

A photograph of a hybrid operating room (OR) featuring a Philips Azurion with FlexArm C-arm. Two medical professionals in blue scrubs and masks are positioned around a patient on a table. The room is equipped with various medical instruments and a large monitor displaying a medical image. The Philips logo is visible on the C-arm.

PHILIPS

Azurion

Image guided therapy

More efficient use of lab and OR space using Philips Azurion with FlexArm

Philips Azurion with FlexArm supports advanced and multi-purpose use of labs and Hybrid ORs. Through its flexible, efficient design it enables hospitals to support new procedures, staff and suites for years to come.

Aging populations and rising rates of chronic disease have strained health systems around the world. New procedures and medical technologies are rapidly expanding to help relieve this pressure, yet a trend towards value-based care requires health systems to juggle external pressures and accommodate new solutions while also optimizing resources and minimizing cost.

Despite the challenges, health systems must integrate new solutions to transform patient treatment and to pioneer the future of healthcare. Interventional suites and hybrid operating rooms (ORs) are ripe for solution integration.

However, they often have the most expensive floorspace in a hospital and struggle to maximize cases due to inefficiencies such as room utilization, scheduling, turnover times, teamwork, preparation, recovery times and employee satisfaction¹.

This has significant implications for lab and OR managers who face a complex balancing act of maximizing the number of minimally-invasive and surgical cases completed by their staff, while working towards cost optimization. To do so, they must ensure their suites have a setup that allows multiple procedures to be performed in the same room, while reusing existing space as efficiently as possible.

What

Meta-study examining existing research literature to identify high impact opportunities to maximize the operational efficiency of lab/OR suites.

Challenge

Maximize the number of minimally invasive and surgical cases while optimizing resource utilization and minimizing costs.

Key results

Study revealed five areas in which FlexArm can help:

- Improvement of room utilization through combining multiple specialties in a multi-purpose suite
- Optimized flexibility combined with a compact cost-effective design, freeing up lab/OR space
- Support of new, more complex procedures, new staff and new suites through ease of use
- Reduction of procedure time through easy positioning, automatic patient alignment, reduced setup, and switching time
- Improvement of workflow for radial access and off-center imaging procedures, reducing costs associated with overnight stays

Lab managers must facilitate seamless switching and setup between teams as well as between increasingly complex procedures. Furthermore, they must manage staff satisfaction and motivation in light of the growing competition between hospitals/practices for top talent and ensure that the systems being used are easy to learn and intuitive to use. **In short, lab and OR managers must perform to the highest levels, while balancing numerous priorities, and be the beating heart of a hospital where the vision of value-based care is realized every day.**

Any solution employed by lab and OR managers to achieve these goals therefore must be both cost-effective and long-term. At Philips, improving the efficiency and quality of interventional procedures have been key drivers since creating the first interventional suite.

One extra patient each day

Azurion with FlexArm is the next step for Philips on its Azurion innovation journey. Through a partnership with St. Antonius Hospital, a leading interventional institute in the Netherlands and one of the first to install the Azurion system, Philips tested the ability of Azurion to maximize workflow efficiency and delivered economic proof with a clinical study during everyday use.

St. Antonius Hospital saw a reduction in patient preparation time (12%), procedure time (17%) and post-procedure lab time (28%), allowing one extra patient to be treated each day.

The Azurion ProcedureCards facilitate rapid setup for each new patient and allow physicians to pre-program their preferences so that a one-click operation accelerates their readiness. It avoids the need for a lengthy or complicated recalibration process at critical shift or procedure handovers.

At St. Antonius, the hospital's clinical protocols and checklists were integrated into the Azurion ProcedureCards. As the Azurion Procedure Cards are automatically and procedure-specifically executed, all clinical protocols and checklists are automatically made available at the start of the procedure, which positively impacted standardization.

In a simulation study 91% of physicians stated that ProcedureCards standardize their way of working, a significant improvement when looking to optimize speed, efficiency and room utilization². 100% of physicians in this study also believed that these checklists and protocols installed on the system will help minimize preparation errors.

“With the Azurion system, we were able to change our workflow in such a way that we now can do more patients in a single day, resulting in more patients a week, resulting in more patients per year, with no compromise to patient safety or quality of care.”

