This is certainly a revolutionary interpretaiton. The authors do not claim to have written the last word on the subject, but it would be a very foolish person who, in the future, wrote about the convict period without taking account of the argument in this splendid book. It should also help the curious tourist to understand that out beautiful colonial buildings were built not by thieves and vagabonds but by skilled tradesmen.

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Guns for the Tsar: American Technology and the Small Arms Industry in Nineteenth-Century Russia *by Joseph Bradley**
(Northern Illinois University Press, De Kalb, Illinois, 1990), pp. xi + 274, $US27.50, ISBN 0-87580-154-4.

One of the more remarkable episodes in the recent Gulf War was the presence of US Navy officers on board Soviet ships patrolling the Gulf area in what was described as "an unprecedented post-war act of co-operation" between the two superpowers[1] Perhaps post-war, but co-operation between the United States and Russia in military matters is no new thing, as this interesting and readable volume makes clear. The author's main subject is Tsarist Russia's efforts, following the country's humiliating defeat in the Crimean War, to update its military capability by adopting the latest small arms technology, then mainly emanating from the United States. In focusing on this topic, Bradley endeavours to draw some general conclusions concerning the transfer of technology from an industrially advanced to a relatively backward country. He argues that, by and large, the development of a naturalised, state-run arms-making industry in Russia, adapting the work organisation and parts exchange techniques of firms like Colt to local conditions was a success, and significantly contributed to the country's transition from a feudal to a machine-based economy without the need of an intervening craft stage. Moreover, in an Epilogue to his concluding chapter, Bradley suggests that the Soviet development model, based on centrally planned production and procurement, perhaps lies less in Soviet ideology as in a legacy of pre-revolutionary military industries.

One may question whether a small arms industry, based in three state armouries (Tula, Sestroretsk and Izhevsk) can bear the weight of such an interpretation; nevertheless, Bradley would seem to have a point to make in stressing the importance of armaments production in Russia's mid-to-late-19th century industrial transformation, a topic which frequently receives no mention at all[2]. Certainly, for a country defeated on its own soil at Crimea, largely through trying to meet British and French rifled firearms with a range of 1,200 yards, with smoothbore muskets with 300 yards range (though at least one recent author disputes this[3]), Russia's emergence as a major world power within a generation — to the extent of causing serious worries to the garrison at far-flung Fort Lytton in Queensland, who were concerned about Russia's possession of machine guns during the 'Russian Scare' of 1885[4] — was a remarkable

* I am grateful to Maurie Albert, Margaret Campbell and Jana Kahabka for help in preparing this review.

achievement. By early 1919 the new Soviet Government, though cut off from the west and pressed on all sides, was making and mending its own light artillery[5].

This economic self-sufficiency can be seen as a direct legacy of Minister of War (1861-81), Count Dimitrii Miliutin's policy of eliminating reliance on foreign arms purchases. As Miliutin explained in a memorandum to a Colonel Alexander Gorlov, who had expressed a preference for the military qualities of the British-made Martini-Henry rifle, "Russia is not Egypt, she is not the Papal States, to limit herself to orders to equip her army. We must build our own factories so we can make our own weapons in the future" (p. 119). Miliutin's foresight in choosing a Russian adaptation (called Berdanka) of the American inventor Hiram Berdan's Berdan 2 rifle, with its sliding-bolt action, metallic cartridges and ease of maintenance under a licensing agreement with Berdan and the Colt Company (who initially supplied machinery to the Tula armoury), over the block-breech Martini-Henry (which had a tendency to blow up in the soldier's face when not serviced properly[6]), is shown by the fact that the Berdanka was still being used in World War I, in the Russian Revolution and in the Civil War of 1918-20.

There are, according to Bradley, circumstances in which state-run enterprises *can* be more efficient (a timely observation in this current climate of seemingly uncritical acceptance of the benefits of privatisation). As he notes, conservative, risk-adverse behaviour and the fear of loss among manufacturers has frequently constrained innovation and the diffusion of new technology. Armaments production is an illustration of the positive role that state intervention, on the other hand, can take. As Bradley explains (though, of course, he is not the first to do so[7]) that the Government armouries at Springfield and Harpers Ferry had more time and money to pursue the development of interchangeability of parts (later taken up by Colt and other firms) — an extremely valuable quality on the battlefield — and were able to lead the way in this characteristic feature of 19th century American manufacturing technology, which was later to revolutionise the production of a whole range of civilian products, from sewing machines to bicycles and agricultural implements. Once initiated, this new direction in manufacturing technology was bound to profoundly influence developments in the machine-tool industry which, in turn, fed back into armaments production. With regard to Russia specifically, Bradley notes that before 1868, when calipers appeared in that country, even mechanics and opticians could not measure more precisely than 0.6mm. With the adoption of the Berdan rifle, however, and the decision to manufacture metallic cartridges, greater precision (of the order of 0.006mm) was required. By 1893, according to a catalogue of Russian exhibits prepared for the Columbian Exposition in Chicago that year, it was "no longer difficult to limit the dimensions of the cartridge to 0.001 of an inch and of instruments to 0.0001 of an inch" (p. 165).

