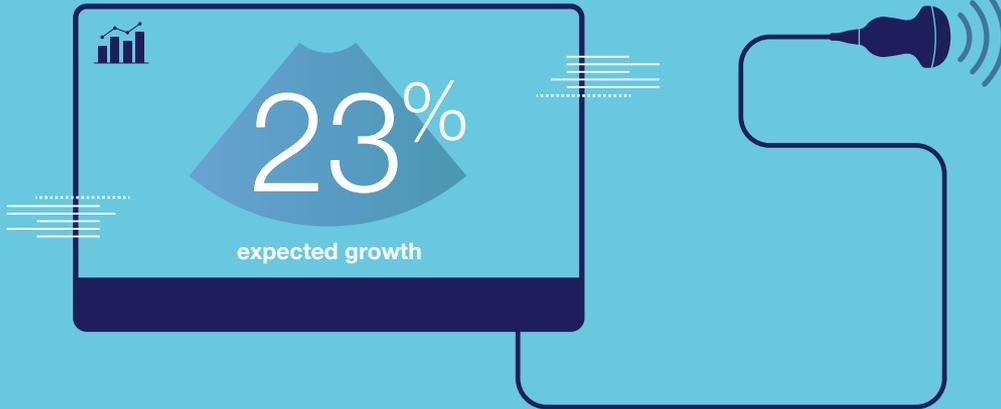


# Ultrasound Machine Comparative Study



## A fast growing profession, going freelance.



The diagnostic medical sonography market is expected to grow by **23%** between 2016 and 2026. Much faster than other jobs<sup>1</sup>

To meet patient demand, hospitals and clinics are turning more frequently to contract agencies for freelance or temporary sonographers.

More than ever before, **sonographers are expected to be able to quickly get up to speed on unfamiliar machines, in new environments**, without sacrificing patient care.

# Shortening the learning curve

Equipment that is easy to learn, and easy to use isn't just a nice to have. It is essential to the smooth running of any clinic or hospital.

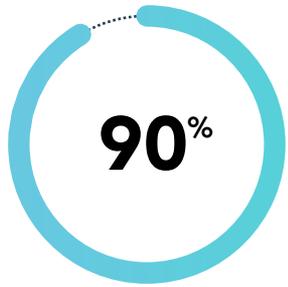
## Employers of sonographers are looking for:

- The use of protocols to standardize exams, so that temporary staff can be consistent with existing practices
- Equipment that can be quickly learned by new staff
- Rapid image acquisition and optimization to address time and resource pressures, without sacrificing diagnostic quality

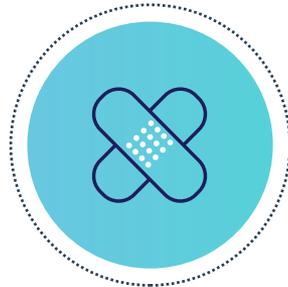


# Sonographers are in pain

**Everyone has the right to work and be safe from injury.**



**90%** of sonographers experience work-related pain for more than half of their career<sup>2,3</sup>



**20% sustain a career ending work related injury**



The repetitive stress of grasping heavy transducers and applying pressure on patients takes a harsh toll on sonographers bodies

## Sonographers are looking for

- Equipment designed with their bodies in mind
- Lightweight transducers and the ability to obtain a quality image without injury
- Equipment that lets them focus on the patient and the image, not the machine

# The Study

With these issues in mind, we wanted to put **leading manufacturers of ultrasound machines to the test.**

We compared the products across key criteria:

- Ease of use and learnability
- Image quality satisfaction
- Successful task completion
- Overall machine preference



**3** Ultrasound Systems



**44** Sonographers



**408** Images Acquired



**1,320** Tasks Completed

## We measured ease of use in 3 different ways:

---



After each task on each machine, we asked participants to **rate their experience** on a scale of 1 to 5



After participants had used each machine, we administered a **standardized questionnaire** about the usability of the machine<sup>4</sup>



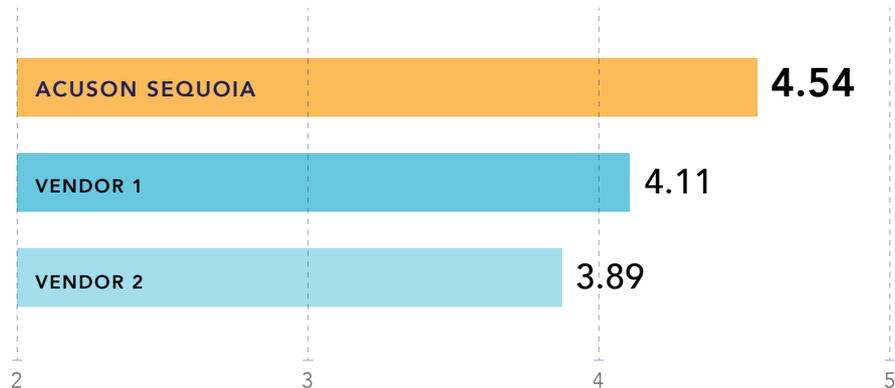
We tracked the successful completion of each task and **compared overall task success** rates

# ACUSON Sequoia with BioAcoustic Technology was rated the easiest

“On a scale of 1 to 5, where 1 is very difficult to use, and 5 is very easy to use, how would you rate your experience with this task?”

