process is a limited ability to adjust the capital plan. Capital plans are often presented as a static plan or report; however, our world is anything but static. Living through a global pandemic seems to have forever darkened our trust in the reliability of tomorrow and cemented the need for flexibility in our organisational planning. Because FCA data is frequently expressed in a static report, the current process does not lend itself well to this need for flexibility that the market demands. Organisations cannot adjust the fixed plan based on their changing needs.[5] This drawback can make the whole effort an inefficient use of funds and create wasteful spending.

Existing FCAs can also lack reliable asset information. Due to the nature of the work, FCAs are frequently limited in scope and must rely on a reduced factor of accuracy. It is frequently cost-prohibitive to pay a consultant to examine every single detail of a facility for an assessment. Due to that reality, approximations are frequently used to save time and money. While in many cases this is appropriate, it can mean important details are missed or critical data is under-analysed. This can result in an FCA not holistically reflecting a facility's true condition. Further, lack of trust in the data can result in underfunding.[6]

TECHNOLOGY ACCENTUATES THE FCA PROCESS

The imperfections discussed here have been present since the creation of the FCA process, but up until recently they have been

difficult to eliminate. New technologies help remediate some of them so well that the improved outcome deserves consideration. The goal here is not to devalue the FCA or argue that organisations should not include them in their capital planning exercises. Rather, our purpose is to explain how new technologies create unique and significant value that can improve the FCA process and make it a more perfect solution for assessing facility condition in service of a capital plan.

Technology plays a key role in assessing risk

Technology greatly enhances our ability to assess risk in facilities. Reports and dashboards can show physical condition changes over time from inspections or condition assessments. They can also track maintenance activity. Technology brings all of this disparate data together into a meaningful format that makes it easier to identify growing risks.

For example, a report or dashboard could show a heating, ventilation and air conditioning (HVAC) system is experiencing 30 per cent more service requests or reactive maintenance than previous years. The technology alerts facility management (FM) to this potential risk before a significant failure occurs so the root cause can be looked into and remediated.

The risk to a facility in the case of a boiler or chiller malfunction is that the facility may be inoperable until the issue is resolved. That could mean the facility is unable to fulfil its mission, be that providing health care, educating children, operating a retail front or running an office. The facility is core to the mission of an organisation, so it is imperative to keep the facility running smoothly by identifying and addressing risks early before they become catastrophic events.

From the maintenance history of an asset to its failure rate and service request volume, there are many different data points involved in monitoring an asset's condition. Technology allows us to not only capture that information, but also efficiently analyse it and make informed decisions based upon it.

Does the assessor go away?

When critiquing and discussing technological improvements to a largely human system, it is quite natural for one to ask: 'does this new technology remove the need for human input into this process?' Simply put, no.

The scenario argued for here sees new technology underscore and improve the work of the human consultant. The technology proposed here principally serves to give the consultant a myriad of highly valuable data streams that aids the work. The consultant is situated at the confluence of these data streams and helps the organisation by collating the data sources in such a way that is useful for the organisation. A visualisation of such a process looks something like Figure 2.

What follows is a description of the new technologies shown and the unique value they bring to the process — and therefore how they improve the outcome.

Digital twins

One great value that technology brings us is the ability to capture and maintain a complete inventory of our facilities in digital format. This is often referred to as a digital twin. When people hear 'digital twin', they often think of building information management (BIM), Revit and full-blown 3D modelling.

