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Proposal
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CityCenterDC | Parcel 1

Washington, D.C.

Executive Summary

CityCenterDC is a multi-building development in the heart of Washington, D.C. With all six buildings under construction simultaneously, the project team must coordinate multiple schedules and crews. While each building is assigned a specific project team, the emphasis lies in the overall progress of the development. This creates the opportunity to explore alternative solutions and techniques regarding the improvement of construction processes in Office Building 1. This proposal outlines the construction analyses, breadths, and master's topics integration, that will be pursued during the Spring 2013 semester.

The typical floor layouts of Office Building 1 create the opportunity to implement a Short Interval Production Schedule (SIPS), specifically to the mechanical or electrical rooms. These rooms carry a level of complexity, along with limited space, which would benefit from a detailed and organized work sequence. This analysis will investigate the impact of coordinated crews and tasks in an effort to increase the efficiency and productivity, as well as quality of work, of the spaces.

Analysis 2 will focus on the impacts a virtual mockup will have on the quality and productivity of work in the previously mentioned mechanical and electrical rooms. Models will be readily available to the project team to utilize on-site. Accurate representations of the systems and work sequences will reduce the problems that may arise during the installation of the complex spaces. In addition, the effects of the virtual mockups will be taken into consideration while creating the SIPS.

Due to tenant redesign requests, there is no electrical branch design. The electrical contractor will receive the design in the upcoming months and be required to begin work immediately in order to avoid delaying the project schedule. Analysis 3 will focus on creating a work plan for a proposed electrical branch system (Breadth #1). This plan will include calculating material and labor costs, creating a schedule, and exploring constructability precautions.

The final analysis explores the impacts of a raised floor system. The current mechanical system requires adjustment of the VAVs with any new floor layout. The implementation of a raised floor system would give the tenants more control and options with respect to a dynamically changing layout. Constructability issues will be addressed along with cost and schedule savings. An architectural breadth will propose design for both the raised floor and ceiling, taking into account height requirements.

All results of the analyses will be compared to the original techniques or systems. Feasibility studies will also aide in the determination of the appropriateness of the implementation of the proposed systems. Knowledge acquired through master's level courses will be applied to Analysis 1 & 2. The following proposal outlines each of the analyses and steps that will be taken to complete them.

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Analysis 1 – Implementation of SIPS at Core

Problem Identification

Office Building 1 of the CityCenterDC development is a 12-story core and shell structure. Floors 3-11 are typical, and among others, include an electrical room, mechanical room, restrooms, and elevator shafts. The complexity and limited space in these rooms creates the potential for schedule delays. It is hard for more than two crews to physically fit into one of these spaces, let alone perform their work side by side. Without properly coordinated crews and a detailed construction plan, the project team carries the risk of delaying the project and incurring additional costs. In addition, Office Building 2 is a mirror image of Office Building 1. This creates even more incentive to explore optimization solutions.

Background Research Performed

The repetitive layout of Office Building 1 creates the opportunity to explore the effects of utilizing a Short Interval Production Schedule (SIPS). By creating a SIPS, crews and tasks can be broken down and detailed to a greater extent. Coordination of each crew can then be used to optimize the work and ensure there is a logical flow. This will eliminate the inconvenience of having several crews in one area. Because each crew will be working in a designated space, for a designated time, they will be able to manage and control their processes better. This will in turn increase the quality of the work, as each crew will be assigned to a particular task which they will perform multiple times. In order to aid in the learning curve, the crews will be presented with virtual mock ups, explained in Analysis 2.

While the existing schedule is organized to resemble SIPS for the core work, it does not designate crews, durations, and specific tasks. If any delays or schedule adjustments must be made, the crews simply move onto another building of the development. This is not an efficient approach to address such an issue, as it creates additional opportunities for problems to arise. Also, the crews that currently perform the work do not necessarily work on all floors of the building, as they may be reassigned to another building. This impacts the quality of the work and creates a learning curve for each new member. With all of this taken into account, the implementation of SIPS has the promise to address the present issues.

