Optimal performance with two or more computer screens

Useful tips and a clear overview of the impact on performance and health

Introduction

Offices are increasingly making use of multiple computer screens. An obvious example is the stockbroker who uses information from several sources to make split-second decisions about buying or selling. To make these kinds of decisions, all the available information has to be clearly visible. Another more everyday example is the use of multiple datasheets, where the easiest way to work is to have them side by side. In general, when information from various sources has to be consolidated, multiple monitors almost always increase efficiency.

But while the use of two or more computer screens can improve performance, an important ergonomic concern, however, is that working with multiple monitors results in more neck rotation and discomfort in the neck and shoulder region.

This whitepaper provides an introduction to the impacts on performance and health when working with multiple computer screens. Section 1 summarises the legislation for visual display unit (VDU) work, and section 2 addresses the impacts. What follows is a practical selection guide that provides information about the most convenient way of using multiple computer screens for various work situations and tasks. The whitepaper concludes with information about which setup provides the most ergonomic benefits.

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Standards and legislation

The legal requirements that a workplace has to meet when doing computer work can be found in EU Directive 90/270/EEC which has been the basis for the national legislation drawn up in each EU member state.

According to Regulation 3 of the Health and Safety Regulations, the **screen**[1] and **keyboard**[2] may not be a single unit. In addition, it should be easy to adjust the **angle**[3] and **height**[4] of the screen. This legislation applies in the United Kingdom and in all EU member states.

90°

90°

1

3 4

2

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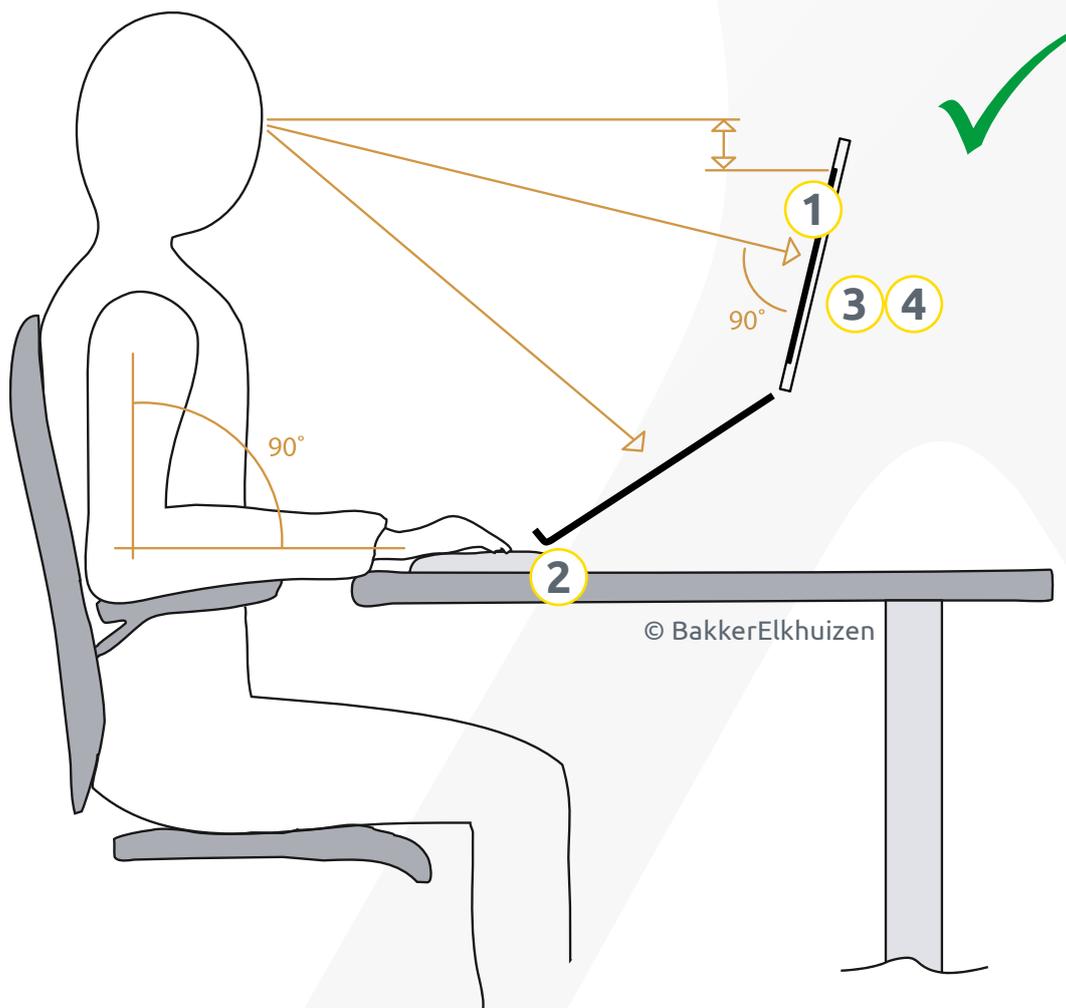
Working safely and productively with multiple computer screens

