

ENGAGING THE SENSES FOR PERFORMANCE  
A Framework for Researching Sensory Design Elements  
and Their Effects on Productivity in the Workplace

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ENGAGING THE SENSES FOR PERFORMANCE

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## SUMMARY

In conjunction with an investigation of past research, this study provides a measured account of changes in worker productivity resulting from changes including the application of new sensory design elements in a typical office environment. A case study is presented that follows a collection agency's relocation of offices in order to provide confirmation of a relationship between employee productivity and changes in the office environment. As noted, these changes included a general application of color in the new environment as compared to the neutral palette of the previous site.

Data representing the total dollar amounts collected by individual employees is compiled for the two months directly prior (November and December 2004) and immediately following (January and February 2005) the company's relocation of offices to a space integrating various colors (red, blue, green, and gold) into the work environment. Information relating to a total of 10 client groups and the average volume per employee are compared for each of the months.

In order to substantiate the findings, the monthly numbers are also compared to the same periods (November/December 2003 and January/February 2004) in the previous year.

## INTRODUCTION

Decisions regarding Real Estate are some of a company's biggest challenges. Whether purchasing or renting, personalizing a space to meet specific needs of a company can be an expensive task. Space Planners ensure that the layout is functional. Contractors are charged with building the space to applicable codes and standards. Much attention is given to reducing costs of construction either through value engineering materials and processes or designing for reduced operating and maintenance expenses. But it is the occupants of the suite that truly determine if the space is a success.

Recent panel discussions conducted by Building Owners and Managers Association (BOMA) International identified how a building can affect occupant satisfaction as it relates to attracting and retaining tenants. While the panel focused on systems technology, building amenities, and security concerns, the study outlined that the environment created within a building has a direct effect on that building's profitability.<sup>1</sup> This leads to the consideration that a better environment could therefore not only benefit building owners and managers but also their tenants.

Corporate executives often feel a responsibility to provide for the well being of their employees. This is not only out of a duty to create a safe place to work but also a desire to keep workers productive which could translate to the company's

bottom line.<sup>2</sup> However, an employee's relationship with their work environment is based on more than just "is the space functional?" or "is it well-built?" While it should not be denied that these are important factors, human perception gauges on a much more subtle level.

As humans, we are always collecting information through our various senses. Due to perception and emotional association, the information gathered through our senses can have both a physical and psychological effect.<sup>3</sup> Sensory design elements are those certain features of an environment such as lighting, sounds, smells, colors, and textures that are absorbed by the senses and directly create a human response.

#### The Office Productivity Link

In a 2004 interview for The Gallup Management Journal, psychology professor Dr Philip Stone of Harvard University expressed the need for organizations to 're-think' what they hope to accomplish with their office space. "People's psychological response to the environment is very important...companies *must* give people an identity at and with the place they work" he explains.<sup>4</sup>

Stephanie Bartos of the Carnegie Mellon School of Architecture agrees and calls for research that assigns value to the effects on productivity in the workplace.<sup>5</sup>

In conjunction with an investigation of past research, this study will attempt to provide a measured account of changes in worker productivity resulting from the application of a new sensory design element in a typical office environment.

## SENSORY DESIGN ELEMENTS

The desire to achieve more profitable worker productivity levels is universal among employers. Hiring the adequate skill levels, having the necessary equipment available, and implementing appropriate business processes are all factors that greatly affect the productivity of a workforce. However, in order to determine if sensory design elements will affect worker productivity, it is important to understand how a person's mood and performance are related to the sensory stimuli presented in an office environment.

The discipline of environmental psychology examines the complex relationship of human behavior to their surroundings. More precisely, it attempts to define how the aesthetics of a particular setting impact the mental and physical well being of its occupants. Sensory features such as lighting, sound, odor, color, and texture, play an integral part in that respect. Gary Evans, professor of Human-Environment Relations at Cornell University, expresses that the need to understand the effect of environmental stimuli was born out of a desire to create spaces that 'work better' for employees. Interestingly, he notes that progress in the field has come from the research in scientific fields rather than the study of facility design.<sup>6</sup> In fact, it is in the arena of science that the majority of information relating to sensory design elements has been found.

## Texture

Information available on the effects of textures can be attributed to research in the treatment of sensory difficulties of patients suffering from Autism and Alzheimer's disease. It has been found that with Alzheimer's patients, variations in textures can create a comforting sensation.<sup>7</sup>

However, studies indicate that many behavioral problems related to Autism are the result of difficulties with 'sensory integration'. That is, the interpretation of sensory stimuli. Therapeutic treatments for such patients concentrate on desensitization in order to avoid negative effects of over-stimulation from varying textures.<sup>8</sup> In general, the use of fabrics in healthcare, hospitality, and office environments can be equated to a desire to introduce a 'comfort of home' feeling into these settings. In addition, the application of textiles in these and in office environments tend to focus on visual interest of pattern rather than tactile stimulation.<sup>9</sup>

## Sound

Audible stimuli can be a considerable factor in a person's pleasure with or dislike of an environment.<sup>10</sup> As the term 'acoustical pollution' suggests, noise, whether the sounds are natural or originating from man-made sources, is considered a negative influence in our lives.<sup>11</sup> Unwanted or disturbing sounds are not only found to be distracting but can also have a significant affect on one's mood and productivity. While judgment has been proven to be more impaired with increased noise levels,<sup>12</sup> research suggests that with increased periods of

exposure, the effects on performance will be reduced.<sup>13</sup> It has also been shown that the subjects' current mood and sensitivity to noise significantly contribute to their level of disturbance.<sup>14</sup>

Research in the treatment of Attention Deficit and sleeping disorders touts the benefit of adding noise to the background in order to mask other sounds that might be disturbing. Such 'white noise' in theory, reduces distractions thereby allowing better concentration and potentially increasing productivity.<sup>15</sup> Others, however, find that the introduction of constant sound serves only to dull auditory function. Their findings suggest that a more structured format, such as classical music, stimulates neurological function increasing attention and boosting intelligence.<sup>16</sup> However, the benefits can diminish over time and periodic variation in tempo is needed to keep increasing activity and productivity levels.<sup>17</sup>

### Smell

Attention to the sense of smell typically revolves around the need to mask problems rather than determining the effects of the stimulus itself. However, continuing research in the field of aromatherapy is discovering the benefits of certain fragrances in reducing stress and improving productivity.

