A Clearer Picture of COMBINED VISION SYSTEMS

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In a world of acronyms, CVS is yet another to add to our list that in the avionics arena is already long enough. However, a CVS is powerful and represents a paradigm shift in the way we can operate our aircraft.

No longer termed a concept, CVSs are being implemented today in new aircraft platforms. The two primary players are Rockwell Collins with its Bombardier Global Vision Pro Line Fusion and Honeywell with its Gulfstream PlaneView cockpits. Other aircraft and avionics manufacturers are rapidly developing and incorporating versions of vision technology to meet a market niche. As pricing allows, CVSs will migrate into smaller and aftermarket cockpits.

SO, WHAT IS A CVS?

A CVS can currently consist of various combinations of four converging technologies integrated to a degree where the whole may exceed the sum of its parts.

Table 1: Below are the four CVS technologies.

EFVS*	Enhanced Flight Vision System	External real time imaging using a vision sensor with the intention of operational credit.
SVS	Synthetic Vision System	Computer generated imaging using aircraft altitude, attitude and current position.
HUD**	Heads Up Display	"Out the window" cockpit optical display system.
HDD	Heads Down Display	Flat panel cockpit displays or electronic flight bags.

** Infrared EFVS is currently the only version of this type of sensor in commercial aircraft.*

*** Although the size of HUDs are becoming smaller, such as the remarkable new Elbit/Kollsman AT-HUD, their size and headroom limits currently dictate a narrow range of candidate aircraft.*

EFVS refers specifically to an external real-time imaging system designed and integrated into an aircraft with the intention of use in operations for credit. On the other hand, an EVS system refers to any external real-time imaging system that may, for example, be used for situational awareness.

Versions of these four technologies have been in the marketplace for a number of years. But, a combination of innovation, physical parameters and integration are providing benefits beyond what each alone can provide. The most powerful part of this jigsaw, however, is the enabler – FAA guidance material.

In 2010, the FAA issued Airworthiness Circulars AC20-167 and AC90-106, one of which provides minimum standard airworthiness criteria. The other is used for operational certification, not just for one of these technologies, but for all in varying configurations. Further, document DO 315A EFVS completed, DO 315B SVS and DO 315C Zero/Zero Operations in work via RTCA SC213, will provide the

EVS behind HUD symbology

means for lower and to zero, visibility operations. A suitable combination of existing or other sensor technologies may emerge to meet the zero visibility minimum performance standards – the ultimate goal.

The key of the ultimate solution is reliable and consistent zero visibility landings, taxi and reduced take-off operations in all weather conditions. This is in addition to other benefits that vision sensors and data-based computers can and do provide.

Below is a series of charts showing the various technologies and how they drive different credits. A credit is a specific operational benefit derived from the application of the FAA ACs.

Table 2: Below is the current and future status of credits in each aircraft operations category.

*Operation**	*Lower landing limits*	*Lower take-off limits*	*Approach ban clearance*	*Taxi operations*
PART 91	Yes	NA	NA	NA
PART 135	Yes	Yes	Yes	RTCA
PART 121	Yes	Yes	Yes	RTCA

** In EU Ops, the same flight rules apply for all three different categories of aircraft.*
NA – not applicable.
RTCA – refers to being "in work" by RTCA SC213 special committee.

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Table 3: Below is the technology combination driving the credit, current and future.

Technology	Lower landing limits	Lower take-off limits	Approach ban clearance	Taxi operations
EFVS w HUD	Yes	Yes	Yes	RTCA
SVS w HUD	RTCA	RTCA	RTCA	RTCA
EFVS w HDD	RTCA	RTCA	RTCA	RTCA
SVS w HDD	RTCA	RTCA	RTCA	RTCA

RTCA – refers to being "in work" by RTCA SC213 special committee.

Table 4: Below is the actual and possible near future credits.

Technology	Lower landing limits (ft)	Lower take-off limits (ft)	Approach ban clearance	Taxi operations
CAT I – ILS w/o EFVS	200	NA	NA	NA
CAT I – ILS w EFVS	100 (EU 1/3RVR)	RTCA	Yes	RTCA
WAAS-LPV w/o EFVS	300-200	NA	NA	NA
WAAS-LPV w EFVS and HUD	100 (EU 1/3RVR)	RTCA	Yes	RTCA
NPA w EFVS and HUD	100 (EU 1/3RVR)	RTCA	NA	RTCA
SVS w HUD	150 (RTCA)	RTCA	RTCA	RTCA
EFVS w HDD	RTCA	RTCA	RTCA	RTCA
SVS w HDD	RTCA	RTCA	RTCA	RTCA

NA – not applicable.
RTCA – refers to being "in work" by RTCA SC213 special committee.
NPA – non precision approach.

The tables clearly indicate that there are many credits still to be had as manufacturers posture and RTCA develop minimum aviation system performance standards by consensus-based debate. As the technologies evolve and better integrate, they begin to meet the minimum performance standards. So, the case for actual credit is made more compelling.

A combination of EFVS and SVS may drive bigger benefits, but unlikely in the near future to meet the ultimate goal, despite converging improvements. With new industry acronyms representing significant milestones such as BEVS, SEVS, AVS and terms like Fusion, we are sure to get there eventually.