Legislation stipulates no other requirements for how two or more monitors have to be used. To gain more insight into this, we examined various studies. The research findings show the impacts on health and performance when using two or more monitors.

Impacts on performance

Several studies have found that the use of two or more computer screens can substantially improve performance (University of Utah, 2008; Colvin, et al., 2004; Czerwinski, et al., 2003). The following two studies are good examples.

In the first study, which was conducted by Colvin, participants received five minutes of training before starting to work with multiple computer screens. All participants worked for one hour using a single monitor and then one hour using two or three monitors. Half of the group worked with two monitors and the other half with three monitors. The task consisted of correcting texts in Word, slide texts in PowerPoint and spreadsheets in Excel as based on a document indicating the changes to be made. These are complex but very common tasks involving VDU work. The findings showed a definite improvement in performance: 10% more production in the same period of time and 33% fewer errors (Colvin, et al., 2004).

Multiple computer screens: 10% more production, 33% fewer errors

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The second study, which was conducted by researchers at the University of Utah, was a successor to the study by Colvin's team. This study examined the effect of screen size and the number of monitors on performance measured as the time required to complete a task. In addition to the more commonly used computer screens measuring 18 to 22 inches, this team of researchers also included widescreen monitors, measuring 22, 26 and 30 inches diagonally. These widescreen monitors can effectively display two applications on a single screen, which is similar to working with two screens.
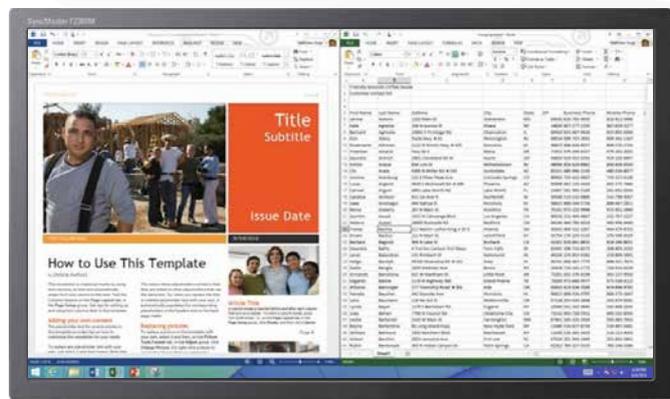

The research findings showed a definite correlation between the size of the monitor and production gain. The larger the monitor, the greater the production gain (Figure 2). The gain was also greater when using two monitors than when using just one that provided the same amount of surface as two. The greatest production gains were shown when using a 26-inch widescreen monitor and when using two 20-inch monitors: an increase of more than 40% in performance as compared to using a single 18-inch computer screen.

Using two 20-inch monitors resulted in the most production gain.