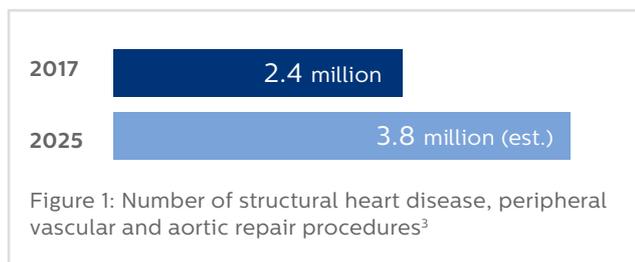


Marco van Strijen, MD,
Interventional Radiologist,
St. Antonius Hospital,
Nieuwegein, the Netherlands



Advanced procedures and multi-purpose rooms

Catheterization (Cath) labs, Angiography (Angio) suites and Hybrid ORs are a focal point of a hospital's ability to diagnose and treat its patients across a wide array of clinical areas quickly and effectively. However, operational inefficiencies can lead to frustrating delays and economic jeopardy. This is compounded by ever rising clinical demand, with the number of minimally invasive procedures growing, as well as the number of patients eligible for them (see Figure 1).



More flexibility is needed to address the different workflow requirements for these new procedures. An effective way to manage this is to perform as many of these procedures as possible in 'multi-purpose use' rooms, which allow for maximum utilization of resources and facilities.

The challenge is to configure a suite that works around staff, allowing them to easily switch between performing a wide range of therapies, while improving the workflow, staff experience and health outcomes in each. In developing Azurion with FlexArm, Philips collaborated closely with leading institutions to break down the daily tasks performed in labs and ORs and create a system geometrically and technologically capable of meeting this challenge (figure 2a/b/c).

With longstanding partner Miami Cardiac and Vascular Institute (MCVI), Philips developed Azurion with FlexArm. The unique geometry of FlexArm offers a new approach to image-guided therapy, providing increased imaging flexibility for diverse procedures. The system's 8-axis movements in combination with image beam rotation allows the C-arm a 270-degree range of movement around the patient table. This addresses the individual workflow setups in terms of staff and supporting equipment positioning, which differs depending on procedure type and complexity.

Radial access procedures without table repositioning

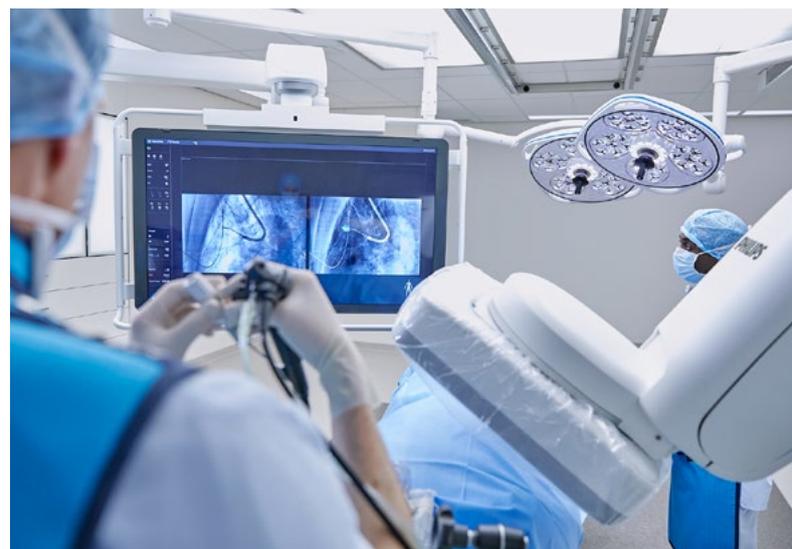
Besides full-body coverage from both table sides, the FlexArm geometry can also be moved laterally which enables physicians to keep the table position stable for the whole procedure. This streamlines the workflow for performing increasingly common upper extremity access procedures (i.e. via the radial, brachial or ulnar artery).

Consequently, the economic value of Azurion with FlexArm is not only reasoned by improved resource utilization with a true multi-purpose room setup but also by optimally supporting less costly upper extremity procedures (such as radial access).