Potential Solutions

The results of my analysis will yield the following potential solutions in regard to the implementation of SIPS on Office Building 1:

- Recommend implementing SIPS as a value adding tool that creates potential for schedule acceleration, cost savings, improved quality, and crew balancing.
- Consider SIPS as an alternative, as calculated savings equal, but do not outweigh those of original strategy, i.e. no value added.
- Do not recommend implementation of SIPS as it does not produce any savings or has the potential for losses compared to original strategy.

Methodology

The following steps will be taken to properly complete this analysis:

- Research implementation techniques of SIPS on other projects, i.e. case studies.
- Investigate if and how many of current project team members have experience with SIPS in the past.
- Develop a sequence of work and balance crews with consideration to project schedule. Identify specific tasks and their respective durations, and designate crews.
- Evaluate potential risks and create a risk management plan
- Evaluate feasibility of implementing SIPS for Office Building 1
- Explore the associated savings or losses (schedule, cost, quality, etc.)
- Develop recommendation

Expected Outcome

It is believed that the implementation of SIPS for Office Building 1 will accelerate the current schedule, produce a more reliable plan, and improve the quality of work. One of the owner's top priorities is schedule acceleration, as their income from leasing depends on it. With the detailed coordination of crews and tasks, the completion dates will be more predictable than the current schedule. The quality of work will also increase because crews will have specific tasks they will repeat on every floor. In addition, virtual mock ups will be provided (see Analysis 2) to crews to ensure proper installation of systems.

Analysis 2 – Core Electrical or Mechanical Room Mock-Up

Problem Identification

The electrical and mechanical closets on each floor of Office Building 1 carry a certain level of complexity. The limited amount of space in addition to the equipment and supporting systems create for a difficult and mistake prone working environment. Any mechanical or electrical room is subject to thorough inspection, and if there are issues, they must be addressed. These issues can take considerable amounts of time to fix, and with closets on every floor of Office Building 1, such mistakes could cause significant schedule delays. It is vital for these rooms to function properly, as the tenants comfort and ability to work can be compromised otherwise. Once again, Floors 3-11 are typical for Office Building 1 (and Office Building 2). As a result, mechanical and electrical closets are also identical, with the minor exception of some piping sizes. It is important to the project team to find a solution to control and assure the timely and successful completion of all closets.

Background Research Performed

The project currently relies on skilled laborers to ensure the proper installation of the electrical and mechanical closets. While experienced individuals are great assets for such tasks, more control is needed to ensure the quality and proper installation. As explained in Technical Report 2, CityCenterDC's use of BIM was limited to clash detection. The BIM efforts that exist were taken on by the mechanical subcontractor, as the project did not include an allowance for BIM. Because these closets affect the mechanical contractor the most, I propose the implementation of a virtual mock up. This mockup can be created using 3D modeling software. It can then be sequenced to produce a 4D model. This model can then be given to the crews via tablets. They would proceed to use these tablets as aides in construction the rooms. Having such a guide will not only increase the quality of the product, but also guarantee proper installation. There is also a potential for schedule acceleration with such a mock up, as the crews will have the steps and procedures readily available to them on site. The virtual mockups can be used as a tool in conjunction with SIPS to increase productivity and quality. The durations and tasks in the SIPS will take into account the effects a virtual mock-up could have.

Potential Solutions

The results of my analysis will yield the following potential solutions in regard to the implementation of virtual mockups for the electrical or mechanical closets in Office Building 1:

- Recommend implementing virtual mock ups as a value adding tool that creates potential for improved quality, proper installation, reduction of re-work, and schedule acceleration.
- Consider virtual mock ups as an alternative, as calculated savings equal, but do not outweigh those of original strategy, i.e. no value added.
- Do not recommend implementation of virtual mockups as it does not produce any savings or has the potential for losses compared to original strategy.

Methodology

The following steps will be taken to properly complete this analysis:

- Research effects of virtual mock ups on other projects via case studies.
- Investigate if and how many of current project team members have experience with virtual mockups.
    - Project management team as well as field employees
- Calculate costs necessary to implement a virtual mock up, i.e. tablets, personnel, time, etc.
- Create an example of a virtual mockup to show team.
    - Document reactions
- Evaluate feasibility of implementing a virtual mock up.