## Ease of use rating

1 is very difficult to use, 5 is very easy to use.



“ Everything is right there. I like that you don't need to go through different pages to get what you need.”

— Participant 40



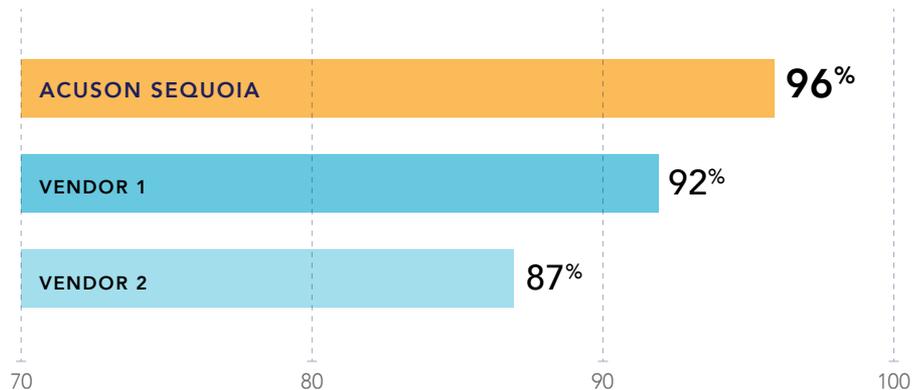
“ That's the best arrow probably ever. Usually it's really hard to get the right angle. ”

— Participant 7

# ACUSON Sequoia had the highest success rate

For each task, sonographers were allowed 3 minutes to complete it. If they were not able to complete it in that time, or if they gave up and asked for help before then, the task was marked unsuccessful.

## Tasks success rates



“Whoaaa that’s cool. It’s really smart post processing to take a signal like that and adjust to the right size. You don’t even need me! It picks up the color so easily. I’d have to work a lot harder on my machine.”

— Participant 26



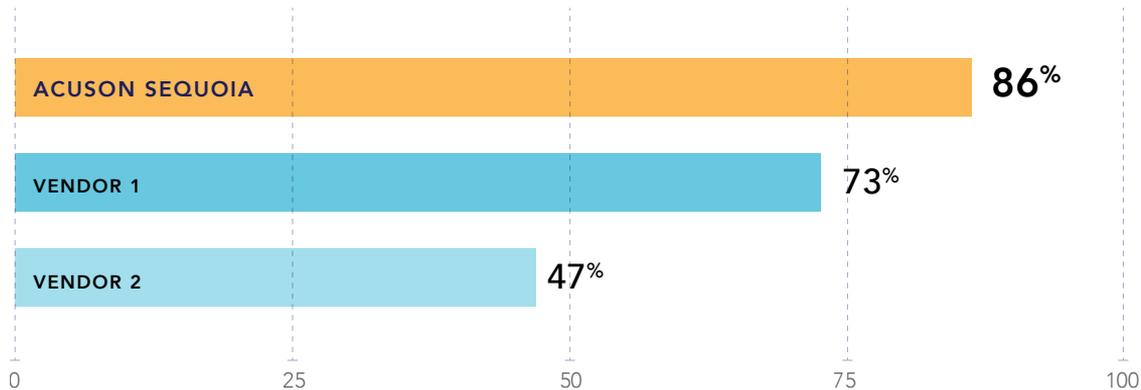
“I’m not used to seeing presets for color flow for specific vessels. It’s beautiful.”

— Participant 14

# ACUSON Sequoia had highest usability score

Participants were administered the standardized System Usability Scale questionnaire.<sup>4</sup> A rating of 85 or over puts the product in the 95<sup>th</sup> percentile of all products tested.<sup>5</sup>

## Average system usability score



“ This is awesome. These are the steps I normally take, but it does it automatically.”

— Participant 24



“ This is almost like an Apple design compared to the other one.”

— Participant 14



“ I love it. It's actually even kinda fun.”

