



CIFE CENTER FOR INTEGRATED FACILITY ENGINEERING

**VDC Use in 2007:
Significant Use, Dramatic Growth, and
Apparent Business Opportunity**

By

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VDC Use in 2007: Significant Use, Dramatic Growth, and Apparent Business Opportunity

Abstract

This study analyzes and compares data from surveys conducted in 2006 and 2007 on the use of Virtual Design and Construction (VDC) and Building Information Modeling (BIM) technologies in the AEC industry. The 100 respondents thus far to the 2007 survey represent a broad mix of geographic locations, business sizes, technical disciplines, and project types. The data suggest that VDC use is significant, expanding quickly and has entered mainstream use. Survey respondents report more and increasingly sophisticated use of the methods in their operations. While value of their work in practice is rarely measured quantitatively, the majority of users report qualitative value across all phases of the design and construction process as well as for all parties to it, which is growing in comparison with survey results of a year ago. A growing proportion of early adopters report plans to transform their organizational strategy, and, in addition, more early adopters are now shifting from individual pilot projects to broad scale use of the methods than in the previous year of the survey.

An ironic finding of our study is that those organizations that respondents themselves and others consider most likely to find value from using VDC, namely architects and facility owners, are the least likely to use or require it on their projects. This result may now be changing for Architects, however, as the biggest annual reported increases in VDC use, implementation efforts, and perceived value occurred in the design phases of the construction process. As VDC use increases, reported impediments to its further adoption by new and existing users are shifting from technical issues such as contractual language and hardware and software to people issues such as training and availability of qualified staff. The survey data and information gathered during one-on-one phone interviews suggest that VDC programs are growing in extent and that once they start organizations grow their use of VDC. Since VDC staff training and availability have become bottlenecks in 2007, we infer that early adopting organizations obtain value at a lower cost than competitors that need to recruit, invest and compete in an established VDC marketplace. Later adopters may find themselves operating at a strategic disadvantage for significant periods of time while they need to offer low prices to overcome lack of perceived marketplace competence and simultaneously pay for their attempts to develop scarce people resources and institutionalize new processes.

Introduction

The Center for Integrated Facility Engineering (CIFE) at Stanford University has been a leading proponent of the VDC and BIM use in the design and construction process, and has helped numerous firms implement the technology on individual projects. This paper describes a survey, now in the second year of what we hope to be an annual effort to track the diffusion of VDC use industry-wide and to evaluate trends in its use over time. It is our belief that use of VDC methods is expanding and has now entered mainstream use, which we did not see in years past.

Adopting companies placed significant effort into implementing VDC programs across all phases of the design and construction process last year and many report reaping benefits from this effort. Many user companies report that they are shifting toward broad VDC implementation and overall organizational transformation based on its use. These users report value in qualitative terms as few measure value quantitatively.

Adoption is not universal, however, and half the 2007 respondents say that they are not using VDC / BIM on any projects. The majority of non-users cite lack of need, lack of request by owners, and lack of qualified providers as the most common reasons for not implementing the technology. Those same respondents indicate they would use the technology if it could improve their process efficiency. Since the majority of current users seem to derive value in the use of VDC for precisely this reason we suggest that a profound disconnect exists between the perceptions and desires of non-users and those of users.

Notes on Survey Methods

This paper highlights the results from two versions of an annual survey which began in 2006. The 2006 survey was considered a beta version and several changes were made to the 2007 version based on experience gained on the earlier instrument. In particular, several new questions were added in 2007 in order to improve clarity or to provide information seen lacking in the 2006 version. Some questions seen as redundant were removed.

A particularly significant change between the two years was a modification in the treatment of respondents who reported having no projects using VDC methods at the time they took the survey. These non-users were diverted past all detailed or direct-experience related questions. Instead, they were asked why they did not use VDC and for what reasons they might begin doing so. From this we hoped to reduce the incidence of respondents skipping questions in the more detailed sections of the survey. In the 2006 beta version, users were not diverted in this manner, but rather they were advised to skip questions that did not pertain to them. We feel this modification has allowed the survey to gather better insight into the perspective of the significant numbers of non-user respondents.

The 2007 data are based on a combination of a web-based survey and individual follow-up interviews with respondents who volunteered to be contacted. As of the writing of this report there were some 100 respondents to the survey and 30 interviews conducted. It is worth noting that this paper compares the results of the 2007 survey with the relatively small population of respondents in the 2006 survey. The earlier instrument gained 40 total responses, and since respondents were advised to skip questions that they did not have direct information to answer many of them skipped large numbers of questions reducing the population size further. This makes data based on percentages of total respondents to the 2006 version somewhat sensitive to fluctuation in the personal experience of individual respondents. Comparisons between the 2007 version of the survey and the following years will be less sensitive to this given what we hope will be continued higher response rates.

Findings

This section reports the findings of the 2007 VDC use survey and compares those findings with the earlier 2006 results.

Survey respondents represent all parts of the AEC industry

Survey respondents in 2007 provided a broad and representative cross-section of all parties in the AEC industry, as shown in Figure 1. Respondents operate throughout the US and the rest of the world, and frequently provide services in multiple phases of the design and construction process. The figure demonstrates the relative percentages of respondents specializing in the various roles and services that make up the process of design, construction and operation of buildings. With the exception of the specific subcontractors providing mechanical, electrical, and plumbing (MEP) and structural steel installation, at least 30% of respondents were involved in each of the specialties listed. Such broad involvement provides a balanced insight into all phases of the process.

The makeup of survey respondents in 2007 is similar to that of 2006 with a few noticeable exceptions. The 2006 survey did not allow a response option for MEP or structural steel subcontractors. While there is an apparent reduction in the number of respondents offering construction specialties, there is a corresponding increase in the proportion pertaining to these subcontractors. We feel that this is a transfer of response between similar categories rather than a fundamental shift in respondent demographics. Respondents offering the Architecture specialty increased from 47% to nearly 50% of the total and the other specialties decreased by a similar 2-8% margin. These are not considered significant shifts. We believe, therefore, that the similarity of response allows for direct comparison of data between the two survey years.

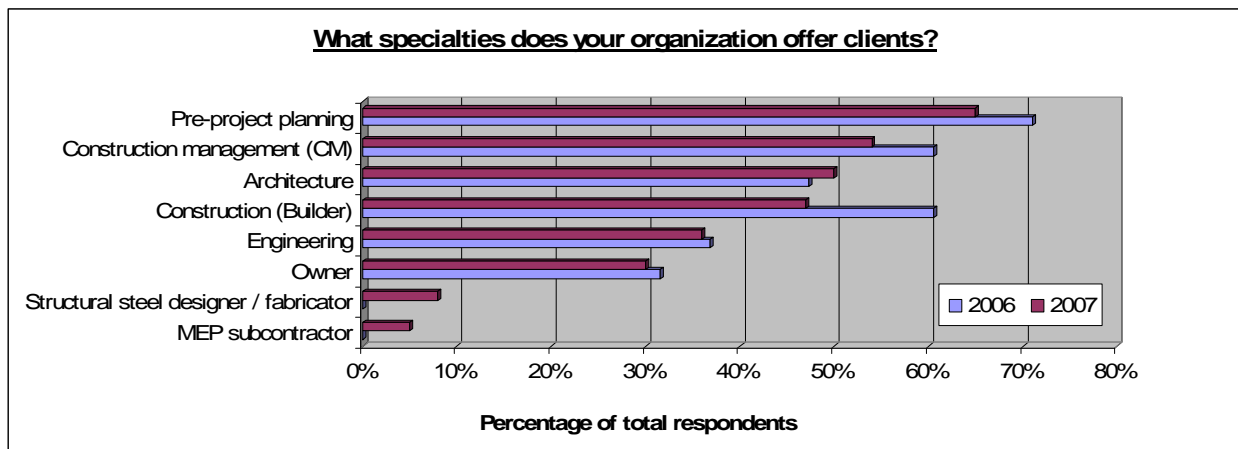


Figure 1: Respondents to the survey represent all specialties and disciplines of the design, construction and operation cycle for buildings, and most respondents reported offering more than one specialty. The proportions of respondents from each discipline are roughly the same in 2007 as in 2006 with the exception that there were slightly more architects and the significantly fewer contractors. Specialty subcontractors, structural steel and mechanical electrical and plumbing, were added options in 2007 which likely diluted the contractor response rate. The increase in percentage of architects, from 47% to 50% of total respondents is not considered a significant change.