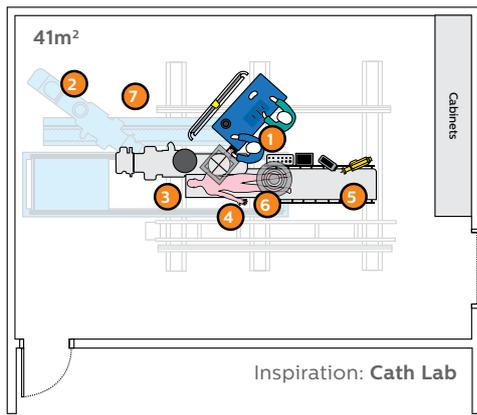
As such, radial access procedures have been shown to facilitate same-day discharge, avoiding costly overnight stays^{4,5}.

The corresponding benefits of swifter treatment, recovery and discharge deliver a huge dividend to health systems. In the US alone, estimates show that \$300 million a year can be saved with transradial access (TRA)⁴.

Azurion with FlexArm has been envisioned, designed and created to maximize the capabilities of Cath labs, Angio suites and Hybrid ORs by enabling advanced procedures and multi-purpose use while freeing up space for staff and vital equipment through its flexible, compact and cost-effective design. Next to single specialty use with FlexArm's flexibility and wide coverage and Azurion's ease of use and work flow features, hospitals are optimally enabled to build advanced multi-purpose rooms.



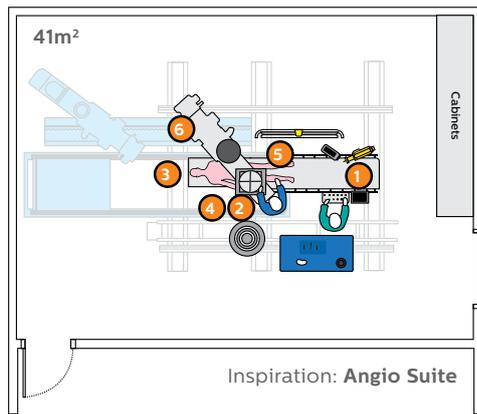
With FlexArm you can **perform basic and complex cardiac procedures in your existing Cath lab space:**



- 1 Doctor can also work on nurse side.
- 2 FlexArm is easy to park and takes up very little space which is beneficial in crash situations (e.g. with Structural Heart Disease procedures).
- 3 Free spot for echo cardiologist or anesthesiologist at head-end.
- 4 Easily align detector with anatomy to improve overall workflow. This allows you to perform radial access procedures with ease.
- 5 No need to pivot or reposition the table.
- 6 Catheters in patients of any length can always be followed from groin to heart.
- 7 Use away – standby function to maintain your setup. The system automatically moves out with the touch of one button, following the same path it did when coming in.

Figure 2a: FlexArm in cardiology procedures

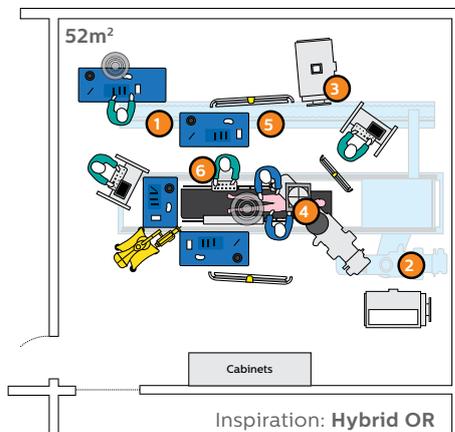
Broaden the set of vascular procedures in the Angio suite with the ease-of-use and flexibility of FlexArm:



- 1 Flow imaging of extremities without repositioning the table (e.g. Bolus Chase / SmartPerfusion).
- 2 Easy system positioning and alignment of detector for simplified dialysis shunt workflow.
- 3 Free spot for anesthesiologist at head-end.
- 4 Easy imaging of radial as Region Of Interest (e.g. AV graft).
- 5 Perform 3D acquisitions from 3 sides of the table (e.g. XperCT) depending on staff and equipment positioning.
- 6 Flexible system positioning (e.g. in a 45 degree angle) for fusion imaging during complex interventional oncology procedures such as transarterial chemoembolization (TACE).

Figure 2b: FlexArm in vascular procedures

Multi-purpose use in the Hybrid OR with FlexArm across a wide range of procedures:



- 1 Long rails that facilitate head-end and foot-end switching.
- 2 System can be parked in every corner of the room.
- 3 FlexArm provides more room to position necessary equipments like OR lights, anesthesia booms and radiation shields.
- 4 Follows the same path from away to standby and back with 'away-standby' function.
- 5 Good ergonomics during long procedures (e.g. FEVAR) for all staff members.
- 6 Intuitive user control (Axsys technology) that gives more independence to the clinical user and allows to position the system in an easy and predictable way.