A recent study found that lavender both improved mood and increased relaxation allowing subjects to complete mathematical calculations with more speed.<sup>18</sup> While accuracy was not measured in that case, an alternate study found reading comprehension levels increased or decreased in relation to the

introduction of either pleasant or unpleasant smells to the testing environment.<sup>19</sup> In the majority of cases, however, the affects of odor in stimulating physical and/or psychological reactions were either too small or too short lived to be of significant importance.<sup>20</sup>

### Lighting

While critics may question the quality of information available,<sup>21</sup> it can not be denied that the effects of indoor lighting on productivity has been extensively explored. A symposium held during the 101<sup>st</sup> Annual Convention of the American Psychological Association expressed the effects of lighting on performance by outlining a direct relationship between the spectral distribution (warm/cool) and luminance (brightness) characteristics that the lighting presents.<sup>22</sup>

Research has shown that the eye responds strongest to the cool range of the visible spectrum resulting in better visual performance. In fact, in this spectral range, it is possible to maintain given levels of performance with lower levels of luminance.<sup>23</sup> A follow up study confirmed these findings but expressed that illumination variance between task and background (i.e. contrast) had a greater effect on performance than did the spectral content of the light.<sup>24</sup> While these studies find lighting to directly affect visual acuity, it does not appear to relate to physical coordination.<sup>25</sup>

Emotional mood and memory performance, however, have proved to be affected by lighting. In measuring mood response to different brightness levels, research has found lower luminance improved interpersonal relations of subjects when working on collaborative tasks even at warm spectral distributions.<sup>26</sup> Other influences appear to also play a part, as the emotional and cognitive responses are not consistent over the variables of subject age or sex.<sup>27</sup>

### Color

In exploration of how environments impact the physical and mental well being of office occupants, we now turn to the sensory design element of color. As indicated by the volumes of design and home décor shows appearing on television, there is an increased public desire to understand how the colors found in our environment make us feel. In fact, most data specific to worker productivity was found to be associated with this topic. In studying color, it is important to consider not only the visual impact created by the use of color, but also the influence colors will have on peoples' mood and productivity when in that environment.

While it has been found that a person's mood will influence preference for certain colors,<sup>28</sup> studies exploring the impact of color on mood and emotional response have had varying results. Research comparing red (warm), blue (cool), and white (neutral) surroundings found that the different environments have no effect on the test subjects emotional state or level of arousal.<sup>29</sup> Other research finds warm colors to illicit active responses and those in cool shades to be more

relaxed.<sup>30</sup> In either case, it is important to note, that neither study investigated the impact that mood would have on performance.

An investigation of study environments concurred with previous findings that in comparison to red environments, blue toned rooms improved the mood of its occupants. However, the results were bittersweet as the improvement in emotional state corresponded with increased errors in the performance of reading tasks. The study investigated further tasks and found performance in mathematical problem solving not affected by the color of the room. However, an alternate study found reading comprehension in red environments worse when compared to blue.<sup>31</sup>

The contradictory findings may be explained by additional research that related variances in performance to the type of task being performed. High-demand tasks fared better in blue spaces while performance on low-demand tasks was better when in red spaces.<sup>32</sup> Less clerical errors have been found to occur in red environments while white (i.e. neutral) environments appear to produce the most proofreading errors when compared to either red or blue spaces.<sup>33</sup> Interestingly, the negative effects of all-white environments appear to dissipate over time.<sup>34</sup>

While the research presented thus far has focused on cognitive performance and mood, physical aptitude has also been studied. Not only have various colors presented in an environment been linked to different levels of eye-fatigue,<sup>35</sup> but physical motor skills may also be affected. In a detailed study of

grip strength, physical performance was found to increase with colorful visual stimulation. The effects were larger with red stimulation when compared to other colors.<sup>36</sup>

A study of the National Football and Hockey Leagues found players on teams with black uniforms incurring more penalties than those wearing other colors. The obvious increase in negative behavior was not directly attributed to a physical response to the color but rather to perceptions (both social and personal) of the performance when that color was introduced.<sup>37</sup> It is therefore important to consider the impact of one's perception of performance with regard to varying color in environments.

In the study comparing reading comprehension and mathematical tasks, data revealed that there was no correlation with either the subject's motivation or satisfaction with their performance with various environmental colors present.<sup>35</sup> In fact between high and low demand tasks, the level of satisfaction appears to be more affected by the type of task being performed rather than the environmental features.<sup>39</sup>

Perception of performance does not always relate to actual performance levels. While subjects in one study stated a preference to work in a beige or white office (under the perception that neutral colors are most conducive to productivity), their performance scores in those environments were lower than in other color scenarios.<sup>40</sup>

Other variables may also contribute to the relationship of color to productivity. As expressed previously, contrast can be an important factor to consider with regard to lighting.<sup>41</sup> Likewise, research shows that it is not necessarily the color itself but rather variations in the saturation and brightness of colors in the environment that are important.<sup>42</sup> In fact, females have been found to respond negatively to low levels of color saturation while males exhibit the same response to highly saturated environments.<sup>43</sup> Other studies have found test scores in various color environments to also be affected by the subject's sex.<sup>44</sup>

If nothing else, previous research expresses the complexity of the possible relationship between environmental color and productivity. Although studies continue to try and identify an answer, there does not appear to be a 'single-color' solution that will improve the productivity of all workers.<sup>45</sup> The following case study will therefore not attempt to identify which color is better than another, rather it will provide a measured account of the changes in productivity resulting from the physical change of an office location that includes the addition of a general application of color in the environment as compared to a previously neutral one.

## CASE STUDY

FOCUS Receivables Management was simply growing faster than their space would allow. Almost four years ago, when starting out, the collection agency's handful of employees worked well in the small suite they rented in the Northwest Atlanta real estate market. As their client base representing a diverse range of industries from automotive to telecommunications providers grew, FOCUS leased up neighboring suites as available until the company occupied just over 14,000 total square feet.