A significant shift in the demographics of respondents can be seen in the large increase in the number of non-users who responded to the survey as demonstrated in Figure 2 in the next section. In 2007, non-users were diverted past detailed project questions to a section of more general questions tailored toward their non-user status. In 2006 this diversion was not present so non-users saw the same questions as users. All respondents in that version were instructed to skip questions they did not have the information to answer, and, there was indeed a significant incidence of respondents skipping questions requiring information from VDC project experience. We infer this indicates non-users largely avoided those questions that did not pertain to them leaving the overall results comparable.

The use of VDC is broad and growing significantly

In Figure 2, respondents report a significant growth in the absolute numbers of projects in the past 12 months on which they attempted to use VDC. The figure shows these use increases by groupings of 0 total projects, 1-3 total projects, and more than 4 total projects. These results separate non-users, pilot users with few projects, and relatively advanced users that have adopted the technology on multiple projects. As stated above, the biggest increase since 2006 is in the number of VDC non-users, which we infer is a consequence of the much larger sample size in the 2007 survey in comparison with the 2006 version. The number of pilot users nearly tripled, and the number of advanced users grew by a quarter.

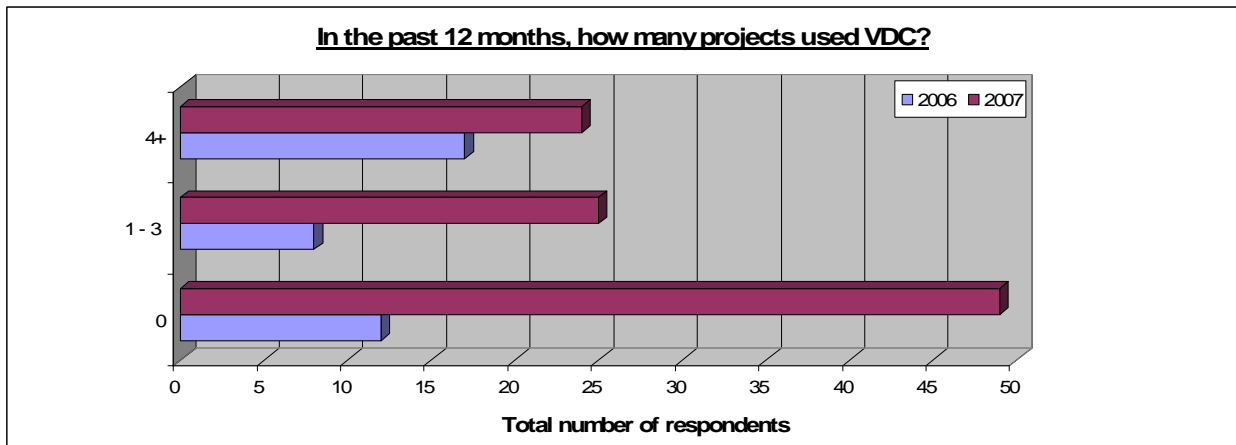


Figure 2: The number of non-user respondents, those reporting having no projects on which they used VDC, jumped from 12 to 49 demonstrating wider advertisement this year. Pilot users, those with 1-3 projects, tripled in absolute number, and established users, those with 4 or more projects, grew by half. With a reasonably large and representative population there are now as many VDC users as non-users among respondents.

Figure 3 shows that VDC-users placed significant attention to developing VDC capability in all phases of the design and construction process. Design phases received the most attention; between 67% and 75% of respondents reported they had paid significant attention to their VDC capability during these phases. This represents a 10-20% increase in attention by respondents over the previous year. Attention paid to VDC capability in the phases of pre-project planning and field construction management decreased by nearly 10% each over the previous year, but the majority or near-majority of users still paid close attention to these areas. Few respondents

reported they paid significant attention to developing VDC capability during O&M which is typical of our findings in other sections of the survey for this phase of the cycle.

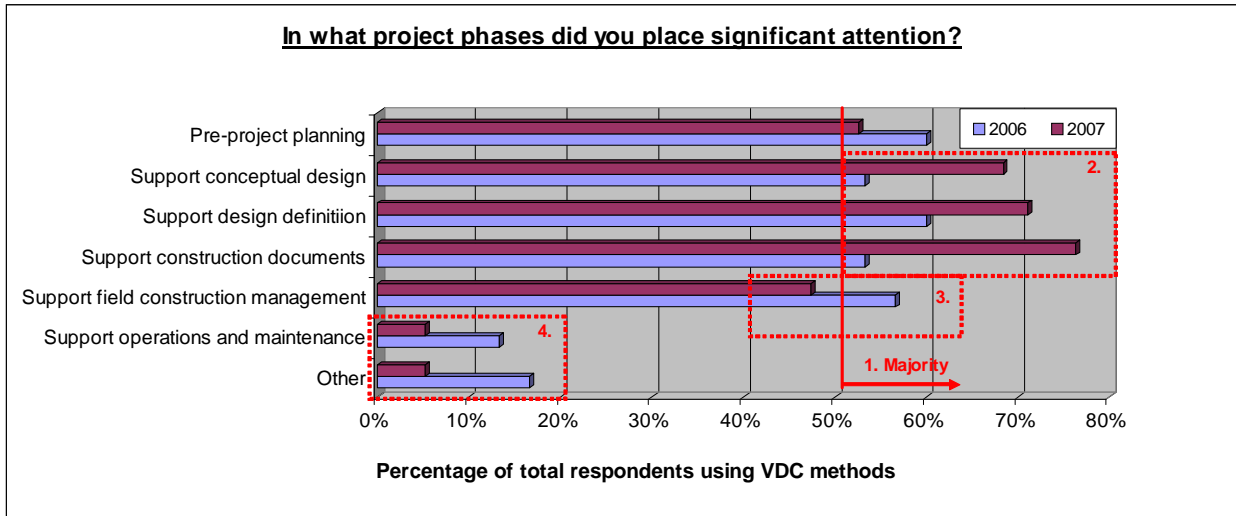


Figure 3: 1. The majority or near majority of users reported placing significant attention in all phases of design and construction. 2. Users reported placing more attention to design phases than any other increasing this response by 10-20% over the previous year. 3. Users reported a 10% reduction in attention placed during construction management, however, and this rate fell slightly behind the majority of respondents. 4. O&M lags the design and construction phases by a wide margin and actually fell by half from 2006 to 2007.

As shown in Figure 4, the majority of respondents report they are creating models in all phases of design and construction excluding operations and maintenance. Additionally, the largest percentages in 2007 occurred during the design process where it is more likely to have an impact on value. As shown in this figure, at least 67% of respondents reported creating models in all phases of design this year. Significantly more respondents reported creating models in all phases during 2007 than in 2006. Though the rate of respondents reporting they created VDC models during the O&M phase grew slightly in 2007 over 2006, these respondents are in the minority and the response rate lags far behind the other phases. A shift to creation of models during the design stage is of potentially great future significance given the procedural efficiencies inherent in having the entire design and construction team operating from a central 3D model created early in the process rather than from individual models created by multiple parties at later stages.