Digital twins, however, exist on a spectrum. On one end of the spectrum is a fully detailed 3D model that allows a user to interact with the building via virtual reality. For example, the user can enter the digital twin in virtual reality (VR) and pull a lever that turns off a real-life valve out in the field. On the other end, a digital twin could be a simple map of all the asbestos in a building based on a recent inspection. The argument

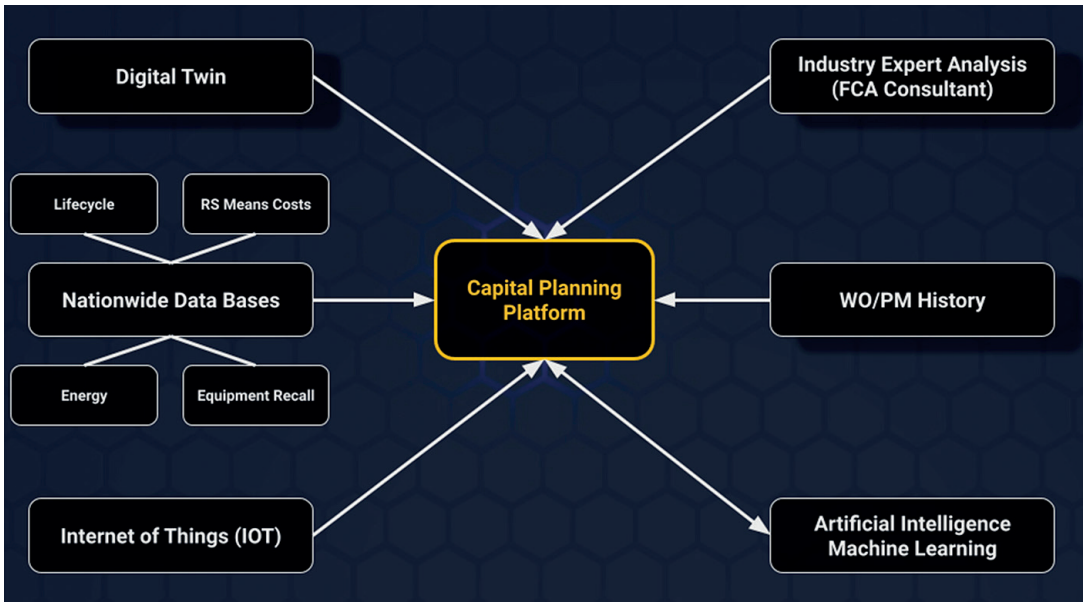

Figure 2 Data streams to aid work

can be made that any iteration of mapped building data is a digital twin of sorts; however, the digital twin's value as a capital planning and FM tool increases as you move along the spectrum from simple to complex.

A real-world example: the City of Las Vegas is currently piloting the use of a 7km^2 digital twin of its downtown in an effort to reduce greenhouse gas emissions and operating costs while improving building performance. Internet of Things (IoT) sensors connected to the digital twin collect real-time data that enables better decisions around energy use and emissions. In addition, the digital twin can model current and future sustainability scenarios to determine where operational efficiencies can be realised.[7]

To be an effective capital planning tool, at a minimum, a digital twin should have objects associated with locations. It should contain all key assets validated, mapped and in a digital environment where more data can be added. A digital twin makes it easier to know where your assets are, what you are maintaining and tracking within your building and where any piece of data you need is located.

It is becoming very common for this information to be captured during construction. Now it can also be created for an existing facility at a cost that is not prohibitive for many organisations.

Utilising digital twins to reflect the living facility in a digital format helps the FCA process and capital planning process in several ways.

One of the struggles of the current FCA process is that limited time, scope or funds often reduces the ability to assess the full detail of an organisation's facilities. A digital twin greatly eases this constraint by providing a quantitative source of truth about a facility that can be analysed. This is particularly true for keeping track of asset life cycles that need little or no physical assessment. This data can be a reliable source of information for the FCA, and findings from the assessment can also frequently be recorded right into the data set. That alone helps coalesce needed data points into a database that can provide value to an organisation.

Digital twins can exist in a live context and also be adjusted or revised quickly to reflect the changing needs of an organisation. The

closer this data lives in relation to the real facility, the better. In addition, the digital twin serves as the foundation of what we will next describe as the capital planning platform.

