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Missile Defense Agency
Confusing Video Games with Reality

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Executive Summary

The recent demonstration to journalists by the Missile Defense Agency (MDA) of its missile defense simulation software was a misleading exercise that failed to address key issues about the limitations of computer simulation, especially at this stage of the test program. This has prompted the Union of Concerned Scientists to set the record straight on two issues:

First, MDA assumed an unrealistically high value for the probability that an interceptor will intercept an incoming warhead. Doing so leads to a situation where additional interceptors can make a significant difference in the overall outcome of an attack. A much more realistic assumption is a low probability of intercept--in which case more interceptors do not help much. The MDA assertion that the system will be more effective if more interceptors are deployed is specious.

Second, the MDA argues that its computer simulation can accurately predict the reliability of its missile defense against a real-world attack--and that this is demonstrated by the program's ability to accurately model the trajectory of the missiles that the United Stated has used in its flight tests. This argument is very misleading. While modeling US missile trajectories is a necessary part of modeling an engagement, it is not nearly sufficient. The complete model will likely have limited predictive value since it will require making assumptions about the characteristics of the attacking missile and incoming warhead, which the United States will not know in advance. Moreover, without intercept tests against a variety of incoming warheads the simulation cannot be validated using real data. Such tests have not taken place and are currently not planned.

Introduction

As part of its publicity campaign for the upcoming deployment of a ground-based missile defense system later this year, the Missile Defense Agency (MDA) invited seven reporters to test-drive its missile defense simulation software.[1] While MDA says that such simulations are useful for training, MDA officials, including MDA Director General Ronald Kadish, have gone well beyond this and claim that the software will provide valuable information about the effectiveness of the defense system. But, as we discuss in more detail below, the MDA computer simulation says very little about what would happen in a real world attack.

Kill Probability of Interceptors is Key, and Unknown

The outcome of any computer simulation depends on what parameter values are put into it. One of the most important parameters for missile defense is the probability that an interceptor will hit its target—the "kill probability."

Incredibly, the simulation reported on in the March 17 editions of the *New York Times* and *Washington Post* assumed the extremely high kill probability of 91%. The Pentagon is, of course, free to put any numbers it wants into its simulation. But it is important to understand whether the numbers it uses are realistic enough for the simulation to be meaningful.

In fact, the United States has no basis for assuming any value for the kill probability. It has not conducted a single flight test of its midcourse missile defense system under conditions that are remotely realistic—even leaving aside the issue of countermeasures. As MDA admits, the tests have had very significant limitations and artificialities. For example, in all cases, the interceptor and attacking missile have followed the same trajectories, the intercepts have had artificially low closing speed, and the defense has relied on *a priori* info about the warhead appearance and its trajectory.

Moreover, assessing the system's kill probability will require a series of flight tests conducted under a range of realistic conditions—which will not happen for years, if ever.

A much more realistic assumption for the kill probability of the interceptors is a value close to zero. As several authoritative assessments have shown,[2] the United States must assume that any real attack would be accompanied by technically simple but potentially devastating countermeasures that would defeat the defense by severely reducing the kill probability of the interceptors.

At least some reporters thought the simulation was intended to convey the message that the system capability was limited by the number of interceptors. This claim was also made by

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[1] James Glanz, "Missiles Incoming, and You're President," *New York Times,* 17 March 2004; Bradley Graham, "Simulated Attacks Repelled In Antimissile War Game," *Washington Post*, 17 March 2004.

[2] See, for example, National Intelligence Council, "Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015," September 1999; Sessler et al., *Countermeasures* (Union of Concerned Scientists/MIT Security Studies Program), April 2000.

General Kadish in his recent testimony to the Senate Armed Services Committee (SASC). Kadish argued that the key limitation of the missile defense system planned for deployment this year was not the kill probability but the number of interceptors:[3]

> "The system we initially will put on alert is modest. It is modest not because the inherent capabilities of the sensors and interceptors themselves are somehow deficient, but rather because we will have a small quantity of weapons."

This statement is not true. For a missile defense system to be effective, the primary issue is not the number of interceptors, but the kill probability—which depends critically on the capabilities of the sensors and interceptors. Moreover, MDA itself has previously acknowledged that the system to be fielded this year is deficient because it is missing a key component—an X-band radar.

If the kill probability is low, even large numbers of interceptors won't help.

For example, the simulation described in the press assumed six interceptors were available to intercept four incoming warheads, and that all four warheads were destroyed. But what would the simulation look like if the probability that an interceptor will hit its target is 10% rather than 91%? In this situation, the probability that at least one warhead gets through is 99.9%.

Even if you had 20 interceptors to fire at the four warheads, there is still an 88% chance that one or more of the missiles will penetrate the defense. Said another way, there is only a 12% chance that the defense will destroy all four missiles.

For Gen. Kadish or others to imply that the number of interceptors available to the defense is the key determinant of effectiveness is simply wrong. These claims appear to be part of an effort to convince Congress to fund its request for 20 additional interceptors to be deployed in the next few years—despite the fact that these interceptors have yet to be used in an intercept test.

Deceptive MDA Claims About Utility of Simulations

Disturbingly, MDA has gone well beyond describing the simulation as a useful "training tool." Gen. Kadish has also claimed that MDA's simulation software will provide valuable information about the effectiveness of the defense system to be deployed later this year, which was apparently a point the demonstration to reporters was intended to make. In his SASC testimony last week, Kadish stated:[4]

> "[O]ur modeling and simulation capabilities are very accurate and allow us to mirror the achieved outcome of a flight test. The graphic below provides an example of why we

[3] Lieutenant General Ronald T. Kadish, "Missile Defense Program and Fiscal Year 2005 Budget" Testimony before the Senate Armed Services Committee, 11 March 2004, p. 12. Available at http://armed-services.senate.gov/statemnt/2004/March/Kadish.pdf

[4] Kadish testimony, 11 March 2004, p. 17.

> believe our simulation capabilities to be the most powerful tools for projecting the reliability of the initial BMD system."

However, the graphic that Gen. Kadish showed was the speed of a missile interceptor during its boost phase in a recent test. The agreement between the computer model and flight data demonstrated that the Missile Defense Agency was able to model the missile with a high degree of accuracy. While the agreement may be impressive, it is not surprising since the booster engine characteristics are known in detail, and the Earth's atmosphere and gravity are known and can be taken into account.

The officials who ran the recent simulation for reporters used the same argument, stating that their model accurately depicted the real world performance of the system because it was "based on years of study" and "that the models have accurately predicted flight performance in a number of previous tests."[5]

But being able to write a computer model of a missile trajectory that predicts "flight performance" of an interceptor is completely different from being able to develop software that indicates anything about the outcome of a real engagement. The flight performance of the interceptor will indicate whether it has enough time to reach the incoming warhead for a given attack scenario. But modeling an engagement requires making assumptions about the characteristics of the attacking missile and incoming warhead, which the United States will not know in advance (despite the assumptions underlying the flight testing program). These assumptions will in turn affect many other parameters that are key to accurately modeling an engagement—such as the probability that the sensors will accurately identify and track the target, and the probability that the interceptor will home on and destroy the target.

It is simply wrong to say that the ability to model a missile trajectory indicates anything about the "reliability of the initial BMD system." Moreover, this is not a trivial point since the MDA has conducted so few flight tests that it will rely on its computer models to assess the military utility of the deployed system.

Either Gen. Kadish is being deliberately deceptive, or he fails to understand the severe limitations on what can be learned from simulations. Neither is very assuring.

[5] Graham, "Simulated Attacks."