Expected Outcome

It is believed that the implementation of a virtual mock-up will be received well by all employees and have the potential to improve quality of the closets, reduce the amount of mistakes and rework, and in conjunction with SIPS, accelerate the schedule. While it will be difficult to quantify the savings, comparisons from case studies will produce estimations. Implementing virtual mock-ups will also help the involved parties enhance their technological knowledge and experience. This will in turn be an aide for the team in future projects, as they will have significant experience with it.

Critical Industry Research

One of the leading topics of discussion in the construction industry is the effective use of BIM on a project. While BIM is being incorporated more and more into complex projects, the extent to which it helps versus the resources and time it consumes are questioned. Some project teams incorporate BIM just because they are required to in the contract, but do not necessarily utilize it effectively. Certain tools such as clash detection are widely accepted to be very beneficial. The goal of my research is to explore the effectiveness of virtual mock-ups for projects. I will conduct interviews with both professionals who have used virtual mock-ups and those who haven't. This will produce a correlation between the anticipated, desired, and achieved results of virtual mock-ups. The subjects of my interviews will be both general contractors and subcontractors. I will also research case studies involving virtual mock-ups. The results of this research will benefit project teams considering the implementation of virtual mock-ups, as well as raise awareness of the capabilities a virtual mock-up can have on a project.

Please refer to Appendix B for sample interview questions.

Analysis 3 – Electrical Branch Distribution System

See Appendix A for Electrical Breadth

Problem Identification

The author of this proposal has extensive educational and work experience in electrical construction. As such, this analysis will focus on construction aspects of an electrical distribution system. The project is currently undergoing major changes in design. The tenants of the space have requested new layouts and items previously not included. Consequently, an electrical branch distribution system design does not exist. The design of the electrical branch distribution system will have to come in the next couple of months. The electrical contractor must be prepared to receive the design at a moment's notice and begin installing the system to eliminate the threat of schedule delays. By designing a typical floor electrical branch distribution system (Breadth #1) and evaluating all of the construction aspects involved (schedule, cost, etc.), this analysis will provide a realistic representation of future work.

Background Research Performed

The main electrical distribution for the building is designed. The contractor is currently waiting on the design of the final electrical branch distribution system. Once received, the contractor will have to begin work immediately. It is important to take precautions and have a preliminary plan on how to approach the work. Office Buildings 1 & 2 share an electrical room, and will have very similar branch distribution systems. After speaking with the electrical contractor, it was confirmed that a representation of an electrical system would greatly help in planning efforts.

Potential Solutions

The results of my analysis will yield the following potential solutions for the recommended electrical distribution system:

- Recommend implementing proposed system and construction techniques.
- Consider system as an alternative, as construction techniques and/or design could be improved.
- Do not recommend system design and/or construction techniques.

Methodology

The following steps will be taken to properly complete this analysis:

- Calculate cost of designed electrical system per floor.
- Create a detailed schedule for construction.
- Calculate labor costs.
- Document constructability issues of typical electrical distribution construction.
    - Evaluate applicability to CityCenterDC
- Document special considerations or precautions (job specific)

Expected Outcome

It is believed that the proposed electrical distribution system will be cost effective and the proposed construction techniques and schedule will keep the project schedule on track. It is expected that the electric al contractor for CityCenterDC should be able to use this analysis as an accurate representation of the real work. The extensive experience of the author in the electrical construction industry will help in developing the topics of this analysis.

Analysis 4 – Raised Floor

See Appendix A for Mechanical Breadth

Problem Identification

As described in Analysis 3, the office space requires customizable design of systems. In addition to the electrical system, the mechanical system of Office Building 1 is also not designed for a dynamically rearranging floor layout. The VAVs of the overhead distribution system require adjustment with every reconfiguration of the floor layout. This would require specialists to adjust the systems when needed. If the systems are not adjusted, the comfort of the tenants is compromised. Once again, this poses both comfort issues for the tenants and future rearrangement costs.