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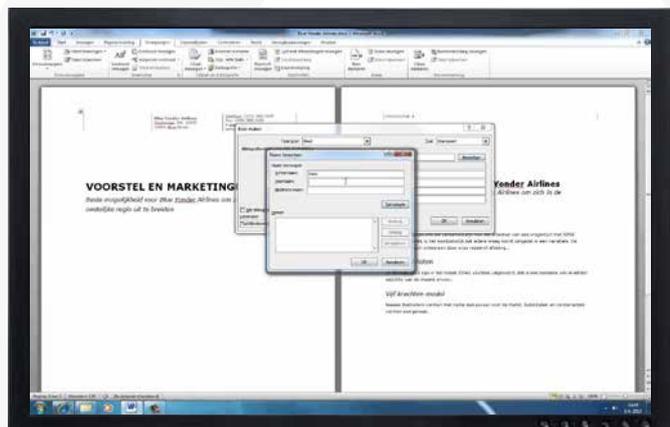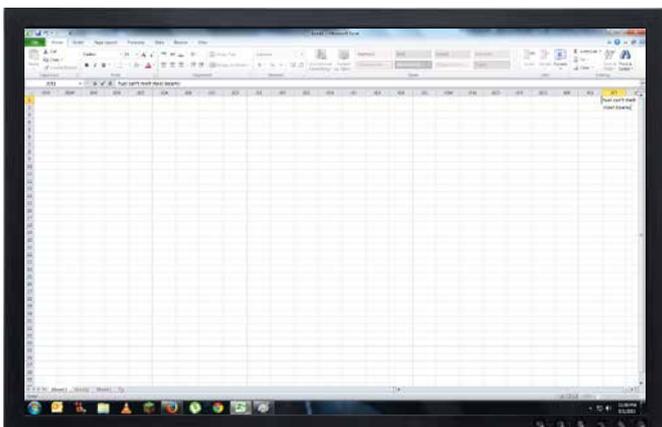
Surprisingly, the use of an even larger (30-inch) widescreen monitor resulted in less production gain than the use of a 26-inch monitor. This indicates that the maximum amount of information we can process on a monitor is limited.

Screen Size and Productivity
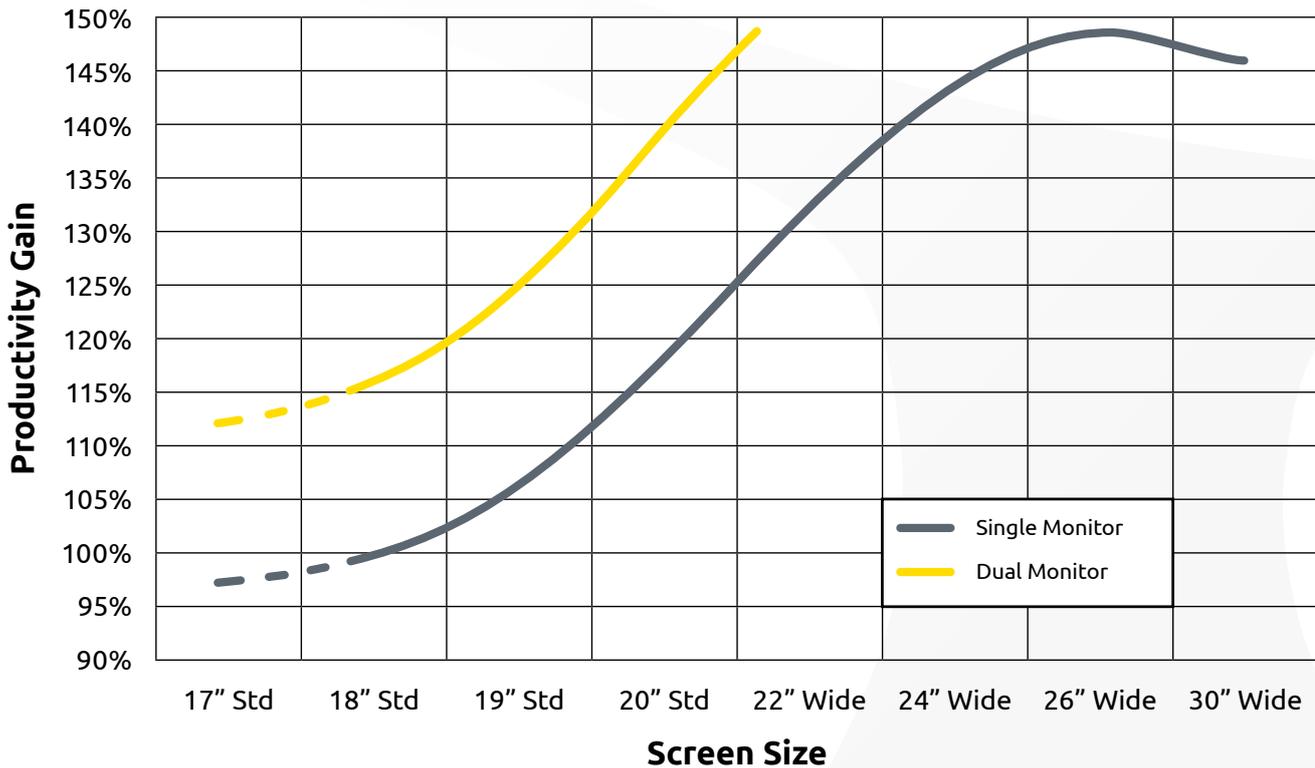
Note: dotted lines indicate estimated productivity gains