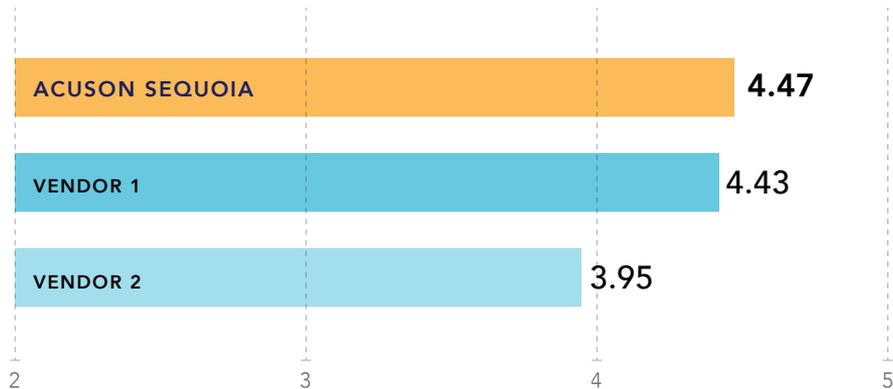
— Participant 30

# A tie for image satisfaction

“On a scale of 1 to 5, where 1 is very unsatisfied, and 5 is very satisfied, how would you rate your satisfaction with this image?”

## Image satisfaction rating

1 is very unsatisfied, 5 is very satisfied



“The images to me are gorgeous! You put the transducer down and the images come out.”

— Participant 44



“These images are beautiful. I would say even better than Vendor 1. And I don’t have to work hard to get them.”

— Participant 34



“The image quality is amazing!”

— Participant 30

# Sonographers strongly preferred ACUSON Sequoia

## Machine preference:

Of the two systems you saw today,  
is there one that you prefer?



82%

Prefer  
ACUSON Sequoia

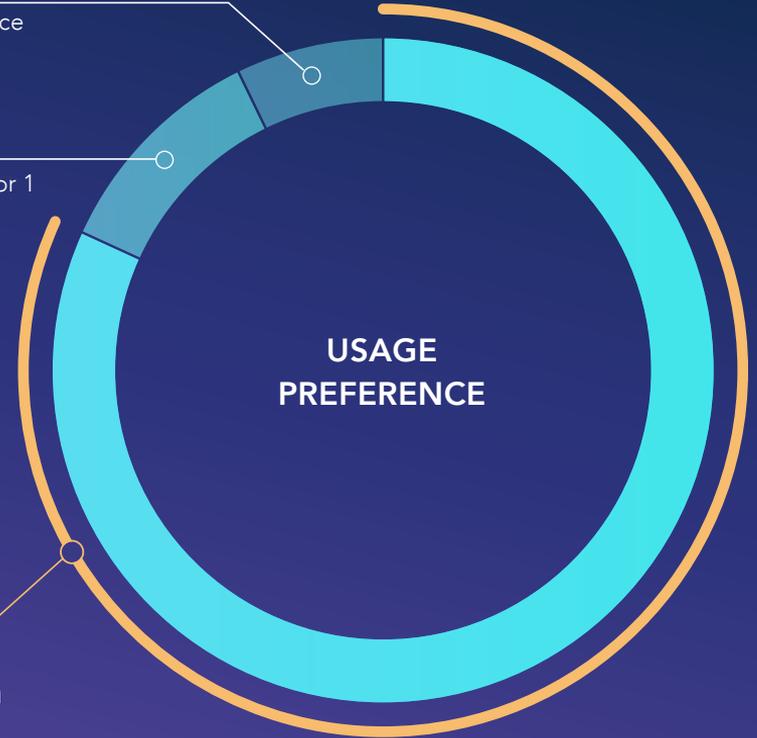
7%

No Preference

11%

Prefer Vendor 1

USAGE  
PREFERENCE



## Sonographers strongly preferred ACUSON Sequoia

---



Siemens definitely. I would trade in all three machines in my lab today for one beautiful system.

— Participant 44



Wow. We're in the process of getting new machines. I need to tell them to get this one.

— Participant 31



Hands down Sequoia is my preference. It's way better, and it's been a good 10 years since I used a Siemens.

— Participant 26

# Understanding the difference

**The ACUSON Sequoia elicited dramatic positive reactions which we rarely observe in product testing.**

- Clapping their hands with delight
- Dropping their mouths open and sitting silently for a few seconds
- In one case, a sonographer actually got up and hugged the machine

We attribute the unusually strong product preference to the ACUSON Sequoia's execution of "delighter features". These are unexpected features which address a need that users have not previously thought about, eliciting a strong positive reaction<sup>6</sup>.



# Delighter features in ACUSON Sequoia



## Double tap gesture to switch between transducers



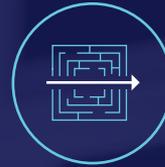
Seriously? Oh my gosh. OK. They win. Big gold star for that.