Background Research Performed

Dynamically changing floor layouts are common to working environments, especially the so-called "cubicle farms." After researching various techniques to accommodate the mechanical and electrical systems in such an environment, I came across a raised floor solution. The developer of CityCenterDC then informed me that they were very experienced with raised floor systems. They have used them in many other projects and are comfortable with idea. Shifting to a raised floor system of course impacts floor height among others, and will need to be one of the major topics of analysis. A raised floor system for this project could solve the issue with customizability for the floor layout. Both the mechanical and electrical systems could be stowed away in the raised floor, allowing for easier access for maintenance and adjustment. Another consideration is the fire protection system in the ceiling and the way that will be dealt with. Constructability is always an issue with a raised floor but in this case, with an experienced owner, many of the issues could be addressed early.

Potential Solutions

The results of my analysis will yield the following potential solutions in regard to use of a SnakeBus system:

- Recommend implementing raised floor system as a value adding tool that will aide in the comfort, customizability of the space, and save rearrangement costs in the future of the spaces.
- Consider raised floor system as an alternative, as calculated savings equal, but do not outweigh those of original system design, i.e. no value added.
- Do not recommend raised floor system as its costs exceeds the savings, due to either installation or incorporation issues.

Methodology

The following steps will be taken to properly complete this analysis:

- Research various types of raised floor system and their effectiveness
- Compare costs of both systems, both upfront and long term
- Evaluate any schedule impacts
- Constructability review with contractors and owner
    - Height restrictions
        - Possibly take away from retail space height (double story)
    - Address fire protection and ceiling
- Research and evaluate which system has higher customer satisfaction
- Feasibility to incorporating such a system with current design

Expected Outcome

It is believed that a raised floor system would be better suited for this building. While the upfront costs of the raised floor may exceed the upfront costs of the original system, lifetime cost will be lower and value would be higher. The analysis will yield quantitative results about the potential savings of the system. In order to resolve the non-quantitative aspect of value, research and interviews will be performed to determine which system tenants are more satisfied with. It is believed that the incorporation of such a system will serve the space better and yield a higher level of satisfaction to both the owner and the tenants. Figure 1 shows an example of a high quality raised floor system.

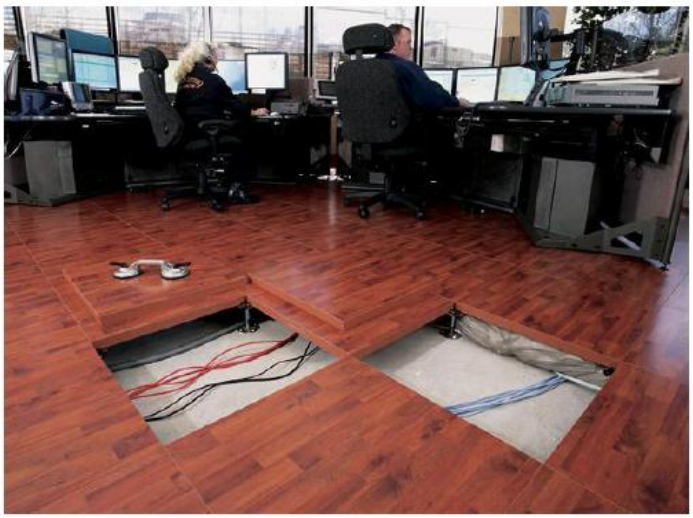


Figure 1: Raised Floor System | Image Courtesy of Google Images

Conclusions

The project team for CityCenterDC put a strong emphasis on the timely completion of Office Building 1. Upon substantial completion of the building, the owner will be able to officially sign a lease with the tenant. At this point the owner will start receiving revenue from the tenant, and begin the fit-out process. As such, schedule savings would speed up both the tenant move-in and revenue exchanges. My analyses revolve around shortening the schedule in an efficient manner that also improves the quality of the product. Analyses 1 & 2 concentrate on creating a more productive and efficient schedule while ensuring the systems are installed with a higher level of quality. Analyses 3 & 4 pertain to creating a more suitable system for the designated spaces as well as reducing lifetime costs. It is believed these analyses will produce beneficial and desirable results for the owner, project team, and future tenants.