Figure 2c: FlexArm in Hybrid OR setting



“A true multi-purpose suite. That’s what we have now. We can do a completely different type of complex Hybrid procedure in the morning from the one in the afternoon and, using Azurion ProcedureCards for quick setup, we can do each in a repeatable, standardized, efficient fashion.”



Barry T. Katzen, MD, Founder and Executive Medical Director, Miami Cardiac & Vascular Institute (MCVI) Baptist Hospital, Miami, USA

The true multi-functional focus of Azurion with FlexArm to facilitate an optimal procedure environment for various disciplines in a one-room setting can be seen in the practical use of its features.

In the Cath lab, Azurion with FlexArm’s ceiling-mounted 8-axis geometry allows optimal positioning for all staff, and frees up space for an echo-cardiologist and anesthesiologist at the head-end of the table in complex procedures, such as mitral valve clippings. The C-arm can also use longitudinal movements to follow devices from the groin to heart without the need for table repositioning.

Similarly, in Angio suites, the FlexArm system provides an optimal view of the anatomy during EVAR procedures while still having the flexibility to position the C-arm in any z-rotation (-135 to 135 degrees). This ability to move around staff and equipment means physicians can work in the position best suited to the procedure, with multiple staff and surgical equipment placed on both sides of the table. The lateral positioning and imaging capability of FlexArm on both table sides can be used for Shunt procedures with improved ergonomics.

Futhermore, the system’s versatile functionality and intuitive controls support multi-purpose use of Hybrid ORs, allowing physicians to smoothly switch from a minimally-invasive procedure to an open procedure when necessary – fast access is made possible by moving the C-arm away from the table to an automatic standby position with one simple move of the Axsys controller.

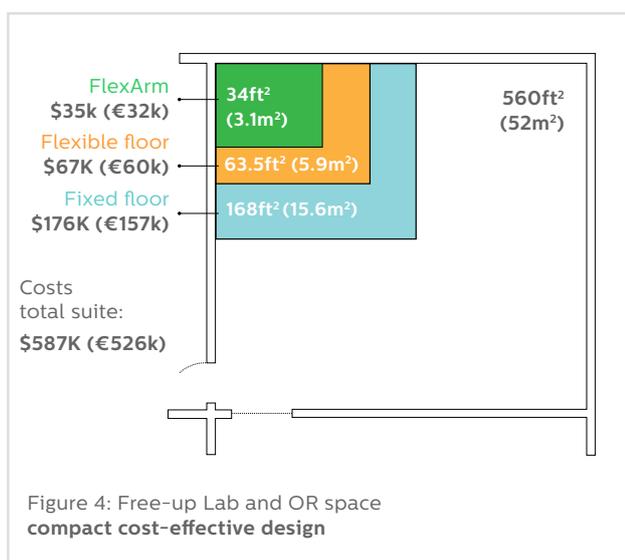
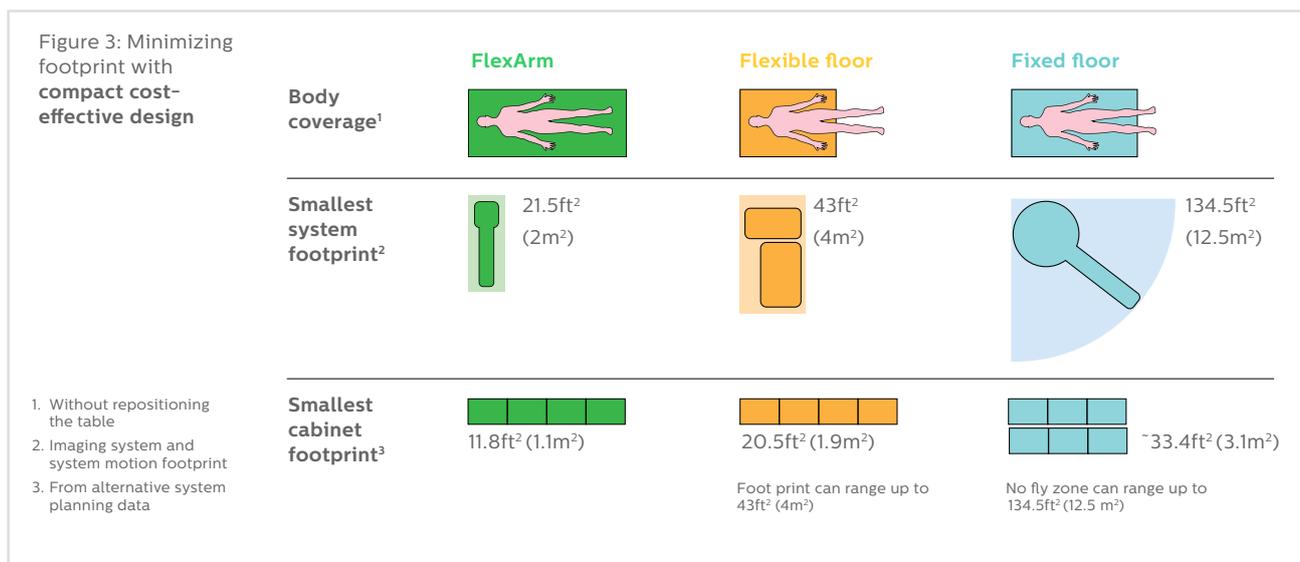
Sharing resources in this way is critical to maximizing operational efficiency while reducing resources and costs. By doing so in multi-purpose labs/ORs, OR managers are fulfilling their goals of reducing costs associated with expensive equipment and resources while maximizing the number of minimally-invasive and surgical cases.