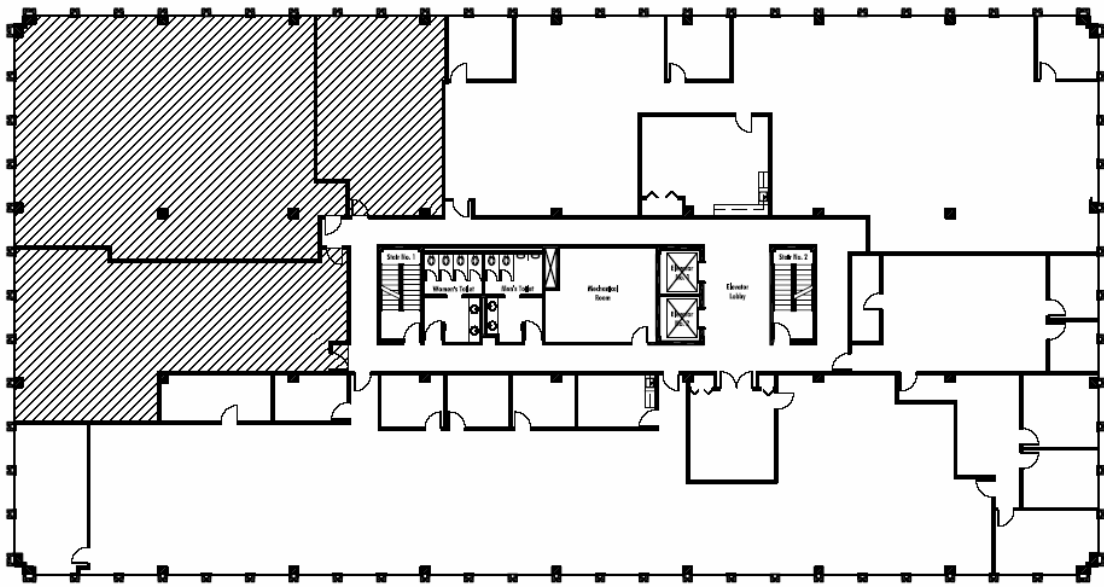


Figure 1: Previous Space Floor Plan

The space was at best disjointed. As the suite had grown piece by piece, the different departments were separated by demising walls making interaction and team building a challenge. Perhaps in an attempt to provide unity among the suites, all walls were painted a solid neutral color. The contrast of the company logo in black provided the only visual interest of the space.



Figure 2: Previous Space (View A)



Figure 3: Previous Space (View B)

After months of planning and construction, FOCUS relocated their Atlanta offices in December 2004 ready to start the new year on a new track. Doubling in size to almost 30,000 square feet, the new suite provides a more spacious layout where needed attention was given to placement of shared services within the suite in order to improve workflow efficiency.

### Sensory Features

New furnishings including rich leathers and deep toned woods were purchased for the executive and marketing areas of the suite. However, in the central location of this study, namely the call center, existing fabric paneled cubicles and desk chairs from the previous office location were used. While reconfigured to fit in the new space, the furnishings in these areas exhibited no change in visual interest of tactile stimulation as a result of the relocation to a new office environment.

Likewise, no changes in auditory or olfactory stimulation were introduced. While the 'office park' location of the new property differed from the more urban mid-rise building that was previously occupied, the building interiors exhibited similar mechanical air distribution, elevators, and other service systems. No increases in ambient noise or environmental odors are detectable within the suite.

Lighting in both locations consisted of evenly distributed 2x4 fixtures. With each fixture housing multiple T-8 fluorescent bulbs, both locations provided uniform spectral distribution and luminance levels.

Of particular interest are the numerous accent walls and columns of various colors that have been interspersed throughout the suite. With a desire to create a rewarding environment for their employees, FOCUS did not wish to mirror the plain neutral colors of their previous space. Rather, in order to ensure the design reflected the corporate image, colors (red, blue, green and gold) were chosen from the company logo to provide a visual interest within the suite.

Accent colors are often used in interior space design as a means of emphasizing certain elements of a space or to identify activity zones. In this case, the strategic placement of patches of color is implemented to define space and identify the location of departments. More than simply contributing to the visual appeal of the office interior, color is used in this instance to complement the changing design of the new workplace and to help create a more effective and energizing environment for employees.

In this case study color provides the dominant sensory change. The design for the new environment did not include significant variation of any of the other sensory design elements (texture, lighting, sound, or smell).



Figure 4: Relocated Office (View A)



Figure 5: Relocated Office (View B)

### Physical Features

Focus Receivables Management prides itself on its advanced technological infrastructure. More than simply allowing customers real-time reports and account updates over the Internet, the company also employs the latest call center phone systems. Through the use of a predictive automated dialer, collection agents no longer lose valuable time dialing telephones and dealing with 'no-answer' responses. The system automatically initiates calls and adjusts the volume of calls to better suit the number of collectors signed into the system.

Employees can therefore focus on conferring with customers and analyzing the debtor's situation in order to determine the reason for the overdue payment. By reviewing credit bureau reports and performing asset searches, the agents can then work with the customer to find the best resolution for all parties involved. The work is performed at networked desktop computers in an open call center environment. Employees obtain as much information as possible from the telephone interviews and entering that information into the computer database to record current account status and assist with future collection efforts.

The team-lead or manager conducts the higher demand tasks to research and analysis of individual accounts. This information is provided to the collectors who perform the clerical tasks of contacting the debtor and entering status updates into the computer database. While the group of collectors assigned to any one client is considered a team, the majority of work is performed individually.

Logistical planning allowed for a seamless relocation of FOCUS' technological infrastructure. The company's dialer system and main database server were the last items to be removed from the former site. With timely reconnection, client web access to their reports was interrupted for less than 30-minutes during the weekend move. Existing desktop computers were re-networked and the call center was up and running for business hours. No new computers, database software, or technological advances were introduced in the new environment.

As noted earlier, the total leased space increased substantially with the office relocation expanding from 14,382sf to a total of 29,141sf on two floors. At first glance it would seem obvious that the doubled amount of workspace would be a major contributing factor to any productivity increases. However, a detailed review suggests otherwise.