Appendix A

Breadth Topics & MAE Requirements

Breadth Topics

Electrical Breadth

As mentioned earlier, an electrical branch distribution design does not exist. This breadth will focus on designing a typical floor branch system. Load requirements will be calculated and the system sized accordingly. Calculations will include sizing of equipment, wire, conduit, etc. for the new system. In addition, material and specific equipment will be selected. The design of the system will be used for the work associated with Analysis #3. All design will comply with the National Electric Code (NEC). Consultation with industry professionals will aid in developing an efficient system.

Architectural Breadth

In reference to Analysis 4, the implementation of a raised floor system will have an effect on the appearance of the space. This breadth will propose designs for the raised floor system appearance as well as the ceiling. The solution will have to take into account the floor-to-ceiling height requirements as well. Because the ceiling space will only contain the fire protection system, one option will explore an exposed ceiling and system with architectural finishes.

MAE Requirements

The knowledge acquired through various MAE 500 level courses pertains to several of my technical analyses. More specifically, concepts from AE 570 Production Management will be incorporated into Analyses 1 & 2. AE 570 revolves around the use of production management to efficiently manage projects. One of the thoroughly covered subjects in the course is SIPS. As mentioned before, this technique will be implemented for the core electrical or mechanical rooms. I will revisit the fundamentals and tools learned in the class and apply them to Office Building 1. In addition to SIPS, the course covered several production tracking and optimization techniques. These will aide in the development of the virtual mock-up implementation plan, and alongside with SIPS, work towards increasing productivity of various processes and shortening the schedule of the project.