Compact cost-effective design and procedure time reductions

Well-structured, high-performing interventional suites and Hybrid ORs are needed both now and in the future. An IMV survey of 203 USA hospitals showed that 60% were planning to install, or were considering installing, a Hybrid OR⁶. However, with current pressures on health systems to improve outcomes while reducing costs, any capital spend must be carefully considered, particularly in the context of interventional suites and ORs, which are the most expensive space in the hospital. Though costs vary per region, it is estimated based on a Dutch average that such rooms cost \$11,000 per 10.8 ft² (€10,000 per m²).

costly, and in order to optimize a return on investment, it is necessary to leverage it as efficiently as possible. The guideline size in the US for a Hybrid OR is 900ft² (84m²), with the installation cost ranging from \$831,011 (€745,935) and \$1,233,797 (€1,106,684) when factors such as civil construction costs, mechanical and electrical installation and fixed equipment are considered (see Appendix 1). In this context, minimizing the cost of installation is vital to delivering value. Next to ceiling mounted designs such as FlexArm, several types of systems are available for interventional suites including fixed floor systems and flexible floor systems, and each comes with its own qualities and limitations (see Figure 3 and Figure 4).

Installing and constructing a Hybrid OR is also



Fixed floor systems have a large footprint consisting of equipment and system movement area. The equipment area size determines how much equipment can be accommodated in the OR. The unpredictable movements associated with such a system mean that no equipment can be placed in an area of approximately 134.5ft² (~12.5m²) around the C-arm. These systems also have limited reach due to their geometry and design, capping the ability to image the whole patient (see Figure 5). In a standard 560ft² (52m²) interventional suite, the cabinet and system footprint will be around 168ft² (15.6m²) and cost ~\$176,000 (€157,000).