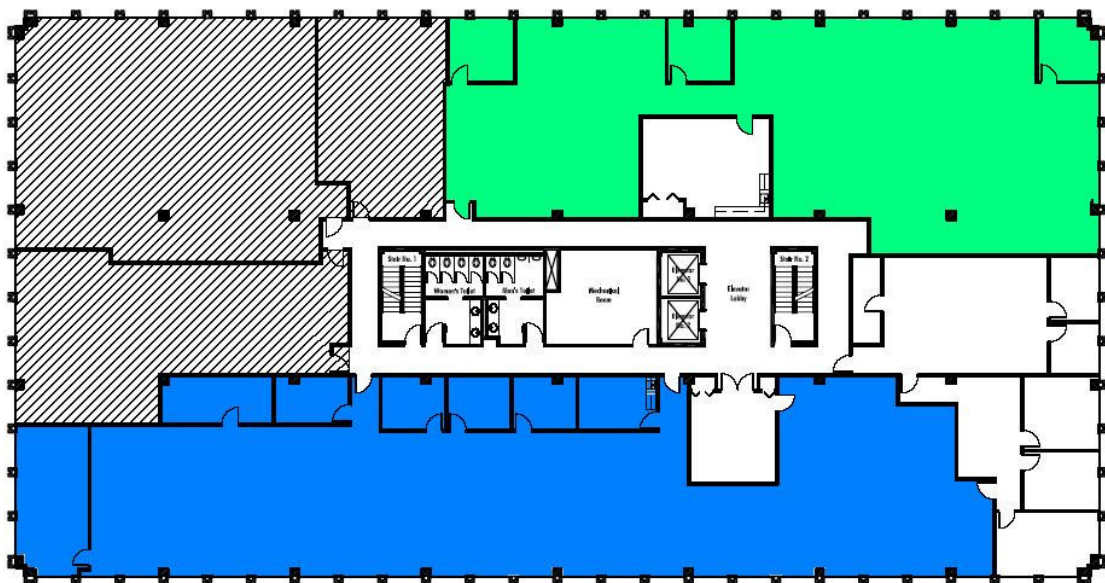


Figure 6: Previous Space – Call Centers

In the previous location, the collections areas were divided into two main open call centers occupying 11,284sf of the total leased amount. The remaining space consisted of reception, break room, and executive offices.

Relocating to multiple floors, the new layout placed reception and the executive offices on the main floor with the call centers and break room on the upper floor. Both the break room and reception were of consistent size in both locations. In contrast, the executive offices grew substantially from a previous 2,108sf to over 12,000sf. This included not only a larger IT area to allow for future growth but also a space for the cash processing function that was previously outsourced.

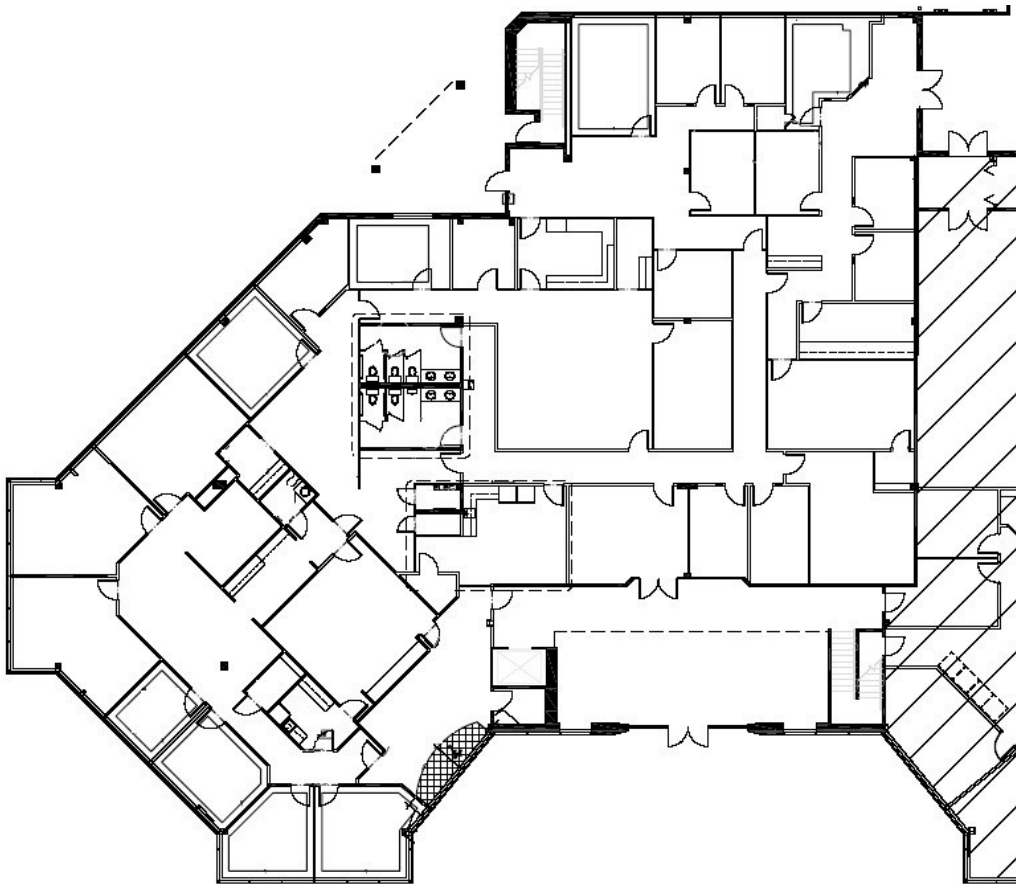


Figure 7: Relocated Office Plan – 1<sup>st</sup> Floor

Interestingly, the 11,461sf allotted to the new call centers only constituted an approximate 1% increase in space. The average number of call center personnel only increased from 136 to 137 workers. The average square footage per call center employee therefore remained constant even though the suites square footage significantly increased.