Appendix B

Sample Interview Questions

Interview Questions

For previous users of virtual mockups

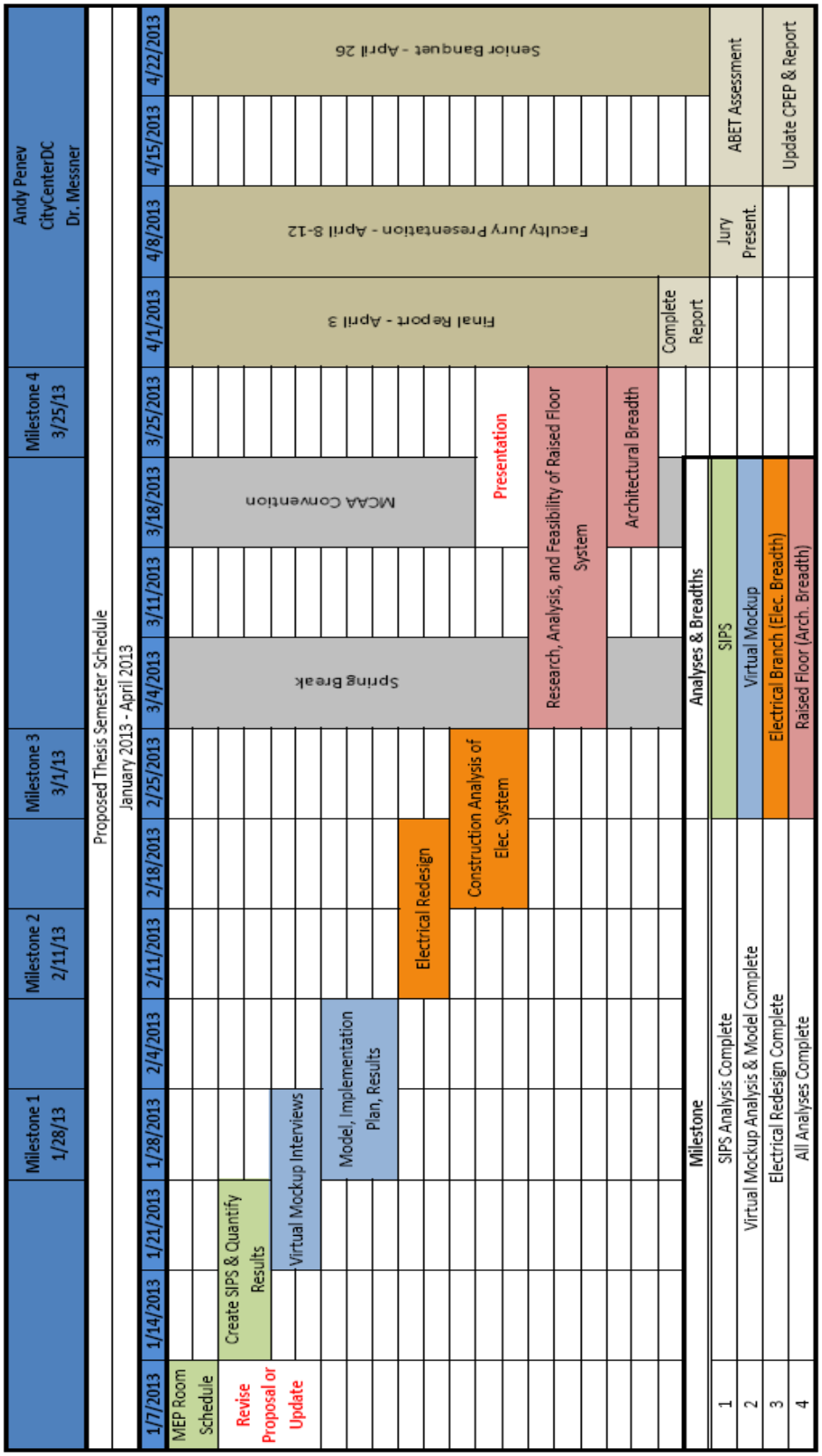
1. What project have you used virtual mockups for?
2. How effective were the mockups?
3. Did you notice a significant improvement in quality of productivity?
4. What were you looking to get out of the mockup?
    a. Did you achieve this result? Explain.
5. What types of resources were necessary to implement virtual mockups?
6. Did you use tablets or keep it in the trailer?
7. Did field crews find it beneficial?
8. If you used virtual mockups again, what would you change, or what would you like to see different?
9. Would you use virtual mockups again?
10. Compared to physical mockups, which would you say is more beneficial?
    a. Which would you prefer?

For those who have never used virtual mockups

1. Are you familiar with the concept of virtual mockups?
2. Would you be willing to use virtual mockups on a project?
3. What would you expect to gain from virtual mockups?
4. Do you think project teams would be open to the implementation of virtual mockups?
5. How would you alter you work plan if virtual mockups were present?

Appendix C

Senior Thesis Timetable


Andy Penev
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Milestone 1
1/28/13
Milestone 2
2/11/13
Milestone 3
3/1/13
Milestone 4
3/25/13
Proposed Thesis Semester Schedule
January 2013 - April 2013
1/7/2013
1/14/2013
1/21/2013
1/28/2013
2/4/2013
2/11/2013
2/18/2013
2/25/2013
3/4/2013
3/11/2013
3/18/2013
3/25/2013
4/1/2013
4/8/2013
4/15/2013
4/22/2013
MEP Room Schedule
Revise Proposal or Update
Create SIPS & Quantify Results
Virtual Mockup Interviews
Model, Implementation Plan, Results
Electrical Redesign
Construction Analysis of Elec. System
Spring Break
MCAA Convention
Presentation
Research, Analysis, and Feasibility of Raised Floor System
Architectural Breadth
Complete Report
Final Report - April 3
Faculty Jury Presentation - April 8-12
Senior Banquet - April 26
Jury Present.
ABET Assessment
Update CPEP & Report
Milestone
Analyses & Breadths
1
SIPS Analysis Complete
SIPS
2
Virtual Mockup Analysis & Model Complete
Virtual Mockup
3
Electrical Redesign Complete
Electrical Branch (Elec. Breadth)
4
All Analyses Complete
Raised Floor (Arch. Breadth)