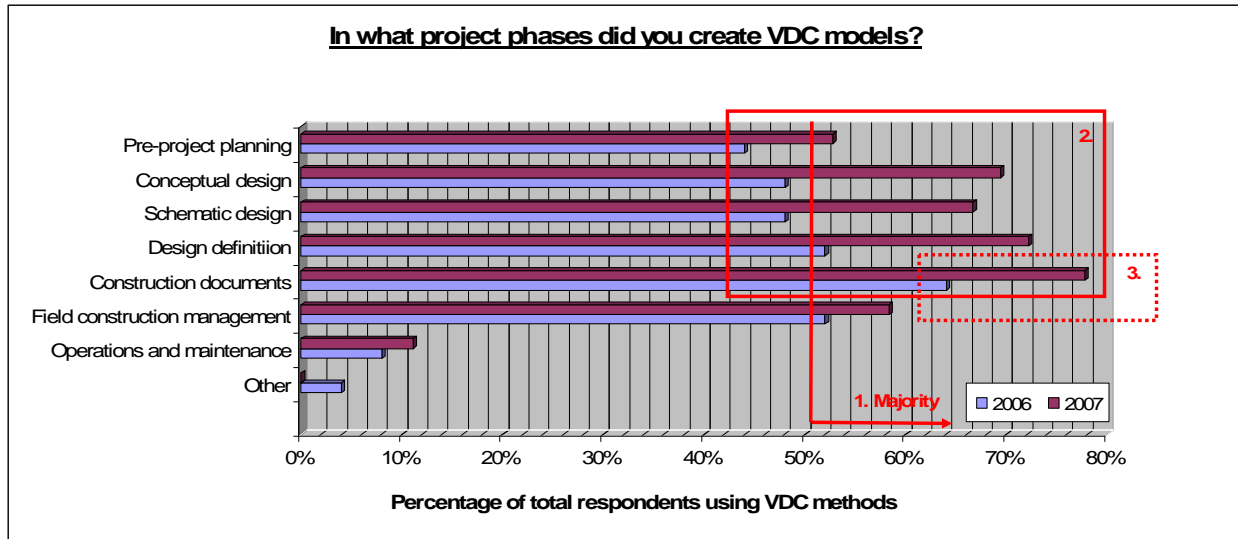


Figure 4: More respondents report creating VDC models in every phase of the design and construction process in 2007. 1. The majority of respondents reported creating models in every phase except operations and maintenance. 2. The increase in model creation was particularly strong in the design phases with greater than 33% growth during the conceptual, schematic, and design definition phases. 3. Nearly 80% of respondents report creating or updating models during the construction documents phase. These results suggest a general, significant, and rapidly growing use of VDC models across phases and company types.

Creation of models earlier in the process allows users to take advantage of the lower cost of adding value or avoiding problems at these stages. Interviews indicate that some users are creating models in the pre-project planning stages to test the economic and technical viability of various concepts prior to choosing a specific direction or embarking upon an actual design. These exercises can yield surprisingly accurate forecasts of final cost, especially if done on design-build or design-assist contract structures where all parties are participating from the beginning. The most advanced users tend to automate the production of documents typically left until later design phases. This is most effective in the construction documents phase and can allow designers to expend greater effort on the actual design rather than the packaging of their product.

As shown in Figure 5, users reported making significant progress at implementing VDC across most design and construction phases. Again, the best progress was reported in the design phases, particularly in conceptual design and design definition, where a solid majority of respondents reported making headway developing VDC capability. Respondents reporting progress in the support of construction documents doubled over the previous year. Indeed, comments on several interviews indicated that automation of construction documents could greatly reduce the administrative effort of the design process. The large increase in progress made in this area, combined with the data from Figure 3 that more models were created during the design document phase than any others, indicates that designers may be capitalizing on construction document automation as true low-hanging fruit. Progress reported on pre-project planning retreated about 10% in 2006, however, there is not any indication from interviews or survey-respondent comments to reinforce or explain this.

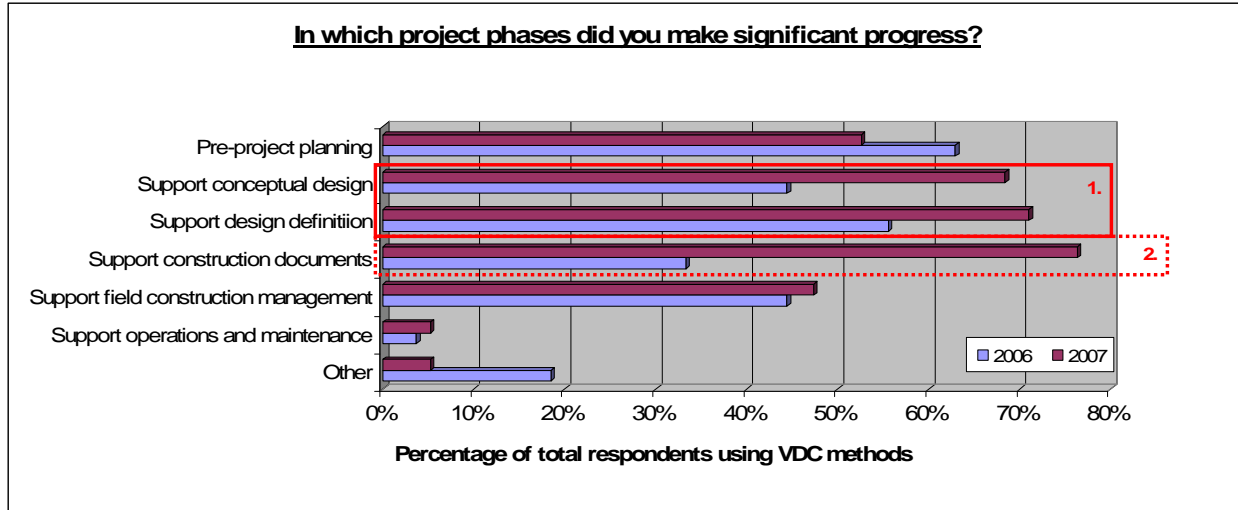


Figure 5: Respondents report dramatic progress across nearly all of the AEC process. 1: This is particularly true during the design phases where progress grew by 25%-33%. 2: Progress made using VDC to support the creation of construction documents more than doubled in the past year indicating a new level of sophistication. There were only nominal gains in support of field operations and operations and maintenance and significant progress on pre-project planning decreased. The data suggest that designers increased their VDC use more quickly than construction, O&M or pre-project planning.

Figure 6 shows the numbers of projects VDC users reported planning for the 12-month period following the date on which they took the survey. It shows that while pilot and advanced users will remain in roughly the same proportions of total users, advanced users are moving toward performing more projects using VDC methods.

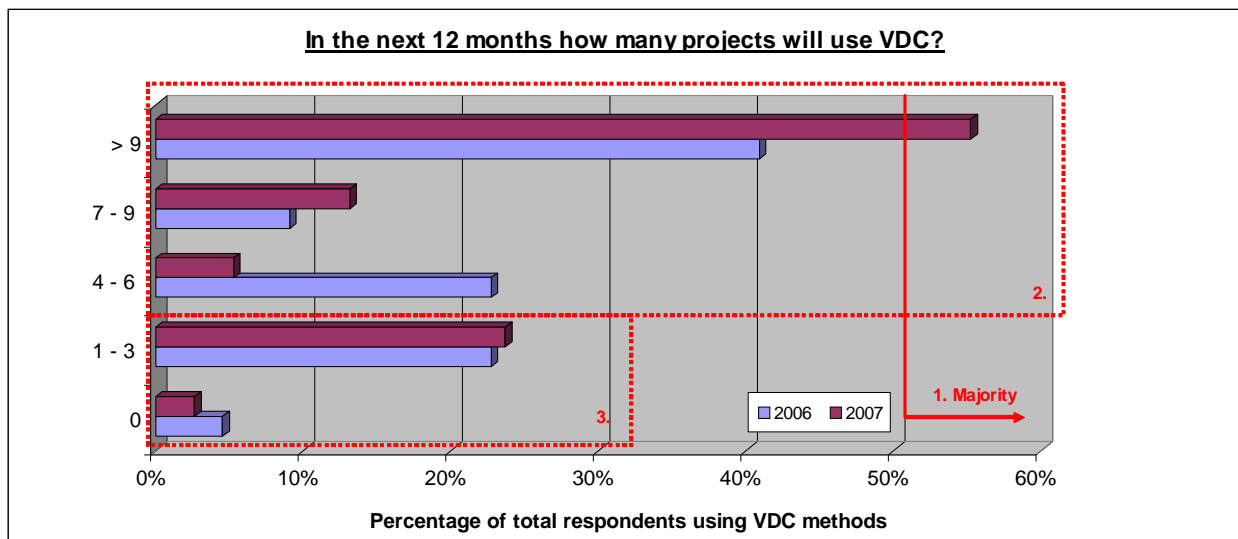


Figure 6: The majority of VDC users planned larger-scale use in 2007. 1. The majority of VDC-users planned 9 or more projects in 2007. 2. Advanced users, those with four or more projects planned, showed a general propensity to plan taking on even more projects. 3. Roughly the same proportion, about 25%, of users reported they were holding steady with no or 1-3 pilot projects planned for the coming year.