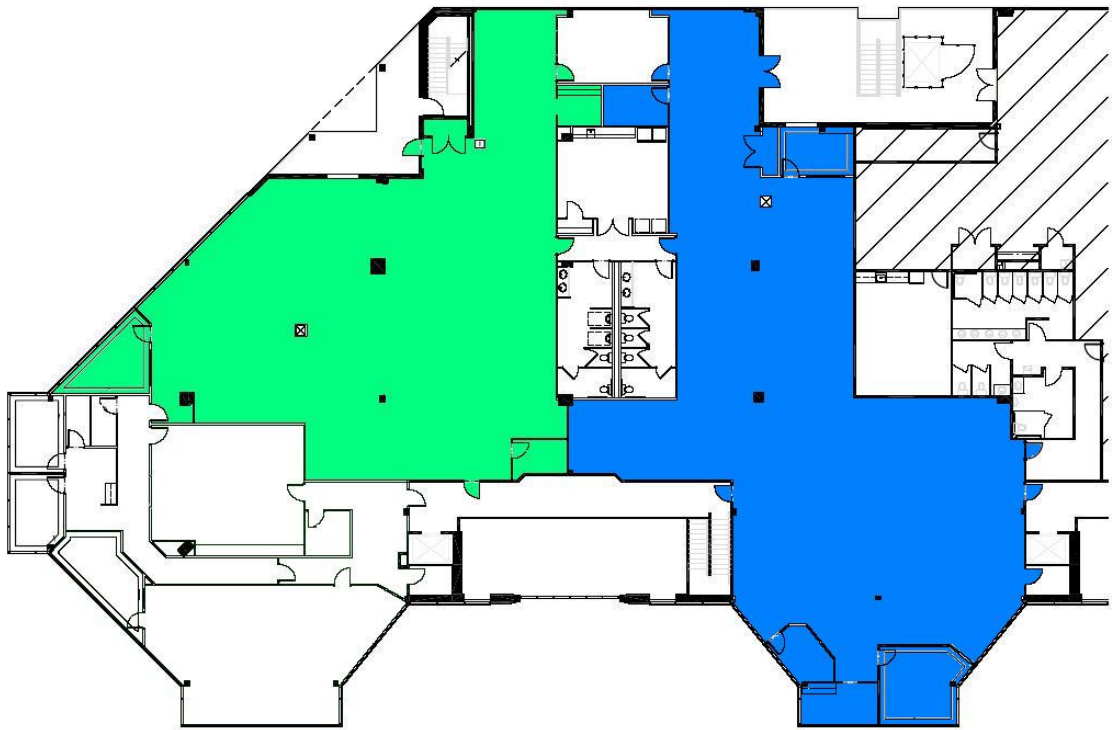


Figure 8: Relocated Office Plan – 2<sup>nd</sup> Floor

## DATA COLLECTION AND ANALYSIS

This study will not only attempt to confirm a relationship between employee productivity and the application of the sensory design element of color into an office environment but also provide a measured account of any changes found. How to measure productivity, however, is a well-debated subject.

In the most straightforward terms, productivity is the ratio between the inputs of an activity to its resulting output. While a rather simple concept, it is sometimes difficult to measure. The US Bureau of Labor Statistics calculates annual indices outlining the productivity numbers for many industries in the business sector. In these cases, however, there is often a defined quantity of product to count as the output. However, the calculation becomes more difficult when, as in most industries, the product is not as clearly defined.<sup>46</sup>

There are two main methods used in determining a measure for productivity. The choice between them often depends on the purpose for the measurement and the quality of data available. Single-Factor measures relate produced output to one variable while Multi-Factor measures take into consideration a combination of several inputs.<sup>47</sup> Such Multi-Factor measures assist in providing insight for comparison of efficiency and competitiveness in relation to other industries or the entire economy. While the Single-Factor method is limited in that respect, it

effectively creates a benchmark to which a company can measure its own growth rate.

Determining the quantity or measure of the output can also significantly affect the productivity measurement. For the purposes of this research, FOCUS Receivables Management provided Daily Performance Report summaries (DPRs) outlining the dollar amounts collected by individual employees. This performance record provides a direct observation of the output volume and will therefore serve as the measure of worker productivity levels in this study. Monthly totals are compiled for each of the two-month periods directly prior (November and December 2004) and immediately following (January and February 2005) the relocation of offices to a space integrating various colors into the work environment.

For the DPRs, employees are divided into groups that are then assigned to a particular client. The groups are of varying size based on the case volume of particular client for the given month. The collection volume for particular clients may be affected not only by the number of cases presented but also the type of credit granted (charge account, auto loan, etc.). Information relating to each of FOCUS' ten Atlanta client groups was used for this study.

Employee totals are combined to determine a client total, which will be compared over the four-month period. While this calculation provides a general sense of team productivity, it does not express any measure of labor input.



Certain anomalies become apparent in the summation of client totals for each of the four months.

Table 2: Monthly Summary by Client

CLIENT#	NOV	DEC	JAN	FEB
1	\$140,479	\$109,012	\$130,001	\$159,282
2	\$27,134	\$37,126	\$0	\$0
3	\$40,113	\$46,877	\$103,850	\$107,420
4	\$57,419	\$54,382	\$68,343	\$107,338
5	\$109,363	\$75,863	\$97,937	\$114,839
6	\$57,916	\$34,424	\$64,525	\$0
7	\$254,590	\$292,050	\$278,325	\$416,899
8	\$100,262	\$57,982	\$105,694	\$118,376
9	\$104,796	\$100,493	\$120,934	\$138,842
10	\$57,628	\$51,957	\$93,652	\$198,751
Total	\$949,700	\$860,166	\$1,063,261	\$1,361,747

Client Group #2: The data shows no balances collected for client #2 for two months during the study period. This represents the fact that collection efforts for this client were transferred to an office location in an alternate city effective January 2005. Any measured variance in productivity following that point could not therefore be attributed to the subject office suite. As such this client's data will be removed from general comparisons in this study.

Client Group #6: The information provided indicates no balances collected for client #6 in the final month of the study. It has been confirmed that this client selected an alternate collection services provider during the period of comparison. As such, this client's data will also be removed from the general comparisons of this study.

Client comparisons

Preliminary analysis finds a measurable increase in the total client collection volume in the months following the office relocation. The total client collection volume, which started at \$949,700 in November 2004, climbed to \$1,361,747 in February 2005. This indicates a 43% overall increase in amounts collected.

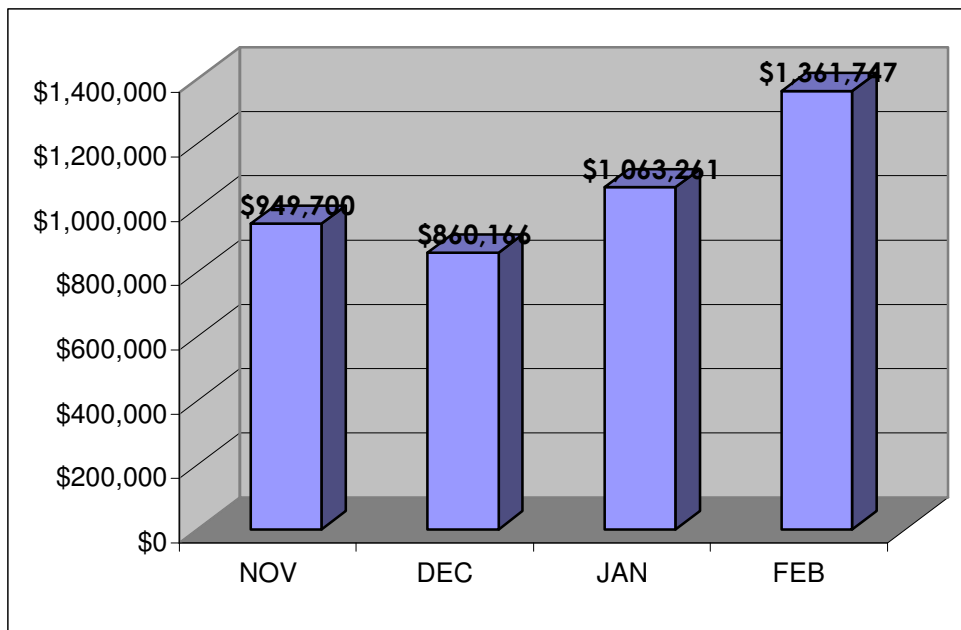


Figure 9: Total Client Collection Volume by Month

With the exception of client #3 and client #7, all groups experienced a decrease in collection for the month of December. The 15% and 17% increases in collections for those clients are a far cry from the average 19% decline of the other groups. The largest drop was 42% (client #8).