Figure 2

Relationship between monitor size and setup (single or dual monitor) and production gain for the task to be completed. Source: University of Utah, 2008.

To summarise: Working with more than one monitor results in a considerable gain in performance and production as compared to using a single monitor. The best performances resulted from using a single 26-inch widescreen monitor (displaying two applications side by side) or a dual-screen setup using two 20-inch monitors.

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Impact on health

With two or more screens, the user's attention has to shift back and forth between them. This setup often means that not only the user's eyes but also his body turns to face one screen and then the other. Working with two screens side by side can thus lead to more frequent neck rotation and muscle strain in the neck and shoulder region (Alabdulmohsen, 2011).

However, using a large enough monitor and the best possible setup of the monitors can largely eliminate this additional muscle strain. This is because, according to research (Sommerich, et al, 2001), a 19-inch or larger screen results in a substantial reduction in neck and shoulder strain. This means that it is a question of creating a balance between the impact on health and a gain in performance.

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Selection guide: How and when to use two computer screens

When does it pay to use two monitors instead of one? Research by Colvin, et al. indicates that, if a user spends more than 20% of his time on tasks involving consolidating information from more than one source, the improved performance definitely makes the investment costs worthwhile (Colvin, et al., 2004). Considering the fact that monitors have become much less expensive than they were when this research was carried out, today's break-even point would be even less than 20%
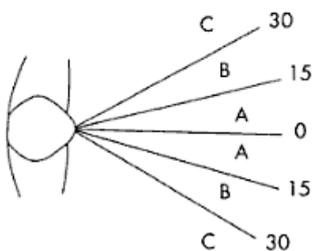
So, if two or more monitors are required, what is the optimal monitor setup? Answering this question involves considering two important factors: 1) the viewing distance, and 2) the position of the monitors from each other and the user.

The viewing distance

The optimal viewing distance partly depends on the quality of the image (contrast, resolution, brightness, etc.) and on the user's visual acuity. However, the greatest factors in determining the optimal viewing distance are the horizontal viewing angle and the size of the characters (character height) on the screen. This also means that there is a direct correlation between the horizontal viewing distance and the size of the computer screens.

A relatively large viewing distance results in less eye strain, because the eyes do not need to accommodate as much. Moving the screen further from the viewer, however, also means that the characters on the screen will have to be enlarged proportionally. The disadvantage of doing this is that less information fits on the screen which results in more scrolling.