We suggest that these data indicate that VDC use is well established and growing within a significant and representative segment of the construction industry. Further, we suggest that

given the degree of attention paid and progress reported, especially earlier in the design phases of the process, this trend is likely to continue. Users report implementing VDC methods on greater absolute numbers of projects and the majority of survey respondents report creating models at all phases of the design and construction process. The majority of respondents report paying significant attention to developing VDC capability, and, they report doing so during the early design phases more than in the past year. Excluding O&M, the majority or near majority of users report making significant progress in all phases of design and construction. While the proportion of users in the pilot and advanced stages of implementation remained essentially the same between the two years, the majority of advanced users in 2007 report having 9 or more projects using VDC. We infer that the significant reports of attention paid to development of VDC capability and corresponding progress made in these areas, as well as the shift of advanced users toward increasing numbers of VDC-based projects indicates a trend toward continued broad operational VDC use.

VDC users see significant value as well as a shift in the nature of impediments to progress

Figure 7 shows that advanced users of VDC technology find it qualitatively valuable and are starting to see fewer technical impediments and more personnel obstacles as they seek to capitalize on this value. We see a majority of survey respondents attest to the value VDC provides to the four key process players, namely, architects, owners, general contractors, and subcontractors. Figure shows that respondents see value across all phases of the construction process, and report sizeable gains in qualitative value over last year in most of those phases. Finally, Figure shows that respondents are more likely to say they derived competitive advantage in winning new projects from using the technology. In broad terms respondents were more likely to see value in VDC use in 2007 and they saw this value in all phases of the process.

Figure 7 indicates the perception held by the various parties in the construction process relative to the key players in that process. Clearly, all parties perceive that architects and owners are deriving the most value from VDC. Subcontractors are consistently perceived as receiving the least. Subcontractors aside, the majority of respondents (50-100% depending on the point of view) saw themselves and all other parties as receiving “some” to “very high” value from VDC. Follow-on interviews with respondents report consistently strong perceptions of value as a result of effective VDC use. Interestingly, many report anecdotally that the highest monetary benefits probably go to the subcontractors due to reduced interferences in the field and correspondingly increased efficiency in their on-site work. Many advanced users report that the main value of VDC is in the ability to coordinate work closely enough to cause a meaningful reduction in the number of personnel and materials, which are on the jobsite at any one time. Thus VDC is seen by some as a direct contributor to the implementation of lean construction methods. The primary beneficiaries of this are MEP and structural steel subs and in some cases, interviews indicate that it can be they who drive implementation of VDC on individual projects.

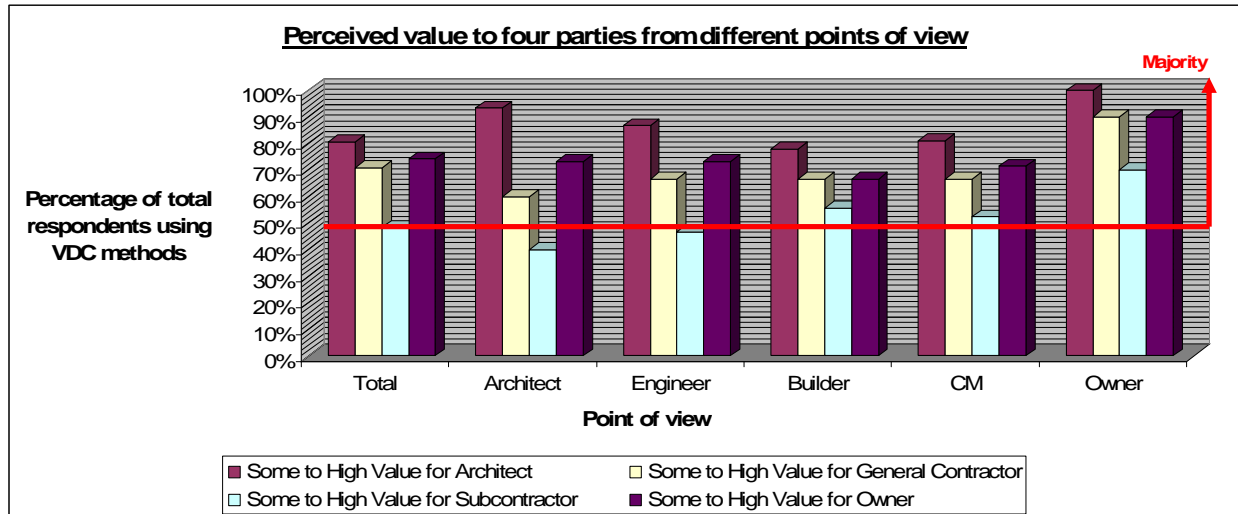


Figure 7: The majority of all parties to the construction process reported seeing qualitative value in the use of VDC. Regardless of the point of view, all respondents saw the primary beneficiaries of VDC as the Architect first and then Owner close behind. Respondents saw the least value going to Subcontractors. This data suggests that those who use VDC consistently see value for themselves and others in the process. Our individual interviews confirm the survey data but indicate that subcontractors may actually receive the most direct financial benefit.

Figure shows that in 2007 respondents reported value in every project phase except operations and maintenance. The most significant use is in Design Definition, and the biggest increase in perceived value occurred during Conceptual Design. Interviews with advanced architect users reported that a primary source of value from VDC use was reduced effort to prepare Construction Documents, which they significantly automate. They then increased time and percentage of effort in earlier design phases, which increased value to the client. These data suggest that the AEC level of influence curve [Paulson - 1976] applies to these VDC users, who report that VDC use helps them make design changes more effectively early in the project lifecycle.

Interviews also reported that operations and maintenance lags the rest of the functional phases in terms of perceived value. Service providers report that owners simply are not asking for facility maintenance information in BIM format, and owners indicate that they do not see a need for it. Since owners are the only party that would benefit from an operations and maintenance supporting model, and are the party least likely to use VDC, it is not surprising that this area lags the rest. Additionally, some interviews indicate that information required for the design and construction phases differs greatly from that needed to make a successful operations and maintenance program and so the models as currently developed would not be useful to owners without further definition and population with the specific information they need. The potential business opportunity or marketing edge for design and construction service providers who could provide viable (O&M) models to their owner clients is real. The fact that owners are not asking for them indicates that they find the cost to change their O&M process to create and use VDC remains prohibitive, or they are unaware of the technology, or the owner is unwilling to take a risk on an unproven method.