Table 3: Client Percentage Change by Month

CLIENT#	NOV-DEC	DEC-JAN	JAN-FEB	NOV-FEB
1	-22%	19%	23%	13%
3	17%	122%	3%	168%
4	-5%	26%	57%	87%
5	-31%	29%	17%	5%
7	15%	-5%	50%	64%
8	-42%	82%	12%	18%
9	-4%	20%	15%	32%
10	-10%	80%	112%	245%

Client #7 declined in January while the other client groups experienced a noticeable increase in collections that month. Totals for client groups #1, #4, #5, and #9 improved an average of 24% while client groups #8 and #10 grew over 3 times that amount. The largest increase was client group #3 whose January collections were 133% higher than the previous month.

While there would be no reason to suspect an equally large increase in the following month, the data outlines that client group #3 was able to maintain the increased volume in February. The average gain for clients #1, #5, #8, and #9 was 14% and clients #4 and #7 each increased 50% or better. Client group #10 more than doubled its collections rising 112% over the month of January.

Recognizing the variations from month to month, it is important to note the all client groups improved their overall collection volume over the period of study. While client group #5 gained a mere 5% from November to February, client group #3 more than doubled (168%) its collections and client group #10 tripled (245%) its total volume during this time.

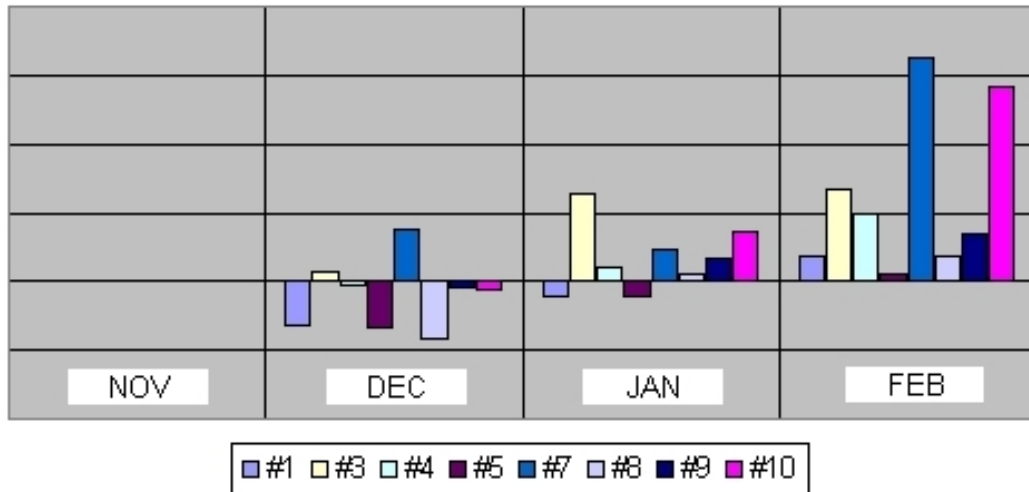


Figure 10: Client Growth by Month

As expressed earlier, the number of employees collecting for a particular client group may vary from month to month based on case volume. It is therefore necessary to determine an average volume per employee for comparison in this study. The average volume per employee is calculated by dividing each of the monthly client totals by the number of group members for the given month.

In some cases, however, the DPRs only provided a client volume rather than employee totals. It was therefore impossible to determine the number of employees on certain collection teams and the average volume per employee could not be calculated for that month. As a result, while data collected relating to clients #7, #8, #9 and #10 remain in the total volume comparisons, not all client groups can be used in the employee average volume comparisons for each month.

Table 4: Monthly Employee Average

CLIENT#	NOV	DEC	JAN	FEB
1	\$7,024	\$5,451	\$5,000	\$5,492
3	\$4,457	\$5,209	\$6,491	\$7,161
4	\$3,378	\$3,625	\$4,271	\$5,111
5	\$13,670	\$10,838	\$13,991	\$14,355
7	#DIV/0!	\$6,954	\$7,952	\$10,422
8	#DIV/0!	\$3,624	\$6,606	#DIV/0!
9	#DIV/0!	\$8,374	\$9,303	\$9,917
10	#DIV/0!	#DIV/0!	\$4,929	\$5,521
Total	#DIV/0!	#DIV/0!	\$7,318	#DIV/0!

Employee Comparisons

As outlined earlier, even without declines typical to other groups in December, client group #3 saw a significant increase in total collection volume in January, which they were able to maintain through February. In comparison, the monthly changes in volume per employee were not as dramatic.

Table 5: Employee Percentage Change by Month

CLIENT#	NOV-DEC	DEC-JAN	JAN-FEB	NOV-FEB
1	-22%	-8%	10%	-22%
3	17%	25%	10%	61%
4	7%	18%	20%	51%
5	-21%	29%	3%	5%

The 17% growth in total client group collections from November to December was mirrored in the average volume per employee for client #3. This too was the case for the 22% decline of client group #1 during that period. While group volume for client #5 declined 31%, the average volume per employee in

December was only 21% lower than the previous month. A similar positive variance is discovered in comparing data for client #4. Although the group total shows a decline of 5%, the average volume per employee indicates a 7% improvement.

With the exception of client #1 which declined an additional 8%, the average volume per employee on the other client groups increased in the month of January. Client #5 recovered from its December losses to be a scant 2% over its November employee average. Clients #3 and #4 on the other hand added an average of \$1500 to each employee's collection volume raising the former 18% and the later 25%.

Each group saw the employee average increase in February. Clients #1 and #3 rose 10% each while client #5 only improved 3% from the previous month. As expected with an impressive client group gain of 57%, client #4 saw the largest average employee increase (20%) in the month of February.

In November and December, client group #3 collected an average of \$43,495 per month, which improved to a monthly average of \$105,635 in January and February. Rather than the 143% increase in average team volume, the data indicates an average increase of only 17% per month in volume per employee over the study period.