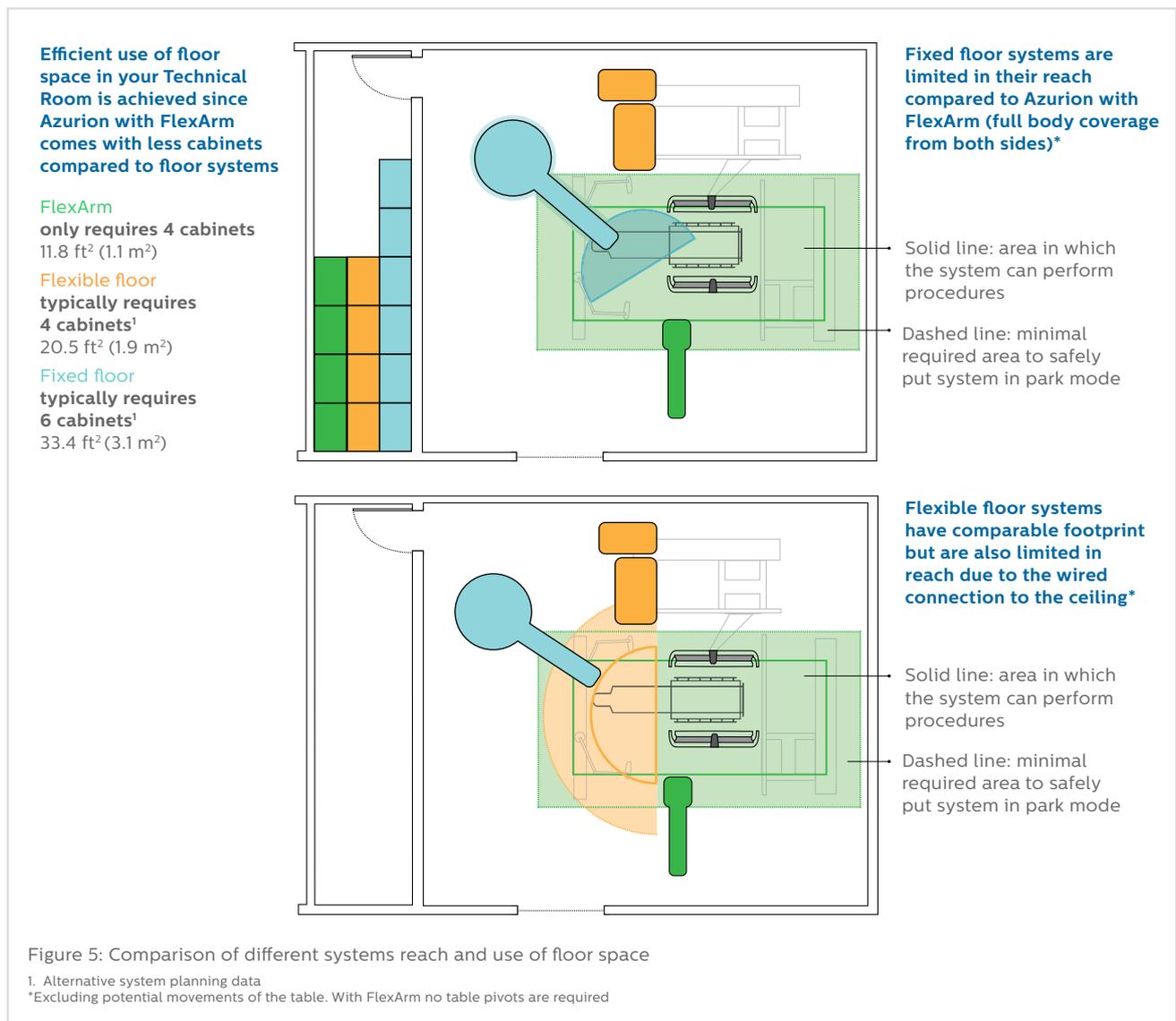
In contrast, Azurion with FlexArm's compact footprint (21.5ft²/2m²) as well as its predictable and controllable movement mean that less floorspace is lost compared to fixed floor systems. Azurion with FlexArm also delivers more efficient use of technical room floor space by having the smallest cabinet footprint (11.8ft²/1.1m² compared to ~33.4ft²/3.1m² for fixed floor systems). The cabinet footprint equates to a lower cost of \$35,000 (€32,000). Furthermore, the system geometry also means that imaging can be performed in a much larger area along the whole patient with no table pivots required.

Flexible floor systems have comparable footprints to Azurion with FlexArm, however they have limitations in reach due to the wired connection to the ceiling. While their system and cabinet footprint is less than that of the fixed floor system (63.5ft²/5.9m²), they still consume more space than the FlexArm system, and at a higher cost of ~\$62,000 (€56,000).

In all lab and OR contexts, Azurion with FlexArm's unique features and design can bring the benefits of an advanced interventional suite into a hospital's existing space.

The movement of the system, combined with the system's ease of use and minimal start up time, brings further economic benefits. These features work together to improve workflow and allow physicians to perform procedures in a faster, more efficient manner, saving time and therefore money.

76% of physicians agreed that by using FlexArm they could make more efficient use of their time spent in the suite, and 88% agreed that FlexArm would help them save time overall⁷.



A future-proof investment

Philips is dedicated to supporting hospitals and health systems in tackling the pressures of maximizing the number of procedures performed, while simultaneously working towards cost optimization. This is realized through creating specialized suites tailored to diverse clinical areas as well as combining multiple specialties in one multi-purpose lab or Hybrid OR.