It is indeed difficult to see how any of this could have been achieved through a reliance on market forces in a country as steeped in traditional ways of doing things as was mid-19th century Russia. Even if craftsmen-gunmakers working for private entrepreneurs could have been encouraged to modernise their product, it is unlikely that they would have been able to supply the large quantities of arms at short notice required in times of war (as was to occur with Turkey in 1877-8, and which Russia won with the help of modern weaponry). In any case, Minister of War Miliutin and others' perception that a government which cannot easily produce arms in wartime leaves itself "at best a hostage of rapacious producers, middlemen, and foreign suppliers, and at worst defenceless" (p. 7) would appear to carry a certain degree of cogency. It is interesting to see that just such an argument was recently used by Australian metalworking unions,

who have claimed that the Australian defence industries decision to close three of its 12 plants (which will mean the loss of 1,500 jobs) resulted from the company's preparedness to "put its own profits before Australia's defence"[8].

Guns for the Tsar is a well-documented (the author has consulted a wealth of Russian-language primary material), highly readable and suprisingly contemporary contribution to the literature on technology transfer.

NOTES AND REFERENCES

1. *The Australian,* 3 September 1990.
2. See, for example, C.D. Darlington, *The Evolution of Man and Society,* Simon and Schuster, New York, 1969, pp. 554-60; B. Supple, 'The state and the industrial revolution 1700-1914', in C.M. Cipolla (ed.), *The Fontana Economic History of Europe,* vol. 3, Fontana/Collins, Glasgow, 1980.
3. Maurice Pearton *(The Knowledgeable State,* Burnett Books, London, 1982) argues that "In the Crimea, the Anglo-French forces had rifles but the troops used them in the same way as the short-range, less accurate muskets with which the Russians were armed" (p. 27).
4. 'Defence, colonial style', *Sunday Mail Magazine* (Brisbane), 24 March 1991.
5. A. Ransome, *Russia in 1919,* B.W. Huebsch, New York, 1919, p. 155.
6. R. Kipling, *Soldiers Three,* London, Macmillan, 1911, p. 105.
7. See E. Ames and N. Rosenberg, 'The Enfield Arsenal in theory and history', in S.B. Saul (ed.), *Technological Change: The United States and Britain in the Nineteenth Century,* Methuen & Co., London, 1970.
8. *The Metal Worker,* February 1991, p.5.

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Multiple Exposures: Chronicles of the Radiation Age *by Catherine Caufield* (University of Chicago Press, Chicago, 1990), pp. vi + 304, $US15.95, ISBN 0-226-09785-4 (pbk).

Catherine Caufield has written an important book on an important topic: the history behind the safety standards limiting the effects of high energy radiation on human beings. She starts her book with a series of questions such as: "Are we delegating too much power and responsiblity to technical experts," and ". . . how well are we protecting ourselves and our descendants?" (p. viii). There is a great deal of fear of the dangers of radiation and this book provides a mass of information in a very readable form that will help to dispel the ignorance of those willing to inform themselves. However, I suspect that fear of the unknown will often be replaced by fear of the known!

Part I starts with the discovery of X-rays by Roentgen in 1895. It was only a matter of weeks before the public were aware of the amazing ability of an X-ray photograph to show bones, flesh being transparent to the new radiation. Within a year the dangers of X-rays became apparent, one of the first victims being Edison's assistant, Clarence Dally, who experienced loss of hair and skin ulceration. Eight years later, after much pain, Dally died of cancer. Simple precautions were taken to limit unnecessary exposure to X-rays by such means as lead screens and limiting the size of the beam, but for 40 years or longer this was rendered ineffective by inappropriate usage by many medical and other practitioners. Women were particularly at risk, as in the use of X-rays to remove excess hair in beauty parlours.It is appalling to realize that one of the main perpetrators was a physician, Dr Albert Geyser, who founded the Tricho Institute, which leased X-ray machines to beauty parlours. While the uses and abuses