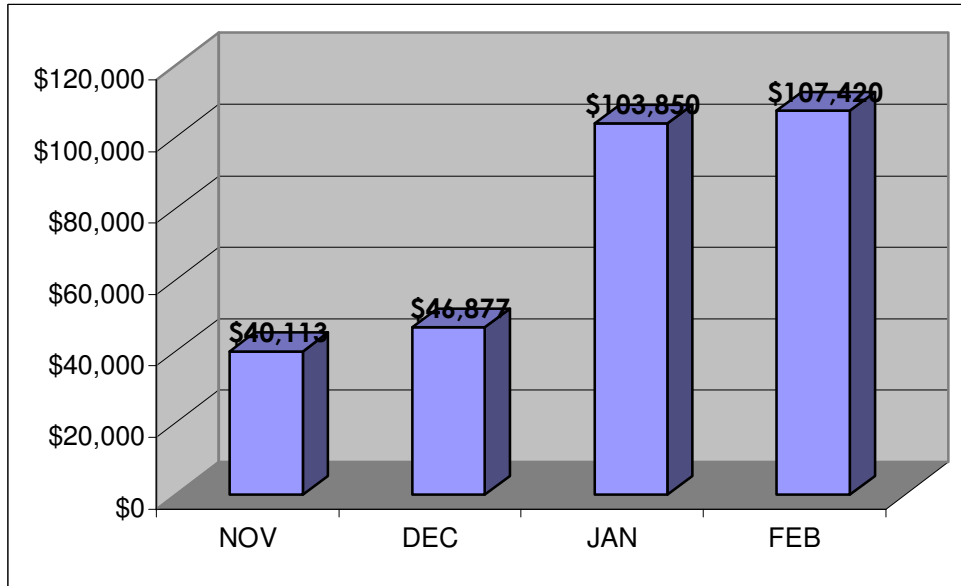


Figure 11: Client #3 Monthly Collection Volume

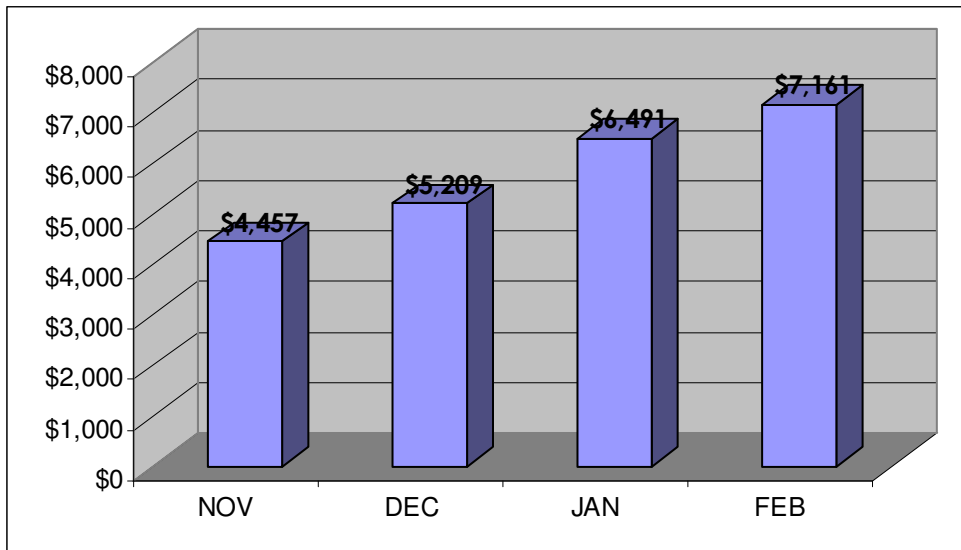


Figure 12: Client #3 Average Monthly Volume per Employee

This steady increase is indicative of what was found with the majority of other client groups. For example, client #4 saw an average increase in monthly volume per employee of 15% while client #5 increased an average of 16% per month. The exception to this finding was client #1 where per employee volume remained within a 1% variance of the reduced December average.

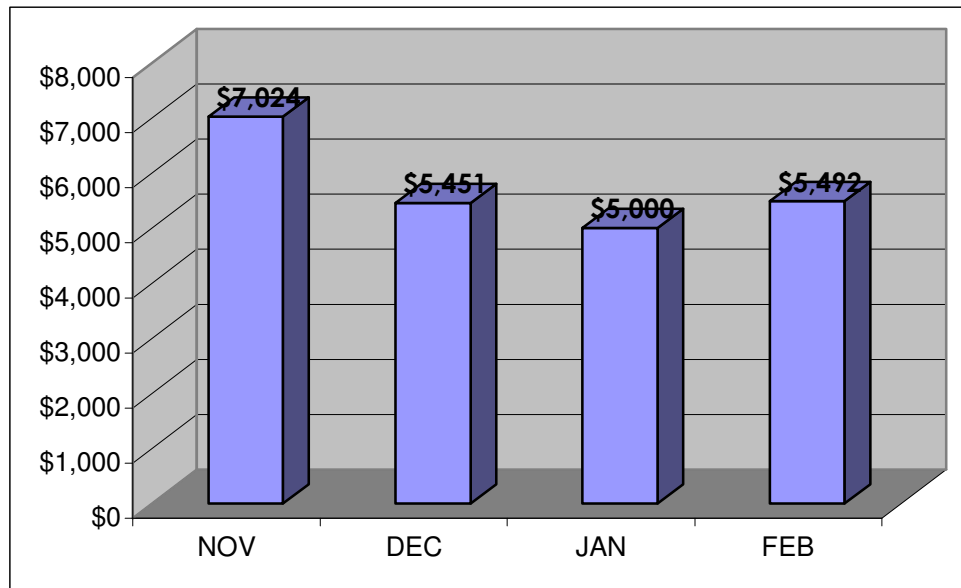


Figure 13: Client #1 Average Monthly Volume per Employee

With respect to the status of the general economy, it should be expressed that growth was experienced during this timeframe as well. However, utilizing the Dow Jones Industrial Average, which indicated only 3.31% increase over the study period as a measure of that growth, the increases in overall client collections and average volume per employee are all that more impressive.

Prior Year Comparison

The findings thus far support that the new environment fosters improved worker productivity. As has been shown, overall collections by client group increased significantly in the months following the office relocation. While the employee comparisons showed a more stable rate, the average dollar amount collected per capita also increased in the new environment.