Capital planning platform

In our exploration of new technologies, perhaps the most transformative is the capital planning platform. This is, in essence, a technology database in which data streams from all of the new technologies discussed in this article are consolidated. This database provides a live stream of refined data about the condition of the facilities in an organisation. It also provides a dynamic capital plan that organisations can use to ensure that spending matches needs and that the mission of the organisation is properly supported. In best practice, the foundation of this database is the digital twin and, therefore, the actual facilities are captured and represented as accurately as possible.

A platform (instead of a report) greatly reduces the waste and inefficiencies generally associated with the existing FCA and capital planning process. A platform allows an organisation to strategically pivot spending and planning as needed based on the current and future state of the facility, all while keeping an eye on the facility's ever-changing condition.

A platform helps optimise a capital plan based on the facility's actual current state and the capital currently available. It can also determine the additional capital needed, and the timeline in which that capital is needed, to reach the optimal ideal facility.

In a situation where the optimal ideal facility would require US$42m, but only US$30m is available, the capital planning platform enables informed decision making on where to spend first. It helps determine what costs are most critical and what costs can be deferred with minimal additional risk.

As some of the major providers of FCAs, architecture-engineering-construction (AEC) companies have realised the importance of integrating FCA results with a capital planning platform or computerised maintenance management system (CMMS) (discussed below). A recent survey illustrates this trend:

- Eighty-one per cent of AEC companies have the ability to integrate FCA results into a capital planning software or CMMS programme the client owns;
- Sixty-six per cent can integrate FCA results into an existing CMMS software tool their client owns;
- Fifty-two per cent are able to integrate FCA results into a proprietary capital planning software tool owned by the company.[8]

The platform alone is not the solution, however. A platform providing this level of information needs to be connected to several other technologies and data streams beyond just the digital twin to successfully provide the needed solution.

National benchmark data

The first technology data stream that our capital planning platform needs is benchmarking and critiquing data. The data existing in a digital twin allows us to take advantage of benchmarking data sets.

The digital twin data set contains information about every asset in the organisation. Databases that track national averages for the expected life cycle, repair cost and replacement cost of those assets provide a good gauge for an organisation to plan and adjust expected spending needs. This data stream can be the foundational measurement that guides basic capital planning decisions.

A database that provides a benchmark for every asset in the facility helps colour in the lines of detail that are often missed by the FCA. This rough data stream must be refined by the specifics of a particular organisation, but it provides a firm foundation of data. For

some more granular assets, the benchmark data serves perfectly as is, while other assets might need more detailed refinement from other data streams.

Complete and accurate benchmark data allows for better understanding of how the condition, operation or maintenance costs of a facility are changing over time. Without this data, you may notice something in the facility is changing, but have nothing to compare it to. For example, a benchmark could be that the 12-month rolling average of service requests per month for a particular building is 47. If, in the last 90 days, the number of service requests has grown to 93, the benchmark data clearly shows service requests have doubled.

Benchmark data highlights when something has significantly changed from the norm and needs to be addressed as opposed to continuing to apply temporary fixes. This knowledge helps keep operating costs under control and supports smarter decision making.

Furthermore, benchmark data helps us in other areas of operations. For instance, it can be used to assess the efficacy of preventive maintenance efforts as well as the performance against spec of equipment in a particular environment. When used in a unifying way, organisations can gain great value from these data streams.

CMMS data

CMMS have come a long way since their inception.[9] The advent of newer architectures that are written on open extensible platforms create unique opportunities for capital planning. These new systems are designed for integration. Integrating work order, preventive maintenance and inspection records into a capital planning platform provide a great historical reference resource for capital planning.

These records help further inform and refine the condition rating of facilities. New systems in the industry are able to import this data stream right into a capital planning platform and allow assessors to utilise the information to make better judgments about the true condition of key assets.

Keep in mind, however, that CMMS software provides no value without complete and accurate data. Therefore, it is incumbent upon the facility owner to require accurate data collection as part of the software implementation.