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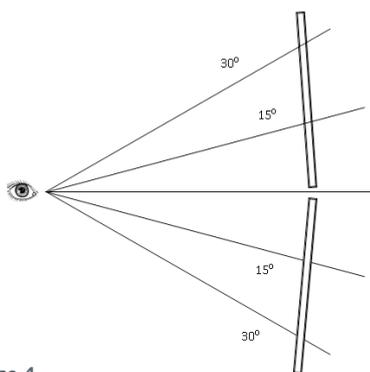*An acceptable horizontal viewing angle lies between 0 and 30°.*

Horizontal viewing angle and viewing distance when using two screens

In the case of two large side by side computer screens, the character height is not necessarily larger than in the case of small computer screens. The screens, therefore, need not be automatically placed further from the eye.

There is another problem, however, the horizontal viewing angle: How wide is the user's field of vision before he has to turn his head and put additional strain on his neck and shoulder muscles? This is why people would rather not sit in the front row in the cinema. Farther back in the theatre, the whole screen is within their horizontal viewing angle.

According to NEN 894-2, the optimal viewing angle lies between 0 and 15° and 0 and -15° (area A). The acceptable viewing angle lies between 0 and 30° and 0 and -30° (area B). Area C is not easily visible anymore. As a result, users will have to turn their head to get a good view of it (see Figure 3).

Figure 3

Horizontal viewing angle in degrees. Areas A and B are easily visible but not area C.

When 24-inch screens are used, part of the screen is soon outside the range of 0-30°. The picture below shows a situation in which two 24-inch computer screens are placed at a viewing distance of 80 cm. Part of both screens is beyond the recommended horizontal viewing angle of 30°. By using two 20-inch computer screens, the width of each screen is reduced by around 10 cm, so the screens are then within the recommended horizontal viewing angle (see Figure 4).

Figure 4

Two 24-inch computer screens positioned at a viewing distance of 80 cm.

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In order to work ergonomically with two 22 or 24-inch computer screens, a larger viewing distance of 70 or 80 cm is needed (see Table 1). A standard desk, however, has a worktop depth of 80 cm, and the foot of a computer screen takes up another 20 to 25 cm. A monitor arm can provide a solution by increasing the viewing distance to the edge of the desk. Buying a deeper desk is a more expensive alternative.

Monitor setup	2 x 17-inch monitors	2 x 19-inch monitors	2 x 20-inch monitors	2 x 22-inch monitors	2 x 24-inch monitors
Recommended minimum viewing distance in cm	60	65	70	82	89

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The ideal position for the computer screens

The position of the computer screens is thus a major factor in providing the user with an ergonomically responsible situation. After all, this contributes to determining the horizontal viewing angle and the viewing distance. In practice, you often see the following two setups, placing both monitors on a monitor arm makes it easy to switch between these two setups.

Computer screens side by side
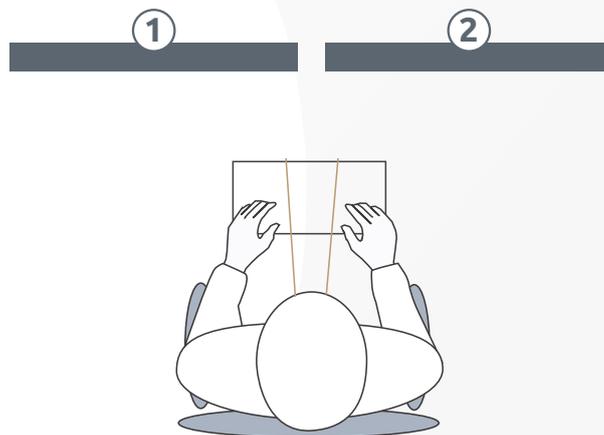
This setup is recommended when the user spends more than a third of his time on tasks involving the processing of data from more than one source. When using this setup, it is convenient to use a small angle (about 15°) in order to reduce the horizontal viewing angle.