However, in order to validate that the improved productivity could be attributed to the relocation of offices, it must be determined if there is a standard growth rate independent of the new environment. An auxiliary analysis comparing the client group collections as well as the average volume per employee for the same period in the prior year will therefore be conducted.

Table 6: Prior Year Monthly Summary by Client

CLIENT#	NOV	DEC	JAN	FEB
1	\$86,659	\$91,057	\$111,317	\$91,287
2	\$96,047	\$85,887	\$110,594	\$124,092
3	\$0	\$0	\$0	\$0
4	\$40,933	\$201,664	\$65,836	\$99,298
5	\$152,341	\$176,408	\$147,986	\$143,150
6	\$73,879	\$94,208	\$111,027	\$126,963
7	\$227,386	\$250,548	\$342,162	\$393,991
8	\$0	\$0	\$0	\$0
9	\$45,449	\$44,392	\$50,098	\$57,764
10	\$85,309	\$89,933	\$99,566	\$94,742

Summation of the four-month period in the prior year finds no data available for client groups #3 and #8 as these companies had not yet been acquired as customers. Data for all of the other groups, however, will be used in the client comparisons. With regard to the employee comparisons, the DPRs only provided group totals for client #10 making it impossible to determine an average volume per employee. Only the remaining clients will therefore be compared.

Table 7: Prior Year Client Percentage Change by Month

CLIENT#	NOV-DEC	DEC-JAN	JAN-FEB	NOV-FEB
1	5%	22%	-18%	5%
2	-11%	29%	12%	29%
4	393%	-67%	51%	143%
5	16%	-16%	-3%	-6%
6	28%	18%	14%	72%
7	10%	37%	15%	73%
9	-2%	13%	15%	27%
10	5%	11%	-5%	11%

Table 8: Prior Year Employee Percentage Change by Month

CLIENT#	NOV-DEC	DEC-JAN	JAN-FEB	NOV-FEB
1	-1%	22%	7%	30%
2	-26%	29%	6%	0%
4	256%	-55%	31%	110%
5	-15%	14%	6%	3%
6	15%	-9%	19%	24%
7	17%	28%	6%	60%
9	-2%	13%	15%	27%

With the exception of client group #2 and #9 which both declined slightly, the prior year data indicates productivity increased from November to December 2003. The average growth among the groups was 13% but client #4 soared to

almost 5 times its previous month's total. The client group data for 2004 indicated a general decline of productivity in December.

Being the month in which the relocation took place, these findings are not surprising. While the physical relocation took place over a weekend in an attempt to minimize disruption to normal business activities, some level of productivity loss was anticipated.

Interestingly, individual employee collections for the month did not necessarily reflect the same declines. Group numbers may have indicated a downward slope in December 2004; however, several client groups saw an increase in per capita collections for that period. Conversely, there was a general increase in total client group numbers for December 2003 but more than half of the client groups saw declines in the average volume per employee.

Previous year data further mirrors the earlier findings with regard to collection volumes. The average total client collection volume for January/February 2005 increased 43% over November/December 2004 volume. The average client collection volume November/December 2003 rose a similar 40% compared to January/February 2004. However, unlike the average 16% increase per month in employee volume found November 2004 to February 2005, the same periods in the previous year saw an average increase of only 9%. While slightly higher, this is inline with the growth of the general economy as once again represented by the Dow Jones Industrial Average which increased 8.1% during this time

## CONCLUSION

The data collected in this case indicates an improvement in worker productivity over the study period.

The average dollar collected per capita increased 16% per month from November/December 2004 to January/February 2005. The client group data for November/December 2004 showed a general decline of productivity in December as compared to the same period in the previous year. This variance is attributed to the physical relocation of offices in December 2004.

Average per capita collections did not necessarily reflect the same rates of growth or decline as indicated by the client group data. For example, employee numbers for December 2004 declined but several client groups saw a per capita increase. Similarly, there were general increases in total client group collections in December 2003 but more than half of the clients saw declines in the average volume per employee that month.

Analysis found a 43% increase in the average total client collection volume in January/February 2005 following the office relocation. The average total client group collection volume of November/December 2003 rose a similar 40% into January/February 2004. However, from November 2003 to February 2004, the volume per employee gained an average of only 9% per month compared to 16% from November 2004 to February 2005.

Therefore, even though the growth rate of client total collection remained stable, the rate at which the per capita productivity increased was greater as a result of the new office environment. By including measures of per capita collections rather than simply overall group dollars and verifying a consistent level of employee turn over, this study eliminates the possibility that the improved productivity was simply the result of increased manpower or employee field experience. We therefore turn to investigate the environmental factors that may have contributed to the measured productivity increase.

### Sensory Features

As outlined previously, the most notable sensory variance between the two offices was the introduction of colorful accent walls and columns throughout the suite. Pulling from the company's logo, deeply saturated red, blue, green and gold were introduced to provide more visual interest than was available in the previously neutral environment. The invigorating tones of the new space create a lively environment that served to energize the call center employees.

While the direct relationship between environmental color and worker productivity is quite complex, in the case study presented, the measured changes in productivity appear to have resulted from the physical relocation of offices to a location that included the addition of colors into the environment. There are additional variable that may have contributed to the positive results.

### Physical Features

The most likely factor contributing to the measured productivity increase is the improved functionality of the new call center layout. The centralized location of both the restroom and break room facilities provides increased convenience that allows workers to return to their desks in a more timely manner. Open access to colleagues as well as managers and group meeting areas helps to foster camaraderie and team morale.

## RECOMMENDATIONS FOR FURTHER STUDY

Worker productivity as has been shown in this particular case study can be affected by the combination of physical and sensory features presented in the office environment. Using only volunteer subjects in sterile testing environments, the previous research presented in this document failed to provide an account of productivity effects in a live office environment. However, as discovered in the case study, it was impossible to isolate the impact on productivity provided by each of the factors that were analyzed and reviewed. The case study noted variances in both the application of color in the office and the functional layout of the suite that resulted in a measured productivity increase. Each factors individual level of impact, however, could not be determined.

Further case study research introducing color into an existing office layout as opposed to an office relocation that included the color variations could help isolate the effects of that single sensory element. Application of similar testing to other industries could determine if the effects would remain consistent over different task types and difficulty levels.

It would be interesting also to investigate the combined effects of several sensory elements simultaneously. For example, would the positive effects of improved lighting be offset by the introduction of unpleasant odors or noises into the environment? Likewise, would two positive influences double the positive effect?

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