Data must be collected and input into the software for every individual facility being managed. It is impossible to make decisions for a portfolio of real estate based on data for only one building. Unless you have three identical buildings in the same climate, built in the same year, and identical in all other ways, different buildings will become radically different over time. They will operate differently, have different preventive maintenance needs, experience different reactive fail rates and even have different maintenance teams.

A CMMS containing complete and accurate data tracks the unique changes occurring across a real estate portfolio so problems can be identified before they become major issues. The longer problems are left unchecked, the larger a capital planning concern it becomes. Instead of minor asset maintenance issues, you could face system failure and high costs — simply because the building was not properly maintained and monitored from the beginning.

Future state data streams

There are two technologies that would be better referred to as ‘future state’. They are high-value and will arrive imminently, but they are not readily available in a capital planning platform today. It would be wise, however, to consider them in planning phases at this point.

IoT

The ever-growing IoT category is already reaching into our facilities in many ways.

Some of the most exciting developments in this space for our purposes are newly arriving.

Companies are at the very beginning of using pump flow monitors, vibration sensors, runtime monitors and other sensors to predict life cycle and potential failures.[10] What is needed in development is a reliable data stream that will enable an organisation to utilise this data for capital planning. For instance, a run-time monitor could perhaps more accurately predict life cycle than current chronological practices could. Similarly, vibration sensors can sense machine patterns that predict failures which could update capital needs projections in a live context. These data points could have great value for organisations.

IoT sensors can also reduce the time between the beginning of an issue and remediation of the issue. The sensor is an immediate alert to an issue that, if addressed in a timely fashion, can be limited to the asset or the room affected and not become a systemic failure in the facility.

The capital planning implications are huge, but IoT data could also greatly affect the way we perform maintenance. Preventive maintenance schedules based on run time over chronology are much more efficient. Furthermore, the opportunity for proactive maintenance when poor patterns in machine operation are recognised can save cost and precious downtime. Saving cost and preventing downtime affects more than daily operations — it has an impact on capital planning as well.

Artificial intelligence and machine learning

Finally, artificial intelligence (AI) and machine learning (ML) are developing technologies in our industry. Both are concepts that can vary widely in practice; however, there are a few ways our capital planning practices could be influenced by these technologies.

First, AI can be utilised to make decisions with the data streams that we have available today. Analysing work order, preventive maintenance and IoT data to make predictions for future capital needs is one area where AI can assist our efforts.

There are already instances where ML is being used to populate asset information into a platform based on a photo of that asset or a photo of the asset data plate. This simple example of ML greatly reduces time and potential mistakes from field asset collection practices.

AI and ML are also allowing large organisations to do scenario planning that provides an understanding of the risk structure of various situations as well as what appropriate mitigation and response plans would look like.

One example of this is preparing for rising water levels due to flooding. Running scenarios can identify possible prevention actions, such as building a wall or berm and lifting all critical infrastructure 4ft off the ground. It can also determine at what point to begin evacuating personnel and critical assets.

These examples only scratch the surface of the possible impact AI and ML can have on capital planning. It is perhaps the area where the most groundbreaking work will be done in our industry in the near future.

CONCLUSION

Most of these major advancements in technology are readily available in our industry and are being connected to capital planning platforms to great effect. Forward-thinking capital planners and facility condition assessors are already using these technologies to give them an edge in their markets.

Those who are taking advantage of this technology offer a better product that gives organisations the data and flexibility they need to productively plan for the future and accomplish their missions. There is increasing demand in the FCA space for

these types of technologies, and requirements for capital planning platforms are finding their way into project specifications.

These technologies, when used well, create transparency in the capital planning process. They also allow executive levels of an organisation to see more clearly into the true needs of their facilities, which will help weed through politics and help organisations coalesce around problem solving. For these reasons, and because of the compelling value they offer our processes, wisdom would suggest more examination into how they might be of benefit.

As we seek to grapple with the challenges of our ageing buildings, a unique opportunity is here for the pursuit of greater excellence. Exciting new technology developments can help us as we work to maintain what those who have come before us have left in our care.

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