— Participant 24



Whaaaaat? I'm sorry. That is awesome. I'm very fond of this machine.

— Participant 30



## Speed and quality of Doppler image post-processing



The Pulsed Wave is awesome. I think of how often I struggle getting in there [to take an image] having them hold their breath. For people in pain and who are sick it's not easy. This saves a lot of time.

— Participant 26



You don't even need me!

— Participant 44

# ACUSON Sequoia was the standout leader

**ACUSON Sequoia was the clear stand out leader in our comparative evaluation of the three leading ultrasound machines.**

Sonographers had the highest success rate on the ACUSON Sequoia.

It received a higher ease of use rating on a per-task basis.

It was tied for first place for image quality.

It received a usability rating which places it in the 95<sup>th</sup> percentile of product usability.<sup>5</sup>

It was by far the most preferred machine.



# Detailed statistical information

**Table 1: Statistical significance for all results (p-values)**

| <b>Data Point</b>         | <b>p-value: ACUSON Sequoia vs Vendor 1</b> | <b>p-value: ACUSON Sequoia vs Vendor 2</b> | <b>p-value: ACUSON Sequoia vs combined</b> |
|---------------------------|--|--|--|
| <b>Ease of use rating</b> | 0.002                                      | 0.0000005                                  | 0.0000002                                  |
| <b>Success rate</b>       | 0.0036                                     | 0.0001                                     | 0.000001                                   |
| <b>Usability score</b>    | 0.009                                      | 0.000000008                                | 0.00000002                                 |
| <b>Image satisfaction</b> | 0.8  | 0.00005                                    | 0.004                                      |

Note: a "p-value" of less than 0.05 is considered statistically significant.<sup>7</sup>

Machine preference confidence interval is 5.7% (using a 95% confidence level). i.e. We are 95% sure that the "true" value is somewhere between 76.1% and 87.5%

# About Macadamian Technologies

---

We design and develop digital and connected experiences to improve healthcare.



Macadamian is a full-service software design and development consulting firm that provides a complete range of product strategy, user experience design and research, data and software engineering services. Ranging from big consumer brands to complex enterprise environments, our goal is to create solutions that are simple and meaningful, prioritizing the experience of the patient, the clinician, and the business needs of our clients.

**This study was sponsored by Siemens Healthineers.**

# Reducing experimental bias

We worked with experienced sonographers with expertise in each of the machines to **develop a set of tasks that did not favor one machine over another.**

Each sonographer performed the same set of tasks on **two different, unfamiliar systems.**

ACUSON Sequoia with BioAcoustic Technology was compared with ultrasound systems **of a similar class** from two other leading manufacturers.

Before using a new machine, sonographers watched a short training video for that system, and then had an additional 5 minutes to familiarize themselves with the system on a patient.

We **swapped the order of the machines** with each participant to eliminate any learnability bias.

For each sonographer, the same patient was the subject for both machines.

Sonographers were not informed of the study sponsor until after completing the study.



**Although this study was sponsored by Siemens Healthineers, we took several measures to minimize bias in the study design.**

# References

---

- 1 Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Diagnostic Medical Sonographers and Cardiovascular Technologists and Technicians, Including Vascular Technologists, <https://www.bls.gov/ooh/healthcare/mobile/diagnostic-medical-sonographers.htm>. Accessed February 25, 2020.
- 2 Murphey, Susan. Work Related Musculoskeletal Disorders In Sonography. Society of Diagnostic Medical Sonography. <https://www.sdms.org/docs/default-source/Resources/work-related-musculoskeletal-disorders-in-sonography-white-paper.pdf>. Accessed February 25, 2020.
- 3 Pallotta, Olivia, Roberts, A. (2016) Musculoskeletal pain and injury in sonographers, causes and solutions. Australian Sonographers Association: Sonography, vol 4, no 1 <https://onlinelibrary.wiley.com/doi/full/10.1002/sono.12093>. Accessed February 25, 2020.
- 4 System usability scale (n.d.) in Wikipedia. [https://en.wikipedia.org/wiki/System\\_usability\\_scale](https://en.wikipedia.org/wiki/System_usability_scale) Accessed February 25, 2020.
- 5 Saura, Jeff. (2011) Measuring usability with the System Usability Scale (SUS). <https://measuringu.com/sus/>. Accessed February 25, 2020.
- 6 Kano model (n.d.) in Wikipedia. [https://en.wikipedia.org/wiki/Kano\\_model](https://en.wikipedia.org/wiki/Kano_model). Accessed February 25, 2020.
- 7 p-value: usage (n.d.) in Wikipedia. [https://en.wikipedia.org/wiki/System\\_usability\\_scale](https://en.wikipedia.org/wiki/System_usability_scale). Accessed February 25, 2020.