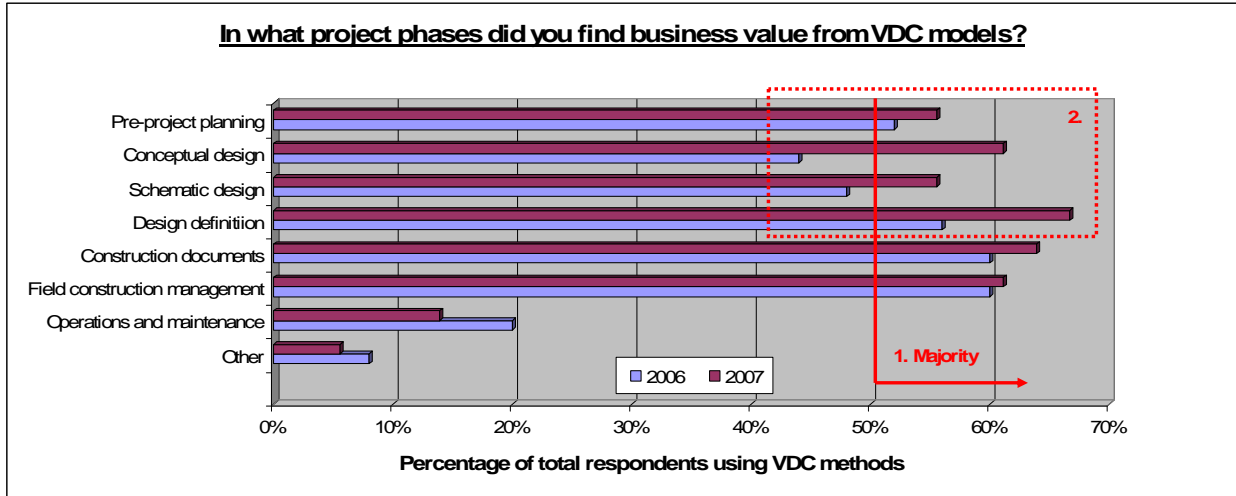


Figure 8: The majority of VDC users now find value in every part of the design and construction process. 1: The majority of respondents see value in every phase except operations and maintenance. 2: The biggest gains were in design phases. The conceptual design phase in particular increased by more than 30% such that 2/3 of respondents report seeing business value in this phase. Operations and maintenance lagged far behind the rest of the survey and actually decreased from the year prior. This point is supported by our individual interviews, which indicate that owners rarely ask for VDC models to support their ownership and see little value in doing so.

Users indicated an increased sense of the marketing impact of VDC in 2007 in both a positive and negative way. From Figure it is clear that nearly two thirds of respondents in 2007 saw significant value of new projects won based in part on competitive advantage gained through VDC use. The previous year, less than half of respondents reported an increase. It is clear that the diversion of non-users past detailed questions had a dramatic effect on the rate of respondents saying they did not know the overall impact of VDC. In 2006 more than half the survey respondents said they did not know the marketing impact of their VDC use. Cross-tabulation with non-users shows this category to be close to a third of total respondents, which is similar to the 25% of respondents calling themselves non-users in 2007.

Nearly 17% of respondents indicate that the use of VDC *reduced* the value of new work won. These respondents did not agree to be contacted for further information so we could not use interviews to explore the result. Interviews with other companies did not suggest any negative value. Data cross tabulation indicates that some respondents citing negative value also said that they saw value in VDC use and that it might allow them to reduce contingency on future projects. This inconsistency with reported reduced value of new work suggests that some respondents may have found the intent of the question confusing. They may also find that VDC provides benefits but their cost of VDC use puts them at a competitive disadvantage.

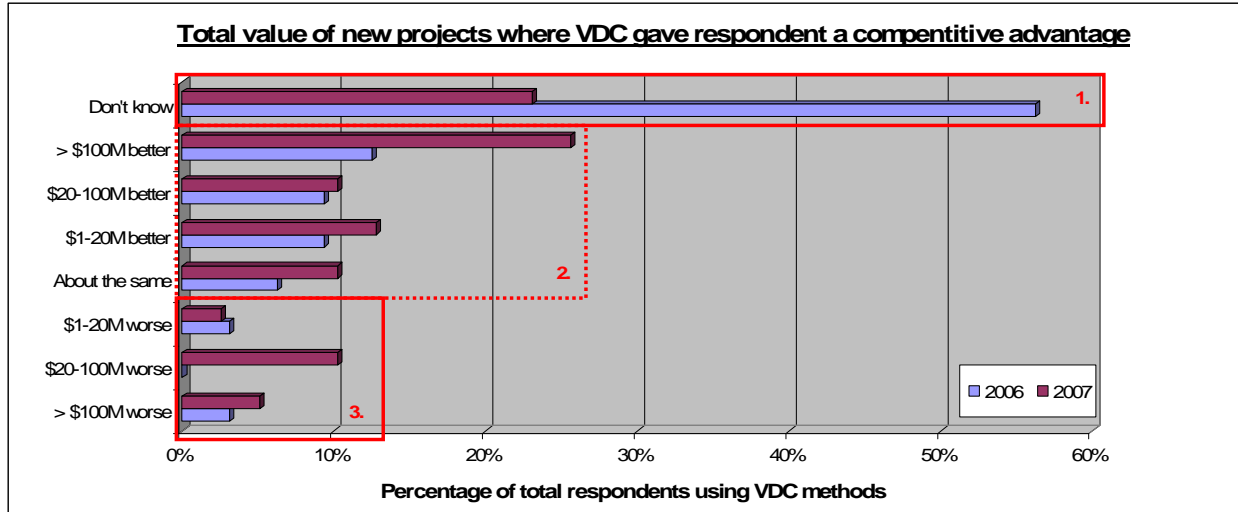


Figure 9: Respondents perceived some increase in the value of VDC as a competitive advantage for winning new work in 2007. 1. The number of respondents reporting not knowing the value of the competitive advantage given by VDC shrank dramatically due in large part to the new survey structure that diverted non VDC-users past this question. 2. The number of respondents who feel that VDC gave them more than \$100M additional new work nearly doubled. 3. Those perceiving a loss of work as a result of their VDC usage grew by a significant margin as well. Our individual interviews do not reinforce the lost-value data as yet, and the survey does not allow explanation of this loss.

The nature of impediments to finding value in VDC use is changing. As the use of VDC increases, the need for qualified personnel and third-party firms to produce models is increasing as well. Perhaps the most significant signal of actual increased adoption of VDC is in the perception by users that finding qualified personnel is now a bigger obstacle to deriving value from VDC. As can be seen from Figure below, this perception has increased dramatically from the previous year, and overshadows technical or cost impediments that have stayed consistent or decreased between survey years. Survey respondents saw a lack of training and availability of staffing as the two biggest issues, both surpassing lack of hardware and software tools which was the biggest concern the year before. Additionally, contractual impediments, previously the second biggest obstacle, decreased dramatically in the past year. Interviews consistently indicate that lack of qualified contracting parties and pre-trained personnel are limiting the ability to implement VDC on a wider basis. Companies are trying to move forward through implementation through on-the-job training and offsite 3rd party training which often results in less efficient first steps toward implementation.

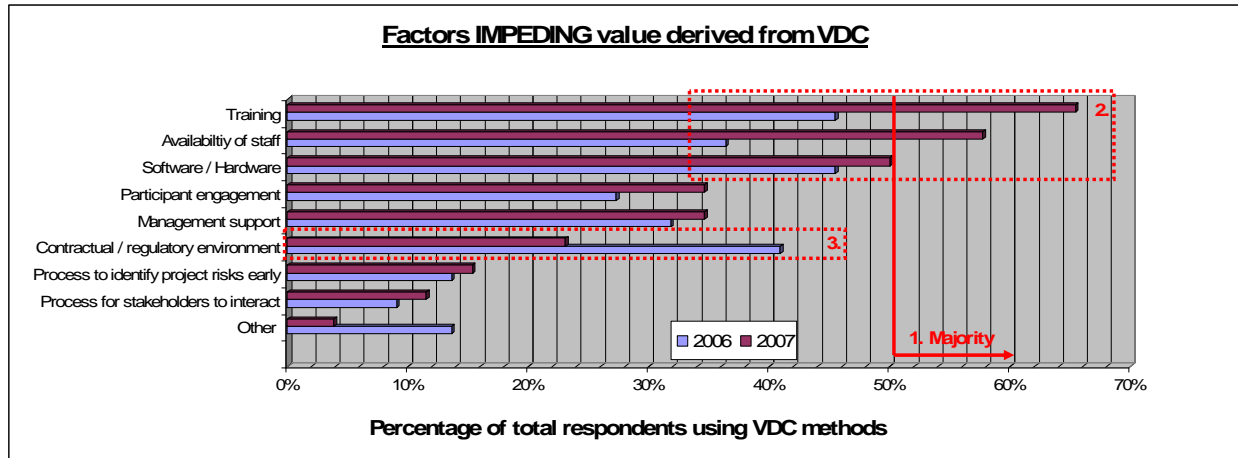


Figure 10: Respondents reported a significant shift in their perceptions of the principal impediments to deriving value from VDC. 1. The majority now see training and availability of staff as most limiting. 2. Greater growth in concerns over personnel issues pushed technical concerns with software and hardware from the biggest concern 2006 to a somewhat distant third position in 2007. 3. Contractual language dropped by nearly half in the biggest single shift from the prior year. The data suggest that as VDC use grows personnel issues are coming to dominate contractual and technical issues.