Table 5: Below are some of the requirements of the two technologies currently in use.

Requirement	EFVS	SVS
Need GPS	No	Yes
Need database	No	Yes
Sufficient external visibility	Yes	No
Database	No	Yes
Ground infrastructure	Yes (airport/approach lights)	No
GPS Satellites	No	Yes (for orientation)

Table 6: Below are some of the 'non-credit' benefits of the two technologies currently in use.

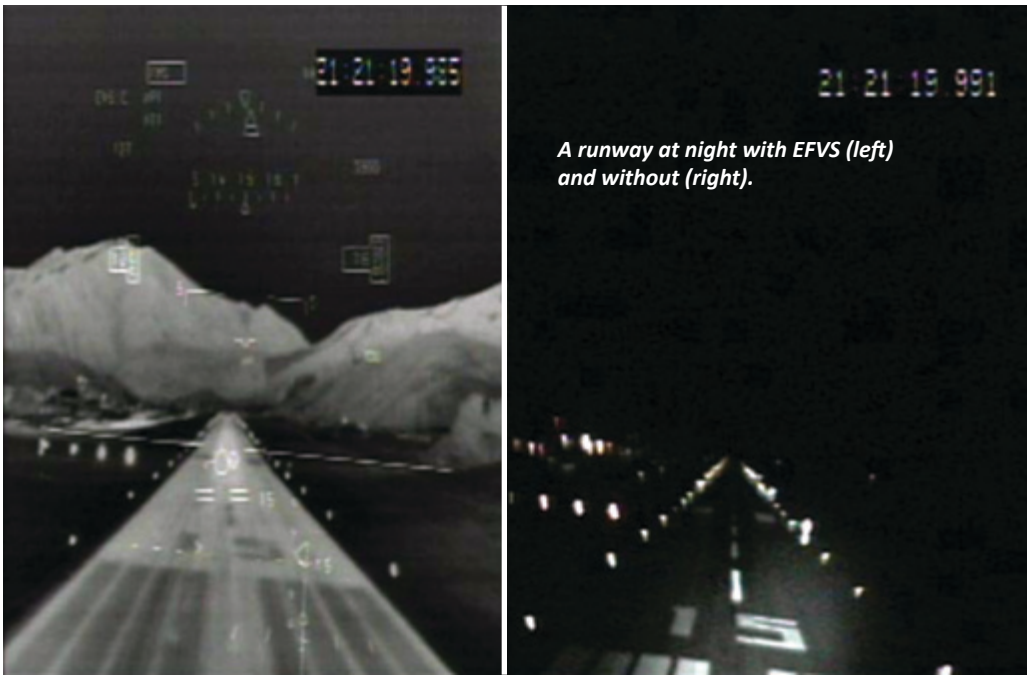
Benefit	EFVS	SVS
Situational awareness	Yes	Yes
Night into day	Yes	Yes
Accurate landing within TDZ*	Yes w HUD FPV**	No
Unusual attitude display	Yes w HUD	No
Fuel and ops cost saving	Yes	Yes

**** Touch down zone.***
***** Flight path vector.***

Current certifications for operational credit require the integration of EFVS and existing aircraft flight data on a HUD. The certified systems are approved for use under FAR 91.175 that does not change but provides an alternative means to operate during low visibility conditions that equates to the human eye. Today, only two cooled EFVS sensors are approved for credit.

Appropriately qualified EFVS operators may conduct WAAS/LPV, ILS or NP approaches and then complete Category I lower landings in poor visibility conditions today.

So, what CVSs could provide is the ability to taxi, take off and land with the advantage of high resolution situational awareness and the current application of limited FAA low-visibility operations in most weather conditions. This could eventually extend to full FAA and international operational credit in all weather conditions as soon as the technology meets the enabled minimum zero visibility requirement. International operations may then follow suit.



A runway at night with EFVS (left) and without (right).

More than 1,200 aircraft are currently outfitted with either Elbit/Kollsman or CMC EFVS systems able to take advantage of various operational credits. Many more include basic EVS and SVS configurations. CVSs are being embraced by more aircraft and avionics producers each year, while their research and development departments pursue smarter means of inching closer to the ultimate goal.

It has taken nearly 70 years to break the limit of 200-foot landing minimums for Category I or less, achieved by our old friend ILS. While Category II and III operations are possible for some, they require aircraft, crew and ground infrastructure re-certification that may not be maintained for much longer. Even better, with a CVS, the operation is not limited to certain airports or runways. As with RNP/WAAS (LPV), the limit is the approach and aircraft equipage not the ground infrastructure. While the WAAS (LPV) can bring you down to ILS like DH/DA limits, a CVS transitions from there.

A future ultimate solution scenario could therefore be:

In zero visibility, taxi from the ramp or gate to active runway, take off, climb and conduct the en route flight plan day or night with panoramic situational awareness, complete state-of-the-art continuous descent approach, transition to land in zero visibility and have clear vision all the way. This also provides the flight operations manager the confidence to plan and execute trips from and to all locations throughout the year.

As NextGen is mapped and implemented, those best equipped will be best served. A CVS equipped aircraft will be cockpit centric, and therefore, more self-sufficient in flight operations. ❑