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A main screen directly in front of the
user and an additional screen to the
right or left of it (at an angle of 15°)
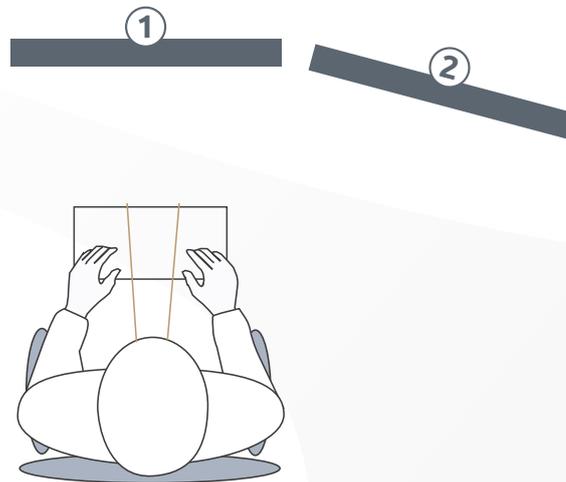
This setup is recommended when the user spends the
majority of his time on conducting tasks requiring a single
monitor. The risk of potential neck and shoulder strain is then
eliminated by adjusting the viewing distance correctly. The
recommended monitor size is 19 inches or larger in order
to minimise neck rotation and optimise performance.

**Click here for more examples
of monitor arm solutions.**

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Conclusion

Working with more than one computer screen results in considerable production gain. For four hours of VDU work a day, this gain easily amounts to more than 30 minutes a day. And, with screens up to 26 inches, the greater the screen, the greater the production gain.

To prevent additional neck and shoulder strain resulting from the use of multiple screens, creating an ergonomic workplace with one or more monitor arms is recommended. A monitor arm makes it easy to adjust the viewing distance and the placement of the screens and also provides more room on the desk.

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About BakkerElkhuizen

BakkerElkhuizen develops excellent products for making computer use healthy and efficient. Products from BakkerElkhuizen display the perfect combination of function, ergonomics and design.

BakkerElkhuizen advises and helps companies equip their workplace, including offices that use telecommuting and flexible working, so that each workstation receives the right solution and the right accessories.

BakkerElkhuizen bases this on four workstation concepts:
- permanent workstation
- mobile workstation
- flexible workstation
- home workstation

The point of departure is that an employee must be able to perform his or her computer work comfortably, healthily and efficiently wherever he or she works. People come first in everything that BakkerElkhuizen does, whether it concerns developing new products, performing research or cooperating with suppliers, resellers and customers.

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References

- Working Conditions Provisions: Health and Safety (Display Screen Equipment) Regulations 1992 as amended by the Health and Safety (Miscellaneous Amendments) Regulations 2002

- Szeto GPY, Chan CCY, Chan SKM, Lai HY, Lau EPY. The effects of using a single display screen versus dual screens on neck-shoulder muscle activity during computer tasks. International Journal of Industrial Ergonomics. 2004: 44; 460-465

- Rabab T. Alabdulmohsen. Effect of single/dual monitor use on the behavior of neck-shoulder musculature. Master Thesis West Virginia University. Department of Industrial and Management System Engineering. Morgantown, West Virginia 2011

- University of Utah. Monitor Size and Aspect Ratio Productivity Research. A Comparison of Single and Dual Traditional Aspect Displays with a Widescreen Display over Productivity. 2008

- Colvin J, Tobler N, Anderson JA. Rocky Mountain Communication Review. 2004; 2(1); 31-53

- Mary Czerwinski, Greg Smith, Tim Regan, Brian Meyers, George Robertson and Gary Starkweather. Toward Characterizing the Productivity Benefits of Very Large Displays. Interact. 2003

- Sommerich CM1, Joines SM, Psihogios JP. Effects of computer monitor viewing angle and related factors on strain, performance, and preference outcomes. Hum Factors. 2001 Spring;43(1):39-55

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