As dramatic as the increase in perceived value was in Figure and Figure, respondents only reported qualitative value. Indeed, more than 80% of respondents stated that they do not track performance on VDC projects separately from non-VDC projects and fewer than 20% of respondents said that their cost information was based on formal company records. Interviews indicate that the majority of firms find tracking of quantitative data for metrics on the impact of VDC difficult. Interviews report that some do not know what data to track, and many report that they do not know how to attribute or credit change in performance to VDC use on a given project. Most users who report specific quantitative impacts do so for numbers of issues caught using VDC methods that would normally be found in the field, the number of RFIs, cost of change orders, or reduction in schedule duration between a given VDC project and other projects of similar size and scope on which VDC was not used. Some assign estimated costs to interferences avoided virtually based on past costs for similar issues or estimating the cost of delays avoided.

We suggest that the perception of great qualitative value by VDC-users in the face of a general lack of quantitative data is a by-product of the complex nature of the construction process. There are simply too many variables to be able to attribute success on a single project to one specific part of that process. Results may not be replicable exactly from project to project for just the same reason. However, where well-implemented, VDC allows for better mutual understanding of project requirements and helps avoid many problems virtually before they become problems in the field. For this reason users see value even if they can't quantify it directly.

The data thus far show an overall trend toward a greater perception of value which is both driving and being reinforced by increased significant efforts made toward implementation of VDC. This perceived value is shared by all parties, but seems to be especially strong for designers as shown by the growth in perceived value during the design stages and the dramatic increases in efforts and progress by designers reported in the last section. As growth in use

increases, more pressure will be put on the relatively limited supply of qualified personnel and the need for training and the market for qualified individuals will grow as well.

VDC Users show increasing sophistication

Survey respondents show distinct strata in the level of sophistication of their VDC programs, but a general trend toward increasing capability is seen in our results. The majority of users are currently working with visual methods such as 3D design presentation and clash detection, while fewer than the majority use it for more analytical methods such as direct-generation of cost estimates and shop drawings for fabrication from 3D models. However, there is also a clear trend toward increasing sharing of information between models and use of these models to populate other analysis platforms. Whereas the majority of users today may not be optimally sophisticated in their activity, experience shows, and the data suggest, that as their proficiency with individual technologies and their interoperability improves this use will gain in sophistication.

Figure shows the business purposes for which VDC was used in 2007. The data demonstrate the range of sophistication of respondent VDC programs. A majority of users conduct 3D visualization and clash detection. Significant use of 4D scheduling and visualization of design was made as well as enhancement of field processes such as submittals, shop drawings, safety management, and cost estimation. Some automation of engineering analysis and shop fabrication can be seen. While these rankings vary slightly by community of respondent (architect, general contractor, owner, etc.) they are fairly consistent across them.

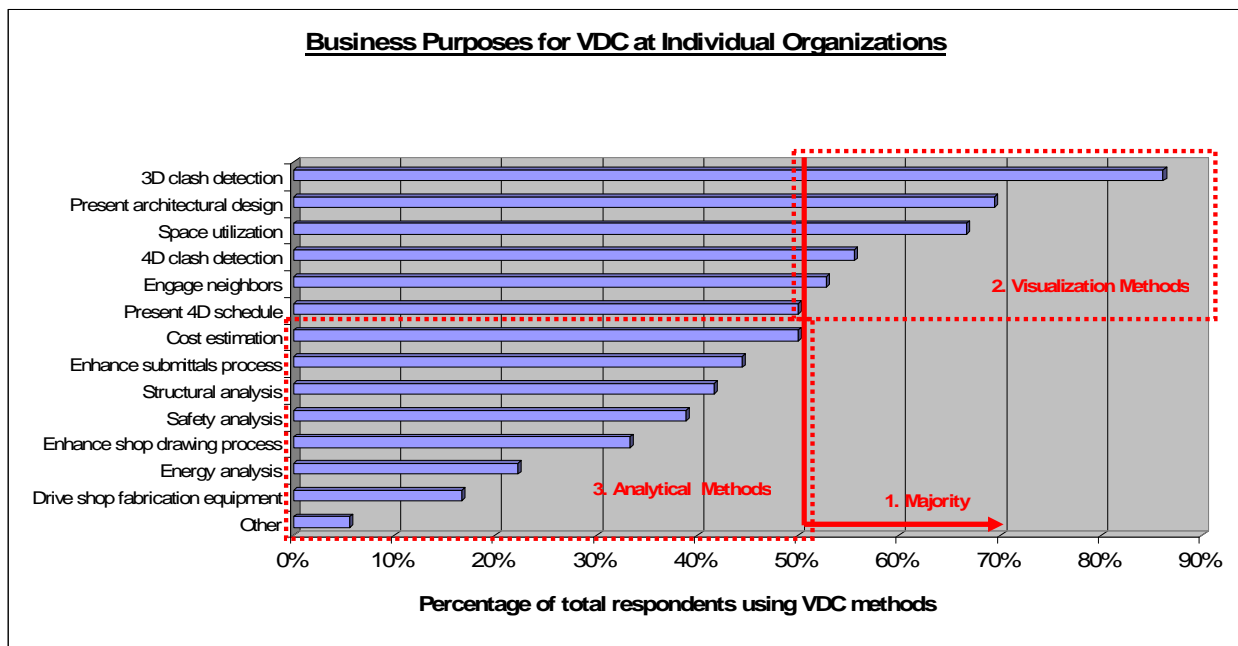


Figure 11: Respondents showed that there is a wide range of sophistication in use of VDC and a clear division between use of visualization methods and more sophisticated analytical methods. 1. The majority of respondents seems to be the dividing line between levels of sophistication. 2. Visualization activities such as clash detection, design presentation, and space planning are used by the majority of respondents. 3. Less than the majority of respondents report being engaged in more analytical methods such as cost estimation,

submittal and shop drawing enhancement, and driving shop fabrication equipment. The data suggest that this range of sophistication found in VDC-user activities may be a good metric of the advancement of VDC technique in the industry.

Of particular note is the use of 3D clash detection which almost 90% of respondents report as a business purpose of their VDC use. Interviews indicate that this may be the easiest and most productive use of 3D VDC models in construction field management. Most interviewees who successfully use VDC indicate that they achieve great success at avoiding field coordination problems by eliminating conflicts virtually before ever breaking ground. Indeed, more advanced users begin to trust this coordination enough to perform off-site fabrication of materials such as ducting, piping and structural steel. Companies at this level report, for example, as much as 90% offsite fabrication of pipe and ducting as a result of their 3D VDC modeling.

In addition to showing sophistication in the applications for which VDC was being used, the 2007 survey shows that users increased their reuse of information between VDC and other application platforms. Figure 10 demonstrates this trend. Of particular note was the high rate of information reuse between programs. Indeed, nearly 80% of respondents indicate they share their VDC models with 2D CAD, and roughly 64% say they generate their 2D drawings from their 3D models. There was a corresponding reduction in the numbers of respondents reporting that they recreated information, or manually created 3D models from 2D drawings between 2006 and 2007.