As the Hybrid OR environment is expanding into new fields such as image-guided lung and spine procedures, we are committed to ensuring physicians are optimally supported and equipped to facilitate novel techniques in these areas. The system's capabilities have been rigorously tested with a view to support entirely new innovative procedures. Indeed, 93% of physicians in a simulation study agreed that Azurion with FlexArm's flexibility, provided by its unique 8 axis C-arm, can support such novel procedures².

Philips has worked extensively with physicians to ensure that Azurion with FlexArm's Axsys technology allows users to intuitively operate the system. This has translated to the system having a score of 92 out of 100 on the System Usability Scale (SUS) – an exceptional result. Once installed, Azurion with FlexArm can fit with the user interface of existing Philips systems to allow a seamless transition for current staff, and the system's own intuitive user interface is easy to learn for new staff entering the lab or Hybrid OR for the first time. Philips is acutely aware of the rapid rate of advancement in minimally-invasive procedures and has equipped the system to support hospitals long into the future as they welcome new staff and need to adopt new procedures in novel clinical areas.

“We're very excited about what this technology is going to do to our whole commitment to innovation. We now have one of the most unique environments in the world for physicians to create new procedures and new ideas.”



Barry T. Katzen, MD, Founder and Executive Medical Director, Miami Cardiac & Vascular Institute (MCVI) Baptist Hospital, Miami, USA



References

1 Reed GW, et al. Operational efficiency and productivity improvement initiatives in a large cardiac catheterization laboratory. *J Am Coll Cardiol* 2018;11:329-338

2 Evaluated with clinical users in a simulated lab environment

3 Based on Peripheral Vascular, Aortic Repair, Heart Valve and Structural Heart Closure Devices Report from Millennium Resource Group.

4 Costs Associated With Access Site and Same-Day Discharge Among Medicare Beneficiaries Undergoing Percutaneous Coronary Intervention, Amin A.P. et al., 2017

5 Evaluation of a protocol for same-day discharge after radial lounge monitoring in a southern Swiss referral percutaneous coronary intervention centre, Biasco L, et al., 2017

6 Survey European Society for Vascular Surgery 2014, Survey Society for Vascular Surgery 2014 (USA) and 303 survey participants.

7 Compared to the suites with Azurion 7 C20. Evaluated with clinical users in a simulated lab environment after approximately 20 minutes of practicing C-arm and table positioning.

Appendix

Appendix 1: In order to achieve a positive Return On Investment, expensive lab space should be leveraged most efficiently

Cost of construction of Hybrid OR	Netherlands	U.S. – NYC	U.S. – Miami
Total (900ft²)¹	\$ 948,134 (€ 850,584)	\$ 1,233,797 (€ 1,106,684)	\$ 831,011 (€ 745,935)
Civil construction Costs hospital ^{2,3}	\$ 245,010 (€ 220,164)	\$ 324,424 (€ 291,000)	\$ 218,512 (€ 196,000)
Mechanical ^{4, 5}	\$ 46,389 (€ 41,580)	\$ 59,996 (€ 53,815)	\$ 40,409 (€ 36,246)
Electrical ^{4, 5}	\$ 40,291 (€ 36,120)	\$ 52,109 (€ 46,740)	\$ 35,097 (€ 31,481)
Fixed equipment ^{4, 5}	\$ 26,243 (€ 23,520)	\$ 33,941 (€ 34,444)	\$ 22,861 (€ 20,506)
HVAC ^{4, 5}	\$ 590,201 (€ 529,200)	\$ 763,328 (€ 684,685)	\$ 514,131 (€ 461,162)

1 Hybrid OR space of 900NSF / 86m² in line with recommendation from Veteran Affairs: Surgical and Endovascular Services Space Design Standards Hybrid and Endovascular Rooms (p.11).

2 USA figures - Cost of new hospital per square meter; "Construction Cost per Square Foot for Hospitals", Dalvit, D., February 5 2011

3 NL figures - Cost of new radiology centre per square meter; "TNO-rapport Jaarbeeld Bouwkosten zorgsector" Bode, A., June 2010 (slide 34)

4 Philips cost estimate (based on internal Hospital planning data) for Netherlands.

5 For the USA costs of Netherlands are taken as basis for estimate



How to reach us

Please visit
www.philips.com/FlexArm

Results are specific to the institution where they
were obtained and may not reflect the results
achievable at other institutions.