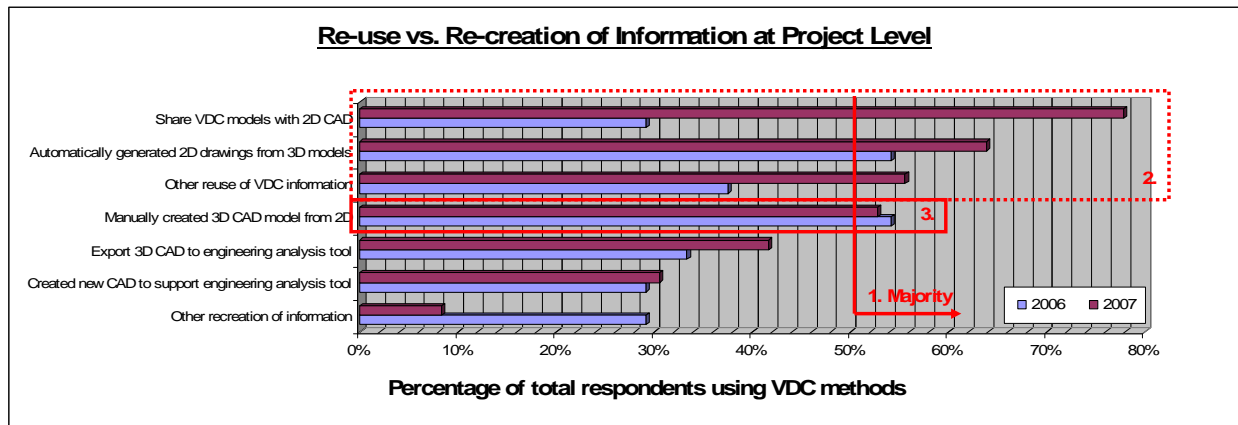


Figure 12: Another indication of VDC sophistication is the degree to which information is shared with non-VDC platforms such as engineering analysis tools and 2D CAD. 1. The majority of VDC users are now sharing and reusing key information rather than recreating it. 2. Sharing of 3D model data, generation of 2D drawings from 3D models and general reuse increased at a rapid rate, the former more than doubling since the 2006 survey. 3. Manual creation of 3D models from 2D drawings showed a slight decrease over 2006 and general recreation of information decreased by about 2/3 from the previous year. These data suggest that VDC-user capability and sophistication in model creation and information sharing is improving with time.

Interviews suggest that the keys to successful implementation of VDC on individual projects is assigning creation of models to one party, defining the process used to share information between parties and between programs up front, and to utilize design-build or design-assist contract types which allow parties to become engaged early on in the process. Thus the management of the processes discussed in Figure 12 is critical to the successful implementation of VDC and the move from novice to advanced user. In the words of one interviewee, “VDC is

not a Panacea.” Mismanagement of these processes can lead to frustration and missed-opportunity.

As in the past, many individual stakeholders require diverse information, and they must themselves provide unique and critical inputs to any effective VDC project. VDC both enables and requires that information to be developed in more detail and then shared and evaluated much more collaboratively and dramatically more quickly than in the past. Thus, each project and participant must carefully support vertical (between functions such as operations and engineering), horizontal (between disciplines such as process piping and electrical design), and longitudinal (over time) integration of model creation, evaluation and use. For this reason certain contractual and team structures that allow for early sharing of information, such as design-build and design-assist, and the adoption of strict format and process controls tend to perform better.

Established VDC users are expanding their focus

We see in the data a shift toward both broader scale use and organization transformation based on VDC among established early-adopters. This shift is very much consistent with the increasing perceptions of value and sophistication among VDC users noted in previous sections. As projects are attempted, users gain experience, overcome technical impediments and see greater value. This greater perception of value shows itself in breadth of use and shifting of organizational and project strategy to capitalize on that value.

Current users demonstrated a significant shift in their use of the technology from a focus on pilot-projects toward broad scale use and even organization transformation. As Figure indicates, the number of companies saying they would make broad scale use of VDC grew from approximately one quarter of respondents in 2006 to nearly 40% in 2007. Similarly, users saying they would transform their organizational strategy grew by a third from 28% to 38%. The number of pilot projects planned by respondents fell significantly, likely due to the structure of the survey which guided current non-users past this question. Though it is not possible to say with surety, we suggest that the reduction in pilot projects below the frequency of broad-scale use also indicates a shift toward more sophisticated capability and is driven by the reported perception of value on the part of the user-community.

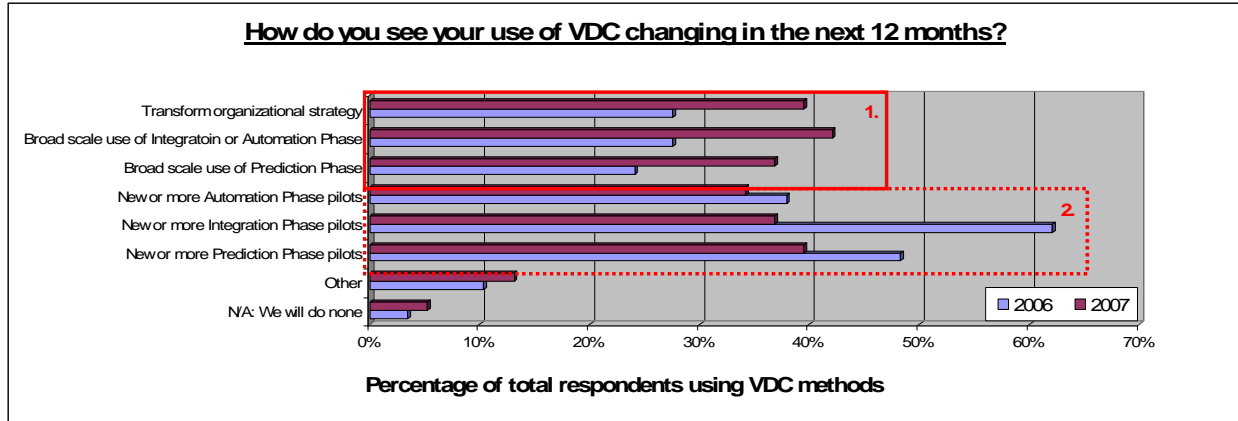


Figure 13: VDC users are shifting toward broad scale use and transformation of corporate strategy from simple pilot projects. 1: Users showed a 30% increase in likelihood to make broad scale use of VDC or to transform their organizational strategy based on VDC use. Cross tabulation of this question against large-scale users, those with greater than 4 VDC-based projects, showed that the majority are planning broad scale use of integration or automation phase VDC. 2: Users showed small to large decreases in plans to launch new pilot projects, including a nearly 50% drop in planned Integration Phase pilots. These data suggest that long-term users of VDC tend to move toward broad scale use of the technology.

Non-users are numerous but show signs of interest

Slightly more than half of 2007 respondents, including a sound majority of facility owners, indicated that they were current non-users. These respondents also indicated that they would try VDC methods if it would improve process efficiency or if owners began asking for it. The value seen by VDC users contradicts the basis of non-user indecision and represents a profoundly important business opportunity of which early adopters may take advantage. Owners will very likely respond to those companies who offer improved services early, and early adopters will likely be able to provide their services at a lower cost relative to those who are late-comers.

Figure indicates that roughly half the respondents to the 2007 survey said they did not make use of VDC / BIM in the previous year. 65% of owners said they were non-users and were therefore the least proficient respondent category. The rest of the groups have a roughly 40% rate of non-use of VDC. This has implications that are better understood when the reasons for non-use are considered.

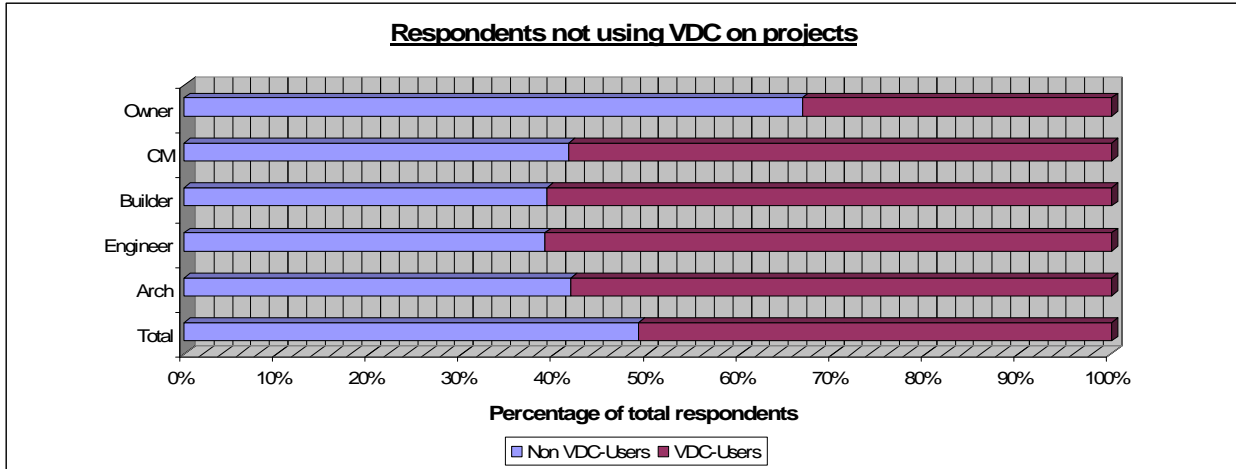


Figure 14: Owners are nearly twice as likely to be non-users as the other parties to the design and construction process. Nearly 2/3 of the other specialties report using VDC on at least one project.

As can be seen in Figure below, nearly half of non-user respondents cited lack of need or request from owners as the primary reason for their not making use of the technology. In contrast, relatively few non-users, only 15% in all, say their non-use is due to being unfamiliar with the technology. Only 12% say it is too costly.

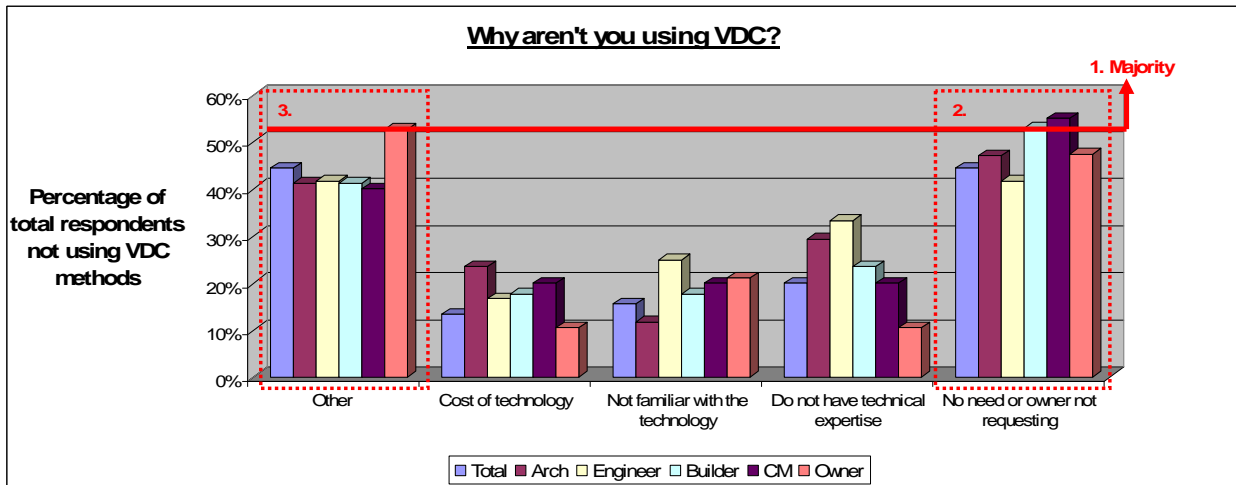


Figure 15: 1. The majority of owners and builders indicate that lack of need or lack of owner request is the leading reason for non-use of VDC on construction projects. 2. The near-majority of all other parties to the process cite need and owner request as the leading reason. 3. The comments associated with the “other” response indicate that many non-users are in the process of starting a pilot project now, or did not have access to a designer or contractor with enough VDC experience to risk a first attempt.

Figure 8 shows that the majority of these same respondents said they would use VDC if they felt it would improve the design and construction process or increase overall efficiency. In particular, we cross-tabulated this information and found that 56% of owners say they see no need for VDC but 90% would use it to get more efficient projects. Similarly, while half of AECs said they don't use VDC because owners don't request it, fully 60% said they would use it if it would improve the process. The results indicate that Owners, who are least likely to be using VDC technology, are the group most likely to start using it if a process or efficiency benefit were

seen from doing so. Likewise, nearly half the respondents from the groups who would implement such programs on their behalf say they are looking to owners to make the first request. We see this as a classic case of a business opportunity where a proven solution is seeking a pool of potential beneficiaries who have only to be shown its existence and importance in order to be convinced.

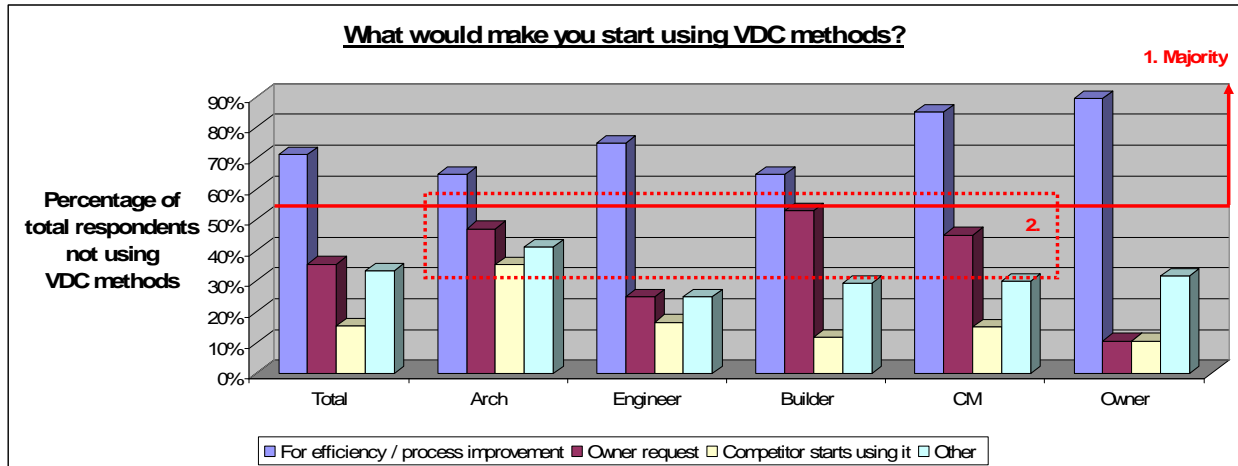


Figure 8: Improved process and efficiency and owner request are leading reasons for use of VDC. 1. The majority of all non-users, and nearly 90% of owners, say they would use VDC methods to improve process and efficiency. 2. The majority or near-majority of all architects, builders and construction managers say they would use the technology if owners requested it. The data suggest a logical disconnect given that most users see the value that non-users say they would begin using VDC to create. This disconnect represents a potential business opportunity given that most professional service providers would use the technology if their clients requested it and those clients indicate overwhelmingly that they would use the technology to gain the exact benefits experience shows they would get.

We suggest that a latent demand exists for VDC technology that will become more apparent as time goes by and VDC-capable companies become more sophisticated. Owners and other parties who are current non-users of VDC overwhelmingly say they would use the technology to get better results, and data from VDC-users tend to indicate that these results are being attained. Where providers demonstrate the potential value to owners it will ever more frequently be accepted and those who can provide the service early on will benefit most.

Conclusion

The VDC Use Survey data indicate that VDC is being used significantly and is growing. As this growth proceeds and advanced users become more proficient they are more likely to perceive value and thus make organizational and strategic shifts in their operations. This process may already be driving a shift in the nature of impediments to progress. Where in the past difficulties were encountered more with technical issues such as hardware and software or contractual terms between the parties involved in a project, they are now more aligned with finding qualified people and providing training. This shift represents emerging acceptance by organizations that their own professional development and retention practices are fundamental bottlenecks, not the practices of their business clients and partners. The bottlenecks become more difficult to overcome as time goes on and will cause early adopters, those who establish capability and procedures before a personnel crunch, to operate at both a value and cost advantage over those

who try to come on board later. Non-users who may find themselves in this position are still very numerous, however, our data show that they would overwhelmingly adopt the technology if they felt it would help them create process improvements or increase their efficiency. These are exactly the results that advanced users report and indicate an important business opportunity for those who can provide VDC-based services early on. Owners, in particular, represent a client base largely unaware of the potential benefits that VDC provides.